FOOD RESEARCH ARCHIVES

of

CHERL-HO LEE
KORPA UNIVERSITY

With the Compliments of
Cherl-Ho Lee
August. 19. 2010

Commemoration of the Retirement of
Professor Cherl-Ho Lee, Korea University
Hanrimwon, August 2010

To m lo ing ife, Se ng-Ok Ro
and h ee da gh e ,
J ng il, Moon il and Han il

What are Archives?

In the course of daily life, individuals and organi ations create and keep information about their personal and business activities. Archivists identify and preserve portions of this recorded information that have lasting value.
These records - and the places they are kept - are called "archives." Archival records take many forms, including correspondence, diaries, financial and legal documents, photographs, and sound recordings.

- Archives Center, National Museum of American History,
Smithsonian Institution, January 1993.

Professor Cherl-Ho Lee honored by Red Stripe Service Merit Medal of Republic of Korea on June 5, 2009, in recognition of his work on national food safety and policy development

Order of Civil Merit, Seongnyu Medal, received in 1998.

Order of Service Medal, Red Stripes, received in 2009

In Memory of Prof. Ro(Mrs. Lee)'s Doctoral Degree in Nursing, Jungsil's M.A. degree in Art History, Moonsil's B.A. degree in East Asian History and Hansil's Bachelor degree in Music in 2002

Prof. Lee's Family photo taken on Hansil's wedding day, July 11, 2009. (From left to right, second daughter Moonsil and her husband Jinhyung Kim, first daughter Jungsil and her husband Yongjeen Jin, and third daughter Hansil and her husband Sooyoung Moon. In the center, grandchildren Diane Kim and Wonjang Jin).

Excellent Research Paper Award, Korean Federation of Science and Technology Societies, 29/4/1994.

Academic Achievement Award, Korean Society of Food Science and Technology, 17/6/2010

2010 IFT Fellow Plaque and Announcing Board at IFT Annual Meeting,
McCormick Place, Chicago, USA, July 17, 2010
(IFT: Institute of Food Technologists, USA)

Prof. Cherl-Ho Lee at IFT Award Ceremony, McCormick Place, Chicago, USA, July 17, 2010

A photo taken with Dr. Marianne Gillette, President of IFT

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Prologue

Born as the youngest son among five siblings, a refugee child from the north, now belong to North Korea where father was imprisoned as a political offender, to the south. Shy and timid boy left middle-school at the second year due to poverty, wandering as a taxi boy, elevator boy and chicken farm labor until re-entered high-school second year class. It is my childhood biography.

I prayed to God, when I took the entrance examination for the Department of Agricultural Chemistry of Korea University, that I would devote myself to solving the food problems of the people if he could let me pass the exam, otherwise, I would work for the church as he might wish.

Now, at the age of retirement, I report my life's work with trembling hands.

"I know both how to be abased, and I know how to abound: every where and in all things I am instructed both to be full and to be hungry, both to abound and to suffer need. I can do all things through Christ, which strengtheneth me.(Philippians 4:12-13)"

"Each time he said 'My gracious favor is all you need. My power works best in your weakness'. So now I am glad to boast about my weaknesses, so that the power of Christ may work through me. (2 Corinthians 12:9)"

Award Presentation

June 17 (Thur)

ROOM 113–115

학술대상 수상강연

Academic Achievement Award Lecture

Chair : Kyu Hang Kyung (Sejong University)

AA-1 *14:10 ~ 14:50*

Food Research Archives of Cherl-Ho Lee, Korea University

Cherl-Ho Lee (Korea University)

Reviewing a life-long research work in a 40 minutes lecture is not an easy job. The Food and Biomaterials Science and Engineering Laboratory of Korea University opened in 1979 when I returned home from MIT in Boston, USA. Over the last 30 years, 193 M.S. and 24 Ph.D. students conducted their thesis researches in my laboratory. Of these students 19 are teaching at universities as professors, 93 are researchers in national or industrial research laboratories. A total of 276 original research papers were published from the laboratory, among these, 52 appeared in SCI journals. The research area of the laboratory could be divided into seven topics; fermentation technology, protein technology, extrusion technology, food irradiation, food rheology and sensory evaluation, food processing and physiological function, and most recently, NMR application in food science. Although these areas appear to vary widely, they are all interlinked. For example. the NMR application focuses primarily on fermented food products for their metabolomic investigations, and protein technology and rheology were applied to extrusion cooking for the pretreatment of fermentation raw materials. Clearly, food science and technology research is complex and requires multidisciplinary training.

The underlying theme of my research work at Korea University was to excavate and upgrade traditional Korean food technologies and introduce them to the world, especially to Western society. I edited two books, *Fish Fermentation Technology* and *Lactic Acid Fermentation of Non-dairy Food and Beverages*, with Western scholars, and authored a book entitled, *Fermentation Technology in Korea*. I also contributed several book chapters related to fermentation technology and Korean dietary culture to English reference books and textbooks. I established the Korea Food Extrusion Research Society in 1985, which continued its activity for 15 years, and I established the Research Society for Korean Traditional Food Industrialization in 1998. Recently, I have become very concerned about the world food situation and Korean food security. In order to ensure and stimulate continuous research effort among young Korean scholars in the field of food safety and security, the Korea Food Security Research Foundation was established last April, and I plan to devote myself to this work.

DDWilliamson
Color With Confidence®

July 1, 2010

Dr. Cherl-Ho Lee
Professor
Graduate School of Biotechnology
Korea University
5-1 Anam-Dong Sungbuk-Ku
Seoul 136-701
Korea

Dear Dr. Lee,

Congratulations on being selected as a Fellow of the Institute of Food Technologists. This is the highest honor that can be bestowed upon an IFT Member by their peers for exemplary accomplishments in the areas of scholarly advancement, service to the profession, inspiration of others to excel in the food science field, responsibility for the success of a new food product and / or improvement of the human condition via food science and technology.

Your contributions to promote food safety in developing countries through fish fermentation technology accompanied with your personal efforts to enhance collaboration between IFT and the Korean society of Food Science and Technology, reflect the qualities of an IFT Fellow.

I look forward to greeting you at the Awards Ceremony on Saturday evening July 17th in Chicago to celebrate your honor of becoming an IFT Fellow.

Sincerely,

Margaret A. Lawson

Margaret A. Lawson
VP Science & Innovation
D.D. Williamson

Past IFT President
IFT Fellow

Nomination of IFT Fellow

Cover Page and Instructions for year 2010

Nominee: Last: **LEE** First: **Cherl-Ho** Middle:

Home address: **143 Egokri, Sohuleub** City: **Pochenshi** State: **Kyunggido** Zip: **487-821** Country: **KOREA**

Phone: 82-2-3290-3414 Fax: 82-2-927-5201 E-mail: **chlee@korea.ac.kr**

Year joined IFT: **1976** Year became a Professional Member: (required) **1982**

Total number of years in profession: **33 years**

Employer: **Korea University**

Business position/title: **Professor**

Employer's address: **1 Anam-dong, Sungbuk-ku, Seoul, 136-701 Korea**

City: **Seoul, 136-701** Country: **KOREA**

Names of 3 to 5 references to whom you must send a reference form:

1. Tai-Wan Kwon
2. David R. Lineback
3. Michael P. Doyle
4. Walter E. L. Spiess
5. Mary Schmidl
6. Robert Buchanan

Proposed Citation Wording *(not more than 30 words)*:

Prof. Lee has made exceptional contributions to food science and technology through an outstanding research program and international collaboration in food fermentation technology and through his outstanding international leadership.

Nominator - *The nominator information below is* ***confidential*** *and will not be seen by the jury.*

Name: Chang Y (Cy) LEE Date submitted: November 23, 2009

Address: Department of Food Science & Technology, Cornell University
City: Geneva State: New York Zip: 14456 Country: USA

Phone: 315-787-2271 Fax: 315-787-2284 E-mail: CYL1@cornell.edu

Nominator's IFT membership classification (check one):

☐Member ☐XX Professional Member ☐Emeritus Member ☐Emeritus Professional Member

Contributions to the profession of food science and technology in industry, academia, government, and related organizations: This may include: Research achievements, as evidenced by publications, patents and presentations:

Having devoted his entire professional career to research and education, Dr. Cherl-Ho Lee has distinguished himself as an internationally renowned authority in food fermentation. He has published more than 250 research papers, 15 books/book chapters and has been a co-authored on >200 abstract presentations at international and national meetings. He also registered 12 patents. He has served or currently serves as major advisor for over 200 MS and PHD students. In addition, he has made significant contributions to enhance food safety and wellbeing in developing countries by organizing numerous conferences, workshops, and seminars at the national and international levels.

He and his colleagues, developed a systematic nomenclature scheme for fermented products and reported it to the 8th ASCA (Association for Science Cooperation in Asia) Conference held in Medan, Indonesia in 1981. He was a project leader and coordinator of Fish Fermentation Research Network of UNU (United Nations University) since 1985. He made a comprehensive survey on fermented marine products in Korea, systematically classified them, and compared with those from other Asian countries, including Japan, Indonesia, Malaysia, Philippines, and Thailand. He organized the UNU Workshop on Fish Fermentation Technology in Seoul in 1987 and edited the book "Fish Fermentation Technology" (UNU Press, 1993) together with Prof. Keith H. Steinkraus (Cornell University, USA) and P.J. Alan Reilly (Natural Resources Institute, UK). This book has been widely used especially in the Southeast Asian countries as a guide for their technical communication and collaborations in the field of food science and technology.

He was a project leader for a UNIDO (UN Industrial Development Organization) joint research project to develop lactic acid beverages with high protein concentration from vegetables at Korea University and MIT, USA in 1987. He isolated a strain of *Leuconostoc mesenteroides* from Sikhae, a traditional Korean lactic acid fermented fishery product and registered the strain as a patented culture for rice-soymilk lactic acid beverage production. The project was expanded in 1990 to a second phase UNIDO project with the title of 'Industrialization of Lactic Acid Fermentation of Cereals and Its Dissemination to the Developing Countries'. Under this project he established an International Training Course on Fermentation Technology at Korea University and educated 8 scientists from developing countries (Sudan, Nigeria, Egypt, Sri Lanka, India, Thailand, Philippines, and Vietnam) for 10 months. In 1992 he organized the UNIDO Workshop on Lactic Acid Fermentation of Non-dairy Food and Beverages in Seoul and co-edited the book "Lactic Acid Fermentation of Non-dairy Food and Beverages" (HarnLimWon, 1994) together with Jens Adler-Nissen (Technical University of Denmark) and Gunter Barwald (Technical University of Berlin, Germany).

He participated in the activities of UNIDO and FAO/WHO to improve the hygienic condition of African countries by upgrading indigenous fermentation methods. He presented papers at the Expert Group Meeting on Applications of Biotechnology to Food Processing held in Ibadan, Nigeria, 16-20 December 1991, the UNIDO Technical Symposium on Food Fermentation Technology held in Dakar, Senegal, 13-16 December 1993, and the FAO/WHO Workshop on the Assessment of Fermentation as a Household Technology for Improving Food Safety held in Pretoria, South Africa, 11-15 December 1995.

He optimized thermal processing conditions for Makkolli (traditional Korean rice beer) using aseptic packaging and extended its shelf-life significantly. By the result of this research aseptically packaged Makkolli began to be exported to Japan and United States in the early 1990's. He also carried out research projects on the utilization of lupine seed for the fermentation substrate replacing soybean under the support of Western Australian Grain Pool. This work opened the importation of lupine seed into Korea as a new feedstuff.

Nestle Research Center in Switzerland supported his studies on the isolation and identification of *Staphylococci* in Korean fermented fishery products and the enzymatic hydrolysis of soybean proteins for the production of functional peptides for six years starting from 1995. He isolated and identified 7 strains of *Staphylococci* useful for the European fermented sausage production. He also identified functional peptides having blood cholesterol level lowering effect from soybean protein hydrolysate produced by the proteases from *Bacillus amyloliguifaciens* FSE-68 isolated from a Korean soybean fermentation starter Meju. In the continuous research he proposed the cholesterol lowering mechanism of soybean protein hydrolysate (J. Agric. Food. Chem. 2007, 55, 10599-10604).

He was the **Secretary General** of the organizing committee for the **11th World Congress of Food Science and Technology, IUFoST**, held in Seoul in 2001. Following the Congress he published "Fermentation Technology in Korea" (Korea University Press, 2001), and distributed the book to the overseas participants to the Congress (approximately 600 food scientists from 50 countries). This book contains in the Appendix 426 English abstracts of research papers related to traditional Korean fermented foods published in the Korean academic journals.

Dr. Lee presented a white paper 'Creative Fermentation Technology for the Future' at the pre-congress internet conference in conjunction with the 12th IUFoST World Congress held in Chicago, USA in 2003. Three eminent scientists, Jens Adler Nissen (Technical University of Denmark), Robert Nout (Wageningen University, The Netherlands) and Rosa Rolle (FAO, Rome), praised and recommended the paper highly. This forum had 42 subscribers from 17 countries, and Pamela Tom (University of California, Davis, USA) and Daryl Lund (University of Wisconsin, Madison, USA) wrote summary of the invited paper and responses to the Journal of Food Science (Vol. 69, Nr.2, Page CRH31-36, 2004).

In 2006, Dr. Lee chaired the 15th Session of FAO/WHO Codex Coordinating Committee for Asia held in Seoul. Recently, he was co-chair for the 2nd KAST (Korean Academy of Science and Technology) and US NA (United States National Academies) Bilateral Symposium on The Science of Food Safety Risk Assessment held in August 24-25, 2009, Seoul, Korea.

Selected publications are listed below to further highlight his professional accomplishments:

Lee, C.H. et. al.: Industrial Food Quality Control, Yu Rim Publisher (1982)
Lee, C.H. et. al.: Food Engineering, Hyung Sul Publisher (1984)
Lee, C.H. et. al.: Bioproduction, Korea University Press (1986)
Lee, C.H. et. al.: Fermented Fish Products in Korea, Yu Rim Publisher (1987)
Lee, C.H. et. al.: Food Extrusion Technology, Yu Rim Publisher (1987)
Lee, C.H. et. al.: Food Extrusion Technology II, Yu Rim Publisher (1988)
Lee, C.H.: Food Orchestra, Yu Rim Publisher (1994)
Lee, C.H. et. al.: New Book on Korean Food, Yu Rim Publisher (1995)
Lee, C.H. and Maeng, Y.S.: White Paper on Food Hygiene Incidences, Korea U. Press (1997)
Haard, N.F., Odunfa, S.A., Lee, C.H. and Quiintero-Ramirez, R.: Fermented Cereals- FAO Bulletin 138, UN (1999)
Lee, C.H. et. al.: Food Evaluation and Quality Control, Yu Rim Publisher (2000)
Ro, S.O. and Lee, C.H.: People Overcame Cancer by Diet Therapy, Yu Rim Publisher (2002)
Lee, C.H. and Kwon, T.W.: Introduction to Korean Food Science, Korea U. Press (2003)
Lee, C.H. et. al.: Modern Biotechnology and Bioindustry. Academy Publisher (2003)
Lee, C.H.: A White Paper on Food Hygiene Incidences II, Korea U. Press (2005)
Lee, C.H. and Park, H.J.: Food Preservation, Korea U. Press (2008)

Honors, awards and other evidence of recognition within the profession.

2009 Order of Service Medal, Red Stripe, Korean Government. In recognition of his service for the development of national food safety policies.
2007 Academic Excellence Award, Korean Society of Microbiology and Biotechnology.
2003 Fellow, International Academy of Food Science and Technology.
2001 Meritorious Service Award. Korean Society of Food Science and Technology. In recognition of his successful management of the 11th IUFoST World Congress.
1999 Fellow, Korean Academy of Science.
1998 Order of Civil Merit, Seongnyu Medal. Korean Government. In recognition of his contribution to the national food hygiene improvement with his book "White Paper on Food Hygiene Incidences" (Korea University Press, 1997).
1994 Excellent Research Paper Award. Korean Federation of Science and Technology Societies.

Evidence of leadership and achievements within the profession.

- Organizer and President of Food Extrusion Research Group in Korea (1986-1992)
- Member of Food Hygiene Council of the Ministry of Health and Welfare of Korea (1988~) and Chair of the Regulation Division of the Council (20008~).
- Secretary General of the Korean Society of Microbiology and Biotechnology (1993-1997)
- Chair, ICGFI (International Consultative Group for Food Irradiation) Workshop on "Harmonization of Procedures and Regulations on Food Irradiation for Asia and Pacific" held in Seoul on April 27-29, 1998.
- Organizer and President of Research Group for Industrialization of Traditional Korean Food (1997-2000)
- Secretary General, 11th IUFoST World Congress of Food Sci and Tech (1998-2001)
- Member, Korean Academy of Science and Technology (1999~)
- President, Korean Society for Food Engineering (2003-2004)
- President, Korean Society of Microbiology and Biotechnology (2005)

- President, Korean Federation of Microbiology Societies (2005)
- Co-chair, Organizing Committee, Korea Conference on Innovative Science and Technology -2006 on Nutrigenomics (2005~2006)
- Chair, CODEX 15th Session of Coordinating Committee for Asia (2006)
- Chairman, Food Safety Evaluation Committee, Korea FDA (2006~)
- President, Korean Society of Food Science and Technology (2007)
- Founding President, Federation of Korean Food Related Societies (2007)
- President of International Life Science Institute (ILSI) Korean Branch (2008~)
- Councilor for Scientific Council of IUFoST (2008 – 2010) and Auditor of IUFoST (2006-2008).
- Member of National Food Safety Policy Council, Prime Minister's Office, Korean Government(2008~)

Service to IFT including National, Regional, Divisional, and other IFT activities. If nominee resides outside of the USA, service to an IFT Affiliate is considered in lieu of or in addition to IFT service.

As the President of Korean Society of Food Science and Technology (KoSFoST), Dr. Cherl-Ho Lee organized Kimchi Symposium for the 2007 IFT Annual Meeting and Food Expo held in Chicago. It was the first symposium on Korean food in the history of IFT Annual Meeting. He presented a keynote speech to the symposium in the title of 'Kimchi, the symbiotic food of Korea'.

He has been a member of IFT since 1976 and a professional member since 1982. He participated in the Food Packaging and Food Engineering divisions. He and his students participated to IFT Annual Meetings and presented numerous research papers as listed below:

1998 Annual Meeting (Atlanta, GA):
Mi-Ryung Kim (Isolation of bitter peptide hydrolysates of soy protein synthesized in *E. coli.*)
Do-Youn Lee (Formation of bitter compounds by heating Korean rice beer, Takju)

1999 Annual Meeting, Chicago, IL):
W.S.Choi (Changes in rheological behavior and textural properties of surimi gel by heating)
J.Y.Kim (Digestibility/mol.structure changes of high amylose corn starch by extrusion cooking)
S.Y.Yoon (Effect of Ohmic heating on structure/permeability of yeast cell membrane)

2000 Annual Meeting (Dallas, TX):
M.S.Kim (Influence of capsaicin on blood flow and oxidation stress)
S.W.Yoon (Determination of blood flow using micro-channel flow analyzer)

2003, 12th IUFoST World Congress (Chicago, IL):
C.H.Lee (Role of biotechnology in modern food production)
C.Y.Lee (Modification of blood rheology and erythrocyte water permeability in hypercholesterolemic male by phytosterol feeding)
H.W.Park (Analysis of fatty acids/triacylglycerol composition of plant oil by GC & ^{13}C NMR)
S.S.Rhee (Antioxidant peptides from Korean rice wine)

2007 Annual Meeting (Chicago, IL):
C.H.Lee (Kimchi, the symbiotic food of Korea)
S.W.Yoon (Antioxidant activity of peptides isolated from soy hydrolysate on MEHP-induced TM4 Sertoli cells)
B.D.Park (Rheological changes of Gochujang by hydrocolloids addition)
S.E.Choi (Isolation and characterization of aroma compounds from herbs)
M.H.Kim (Ginsenoside profile modification of red ginseng by acid impregnation)

2008 Annual Meeting (New Orleans, LA):
Y.S.Hong (Artifacts in measurement of water distribution in soybean using NMR Imaging)
H.S.Son (A novel approach for estimating sugar and alcoholic concentration in wine by using refractometer and hydrometer)

Dr. Lee has made a significant contribution to enhance the collaborative relationship between IFT and KoSFoST (Korean IFT). His efforts are to link KAFTA (Korean American Food Technologists Association), a Society of the Korean-

Americans, with KoSFoST. He also invited many distinguished IFT scholars to Korea as invited speakers for the symposiums and workshops organized by KoSFoST.

Professional History in reverse chronological order, beginning with the nominee's present position and including the 10 years that the nominee made key contributions to the profession and to IFT. Briefly indicate the responsibilities and the nature of the nominee's contributions in each position held, not just the title.

9/1979 to present: Professor of Korea University

Dr. Lee has been a professor of Food Engineering and Food Preservation at Korea University since September 1979. Korea University is one of the leading universities in Korea having 1,200 faculty members and 30,000 students. He belongs to the Graduate School of Biotechnology (now College of Life Science and Biotechnology) consisting of over 40 faculty members and 300 graduate students. Dr. Lee teaches Food Engineering. Food Preservation and Packaging, Quality Control of Food, and Comparative Dietary Culture Studies. At his Laboratory of Food and Biomaterials Science and Engineering, he has trained over 200 MS and Ph.D. candidates and led them to complete their thesis researches during his career at Korea University.

He established the Center for Advanced Food Science and Technology at Korea University in 1998 under the support of Korean Science and Engineering Foundation and served as Director of the Center for 3 years.

He was a visiting professor at the Danish Technical University (Lyngby, Denmark) in 1989-90 for 6 months, working with Professor Jens Adler-Nissen of the Department of Biotechnology. In 1994 he visited Smithsonian Institution, Washington D.C., USA, for 6 months as a visiting researcher. He worked with Dr. Terry Sharrer, a curator of the Museum for American History on the influence of American culture on the food habit of Koreans during the last century. In 1998 he spent 6 months, Japan, as a visiting professor at the Institute for Food Science at Kyoto University. He worked with Prof. Tomohiko Mori on the comparative study on the dietary culture of the Korean and Japanese. He gave several lectures at the Institute, including Health Concepts in the Traditional Korean Diet, and Lactic Acid Fermentation in Traditional Korean Foods.

12/1975 to 7/1979: Research Associate at MIT, USA

Right after the completion of his Ph.D. degree at The Royal Veterinary and Agricultural University in Denmark, Dr. Lee was invited to MIT by Professor Nevin S, Scrimshow, Head of the Department of Nutrition and Food Science, MIT. He worked for Professor Cho-Kyun Rha as her post-doctorate research associate. His research area was the characterization of the rheological properties of food proteins, mainly soybean protein and single-cell protein. He also worked with Professor Anthony Sinskey to isolate protein from thermo-sensitive yeast mutant strains. During this period he published 16 research papers.

6/1971 to 11/1975: Graduate Student at KVL, Denmark

Cherl-Ho Lee entered the Graduate Licentiate (Ph.D.) Course of the Department of Food Science, The Royal Veterinary and Agricultural University of Denmark, Copenhagen in 1971, right after completion of his study at Malling Agricultural College. His adviser was Professor Mogens Jule, Director of Danish Meat Products Laboratory. His major subject was Food Preservation and minor subjects were Animal Physiology and Mathematical Statistics. His Ph.D. dissertation was "The effect of Korean soy sauce and soy paste manufacture on soybean protein quality". As a graduate student of KVL he visited the National Food Research Institute of Japan in Tokyo, for 2 months in 1973-4. Dr. Tokuji Watanabe, Director of NFRI, invited and arranged him to work with Dr. Kyoko Saio, Chief of the Protein Research Laboratory.

5/1970 to 5/1971: Student at Malling Landbrugsskole, Denmark

Cherl-Ho Lee went abroad to study agricultural practice at the Malling Agricultural College in Denmark. He spent one year to learn Danish and general agricultural practice in Denmark.

10/1969 to 4/1970: Researcher at Tong Yang Confectionary Co., Korea

Cherl-Ho Lee entered Tong Yang Confectionary Company in Seoul, right after completion of his 2-year military service as an ROTC Lieutenant. The company was one of leading food companies in Korea. He worked in the research laboratory for product development and quality control.

3/1963 to 2/1967: Student at Korea University

Cherl-Ho Lee entered Korea University, Department of Agricultural Chemistry in 1963. He received Excellent Student Scholarship and graduated as an honor student.

2010 IFT Fellows

Fellow is a unique professional distinction conferred on individuals with outstanding and extraordinary qualifications and experience for their contributions to the food science and technology field. The nominee must have been an IFT Member for 15 years and a Professional Member at the time of nomination. The 15-year member requirement may be waived by the Fellows Jury for those nominees who have spent all or a portion of their careers outside the United States.

IFT has conferred the Fellow designation on a select number of Professional Members every year since 1970. A complete list of Fellows can be found on the IFT website at ift.org.

Cherl-Ho Lee, Professor, Korea University, was recognized for fostering international collaboration in food fermentation technology and for his outstanding research efforts.

In an effort to enhance food safety and well-being in developing countries, Lee organized the UNU Workshop on Fish Fermentation Technology in Seoul Korea and co-edited Fish Fermentation Technology, which has served as a reference and guide in technical communication and collaborations in food science throughout Southeast Asia. He also established an International Training Course on Fermentation Technology at Korea University, which educated eight scientists from developing countries over a 10-month period. Lee has made a significant contribution to enhancing the collaborative relationship between IFT and the Korean Society of Food Science and Technology (KoSFoST) as well as linking the Korean American Food Technologists Association with KoSFoST.

Opening and Welcome Addresses

2nd KAST-US NA Bilateral Symposium on the Science of Food Safety Risk Assessment, Korean Chamber of Commerce and Industry, August 24-25, 2009

▪ Opening Address ▪

Respected Dr. Hyun-Ku Lee, President of the Korean Academy of Science and Technology, Dr. Michael Doyle and delegates of the US National Academies, and distinguished guests and ladies and gentlemen, It is my great pleasure and honor to address opening remarks for the 2nd KAST-US NA Bilateral Symposium on the Science of Food Safety Risk Assessment.

In recent years, we have experienced a series of food safety social issues including hygienic incidences such as melamine issue, controversies in food trade policy like US beef negotiation case, and negative consumer acceptance against new technologies. The controversy on the safety of GM foods and irradiated foods and their mandatory labeling requirements are still hot social issues, which influence the food availability and food industry development of Korea.

However, most of food safety incidences in Korea were known to have no actual risk, but caused by misunderstanding and inappropriate responses to the issues raised by consumers and other interested groups. The conventional perception that detection of hazardous substance in food implies health risk should be changed in the age of highly developed analytical chemistry which is able to detect most chemical components in the micro/nano gram level. Scientific risk analysis is needed to evaluate and to manage the safety of a food in a reasonably acceptable level. This symposium is organized to expand our knowledge on the risk assessment practices applied to the national food safety assurance and disseminate the science-based rationales to the public.

I would like to express my sincere thanks to the Korean Academy of Science and Technology and US National Academies taking this subject for the topic of the 2nd Bilateral Symposium. Professor

Michael Doyle and Dr. Linda Meyers of US NA took great effort for selecting lecturers and developing programs for the symposium. I am grateful for the effort of the members of the organizing committees of both US and Korean sides and the staffs of both organizations.

Tomorrow, we will have an Expert Workshop on Translating Risk Assessment into Policy on the basis of the topics discussed today's symposium. I must say many thanks to all the participants, session chairs and speakers for the successful event, and hope this symposium to contribute greatly to upgrading national food safety and public health.

August 24, 2009
Cherl-Ho Lee, Organizing Committee Chair

2009 ILSI BeSeTo Meeting on Food Safety, Korea University, Seoul, August 26-27, 2009

▪ Opening Remark ▪

Good morning and welcome to Korea.

During the 2009 ILSI Annual Meeting in Tucson, USA, the establishment of ILSI BeSeTo(Beijing-Seoul-Tokyo) Meeting on Food Safety was discussed among the delegates of ILSI Japan, ILSI Focal Point in China and ILSI Korea. The delegates shared the necessity of the meeting and agreed to hold the first meeting in Seoul in August 2009.

In this meeting we will discuss about the food safety issues in each country, reviewing the food hygienic incidences taken place in 2008/2009 in each country, the consequent regulatory changes and socio-economic impacts resulting in regulatory changes. We will review the risk assessment framework of each country and the related problems observed in the translation of risk assessment into risk management and national food policy in general.

ILSI, through HESI and its global network, has been the leading scientific organization in research and communication on risk analysis of biological systems including food. It is desirable to initiate a collaborative effort for reviewing the science and practices underlying the food safety assurance of the countries in this region under the framework of ILSI. The scientific approach on food safety evaluation and management is essential for risk communication to convince consumers the safety of their food and to relieve ambiguous public anxiety.

In this meeting we would like to expand our knowledge and understanding of food safety management systems of other countries and seek the needs and possibilities of harmonizing regulatory and trade barriers among three countries. The outcome of this meeting will be documented in a white-book form and distributed to the ILSI members of the three countries. We would also like to have some cheer-up times for intimate acquaintance of the participants for future collaboration.

I would like to express my sincere thanks to the Executive Directors of the three ILSI branches for their collaboration and preparation of this meeting., especially, Dr. Myeong-Ae Yu for her dedicated effort and enthusiasm.

August 26, 2009
Cherl-Ho Lee, President of ILSI Korea

ILSI Korea/CFGC Expert Workshop on Environmental Risk Assessment of Biotech Crops: Gene Transfer and Impact on Soil Microorganisms, Seoul National University, Korea, December 9, 2009

▪ Opening Address ▪

Distinguished guests, ladies and gentlemen. It is my great pleasure to address opening remark to the ILSI Korea/CFGC Expert Workshop on Environmental Risk Assessment of Biotech Crops: Gene transfer and impact on soil microorganisms. Biosafety of transgenic organisms on environment and human health has been studied extensively throughout the world for the last three decades. A number of GMOs have been released to the environment for the production of foods, medicines and industrial materials after strict examination of their biological effects.

However, public negative opinion on GMO is still remaining, especially in the area of environmental effect. ILSI Korea, as a nonprofit organization that provides a neutral forum for academic, government and industry scientists to identify important food and environmental safety issues, has organized several meetings and workshops on GM food safety and regulatory management for the last three years. This workshop is in the continuum of ILSI Korea's effort to expand scientific understanding on the safety of emerging biotechnology. Scientist generally accept the safety of GM foods permitted by the authorities to market, but controversy on the environmental adverse effects of GMO is still continuing.

In this expert meeting, we will discuss about the environmental safety evaluation of LMOs, especially focusing on the gene transfer in the field and impact on soil microorganisms. I would like to express my sincere thanks to the invited lecturers, Dr. S.C. Seo, Dr. Yosuke Kuroda, Dr. Alan Gray and Dr. Jim Germida, and discussion panels chaired by Prof. Kyu Hang Kyung. Special thanks are given to the sponsoring organizations, Korea RDA and CropLife Korea, especially Dr. Hyo-Geun Park, the president of CropLife Korea, and his staffs for their efforts to organize this workshop. I hope this workshop will provide useful data and relevant scientific information to the participants.

Thank you very much.

December 9, 2009

Cherl-Ho Lee, ILSI Korea President

KFDA-USDA International Workshop on National Laboratory System and Nutrition Data-base Construction, Grand Hilton Hotel, Seoul, May 12, 2009

▪ Congratulatory Remark ▪

Respected Commissioner Dr. Yeo-Pyo Yoon, Congressman Mr. Hong-Jun Ahn, distinguished guests, and ladies and gentlemen. It is my great pleasure to congratulating the opening of KFDA-USDA International Workshop on National Laboratory System and Nutrition Data-base Construction sponsored by ILSI Korea.

ILSI, as a global scientific NGO, emphasizes human health and wellbeing, and put great effort to alleviate the problems of obesity and food safety of the world. The global ILSI PAN project which is Physical Activity and Nutrition project, deals with the prevention and cure of overweight and disease problems through exercise and well-balanced nutrition. ILSI Korea is planning to launch this project in Korea in collaboration with Korea FDA, Korea Health Industry Promotion Institute together with ILSI Korea member companies.

For this kinds of projects, the reliable and well designed analytical practices and resulting food composition data-base are essential. The National Laboratory System securing the precision and accuracy of analytical data by comparing the results between laboratories is necessary, and Korea FDA put great effort to improve NLS activities in Korea.

Today we are going to discuss the framework of NLS in both Korea and USA. This workshop will contribute greatly to up-grading the analytical practices of the laboratories working for Korea FDA. I would like to express my sincere thanks to the invited speakers of this workshop, especially the distinguished speakers from US Department of Agriculture. Exchanging analytical practices and hearing about the advanced methods of analysis will stimulate Korean scientists to improve their analytical skills and capacity.

I must acknowledge the devotion and effort of Dr. He-Kyung Park and her staffs to preparing this workshop. I hope all the participants have valuable time with this workshop today and those overseas participants to have wonderful time and enjoy the beautiful spring season in Korea. Thank you very much.

May 12, 2009
Cherl-Ho Lee, President of ILSI Korea

2009 International Workshop on Framework of Global GMO Safety Assessment and Case Analysis on Its Socioeconomic Impacts, The Korean Chamber of Commerce and Industry, March 23, 2009

▪ Opening Address ▪

Respected Dr. Mike Knowles, the President of ILSI, distinguished guests, and ladies and gentlemen. It is my great pleasure and honor to address opening remark to the 2009 International Workshop on Food Biotechnology organized by ILSI Korea and Korea Biosafety Clearing House of KRIBB.

Last year October, IlSI Korea together with ILSI International Biotech Committee organized the 2008 International Workshop on Food Biotechnology in Seoul, and reviewed the global GMO safety assessment practices, socio-economic impacts of GMO regulation and the consumer acceptance in USA, Europe and Asia. The socio-economic impact of GM food labeling was an important issue, because the Korea FDA planned to notify new regulation on expanding labeling requirement for all

GM foods by December 2008. The public hearing on this issue was held two times in Korea last year and the notification of the new regulation was postponed.

An Expert Group Meeting of the Food Safety Policy Committee under the Prime Minister's Office, ROK reviewed this issue last March 4, and came to a conclusion that more consideration is needed before the implementation of the new regulation. The reasons for the recommendation were; 1) there is no proper method of detection for processed GM foods, and the food traceability in Korea may not be fully constructed within the proposed preparatory period of three years, 2) due to the high negative and unsafe perception of consumers against GM food, expanded labeling will create severe consumers turmoil hampering national security; 3) controlling imported foods with certification papers mainly may not secure the protection of false products from importation, and it will result in counter-discrimination on labeled domestic products; 4) the justification of the present selective labeling requirements harmonized with neighboring countries such as Japan and Taiwan should be respected.

Today we are going to discuss about the framework of global and national GM food safety assessment and the framework of GMO management in Korea and Japan. We will also analyse the results of previous studies on the socio-economic impacts of GM food labeling in Korea. The purpose of this workshop is to provide Korean consumers a sound and balanced information on the scientific basis of the safety assessment of GM food and the rationale of GM food management in respect to food availability and security.

I would like express my sincere thanks to all the participants, invited speakers and chairs who made the workshop possible. I deeply appreciate ILSI, ILSI Biotech Committee, Ministry of Food, Agriculture, Forestry and Fisheries, ROK, Ministry of Commerce, and Korea FDA for their support and assistance. I hope all the participants have valuable time with this workshop today and produce sound opinion on GM food for the benefit of consumers and national food policy making. Thank you very much.

March 23, 2009

Cherl-Ho Lee, President of ILSI Korea

2008 International Workshop on Food Biotechnology: Review on Global Safety Assessment, Socio-economic Evaluation, and Future Development, The Korean Chamber of Commerce and Industry, October 28-29, 2008

▪ Welcome address ▪

Respected Commissioner of Korea FDA, ILSI President Dr. John Ruff, distinguished lecturers, and ladies and gentlemen. It is my great pleasure to address welcome remark for the 2008 International Workshop on Food Biotechnology in Seoul. organized by Korea Food and Drug Administration, ILSI International Biotech Committee, and ILSI Korea.

The commercial production of GM crops has been practised for over a decade and the GM crop market is expanding throughout the world. Due to the difficulties in finding non-GM corn in world crop market and the high cost of non-GM premium, Korea Starch and Syrup Industries Association declared the importation of GM corn last May. But the result was disastrous; the factories' operation rate fell down to 40%, and 10,000 workers of the industry are faced to cut-off. There were no food companies in Korea who dare to label GM mark on their products by using starches and syrup derived from GM corn. Most of Korean food companies moved their supply to imported starch and syrup, mainly from China, where GM labeling is not compulsory. Since present analytical technique cannot detect the starch and syrup products made from GM corn, the food companies can avoid GM labeling simply by using unlabeled imported raw materials.

A recent research on the socioeconomic impact of GM labeling conducted in Korea predicted that the non-GM premium of corn and soybean will pull the crop price up to 20-40%, and the price of vegetable oil will increase up to 24.2%, and those of starch and syrup up to 20.2%. It will results in 955 billion Won(ca. 1 billion US$) annual production deficit of Korean food industries and 323 billion Won reduction in GDP, and 3.6% increase in consumer price index.

The elusion of biotechnology for human welfare, so called sufficient food supply with cheap price, is now turning to catastrophic demon in Korea constraining the food supply and shaking the national food security. This situation arises mainly by the consumer's perception on the safety of GMO. The activist group in Korea continuously educated the people the negative aspects of GMO with unscientific materials for the last decade. Asserting consumers right to know, the activists is now demanding overall labeling of GM foods. On the other hand, the Korean government took no visible action to counter-act to the activists. Korean government is going to comply with the activists' demand. The researchers and academia in Korea are mostly silent too. Science is the way talking general truth. With all the scientific results on the safety of GM food and the governmental approvals to use GM foods, poor communication still bans the use of GM food in Korea.

This workshop is organized to solve this problem and assist the government and general consumers as well to develop better policy to deal with national food security. I must express my sincere thanks to all the invited speakers and chairs, and especially overseas lecturers taking all the trouble of long journey to the Far-eastern land Korea. I deeply appreciate to ILSI and ILSI Biotech Committee, and the members of the Biotech Team of Korea FDA headed by Dr. Dong-Ha Lee for their support and assistance. I must say special thanks to Dr. Myung-Ae Yu, the Executive Director of ILSI Korea, for her devotion and effort for this workshop. Thank you very much.

October 29, 2008

Cherl-Ho Lee, President of ILSI Korea

30th Codex Alimentarius Commission, Joint FAO/WHO Food Standards Programme, FAO Headquarters, Rome, 2-7 July 2007

▪ The 5th CCASIA Session Report ▪

Republic of Korea as Asia coordinator would like to inform the results of the 15th CCASIA (Codex Coordinating Committee for Asia) session held in Seoul, 21-24 November 2007, briefly. The Committee noted the action, such as convening electronic working groups when necessary to facilitate work of the Committee or holding regional workshops organised by FAO, WHO and the Regional Coordinator on subjects of interest to the region.

The Committee agreed to forward the proposed draft Standard for Gochujang to the Commission for adoption at Step 5, and recommend to consider the draft Standard on the Codex Committee on Cereals, Pulses and Legumes (CCCPL) for further elaboration process. Also, The Committee agreed to forward the proposed draft Standard for Ginseng to the Commission for adoption at Step 5, and recommend the Commission to finalize the Standard in a relevant Commodity Committee, preferably in the Committee for Processed Fruits and Vegetables (CCPFV).

The Committee agreed to hold the proposed draft Standard for Fermented Soybean Paste at Step 4, and agree to establish an electronic working group led by the Republic of Korea. The revised text would be circulated for comments at Step 3, prior to the next session of the Committee. The Committee decided to return the proposed draft Standard for Non Fermented soybean Products to Step 2 for redrafting by an electronic working group coordinated by China and Thailand.

The Committee agreed to request the Commission for approval of new work on proposed draft Standard for Chili Sauce which was prepared by the Delegation of Thailand. The Committee further agreed that if new work was approved, Thailand would prepare a proposed draft Standard for comments and consideration by the next session. The Delegation of Indonesia introduced its proposal for new work on the Standard for Edible Sago Flour, and The Committee agreed to request the

approval of this new work to the Commission. The Committee noted that the Delegation of Indonesia, with the assistance from the countries interested in this Standard, should prepare a project document and submit it to the 30th Session of the Commission.

The Delegation of Malaysia introduced the proposal to develop a strategic plan with the goal of strengthening “the food safety infrastructure of all member countries of Asia and the region's contribution to Codex work”. It was agreed that the draft Strategic Plan would be circulated in a separate Circular Letter and that Malaysia would collate the comments and redraft the document, if required, for further consideration at the next session.

The committee was informed that an FAO/WHO Workshop on “Risk Communication why and how” was held on 20 November 2006 immediately preceding the Committee session and noted that the workshop fostered a useful exchange of information and views. The committee expressed its appreciation to FAO and WHO for their efforts in capacity building activities in the region and fully supported continuous activity from FAO and WHO. The committee exchanged information on food control systems and consumer participation in standard setting in countries in the Region. The Committee agreed to nominate Indonesia for appointment as a Regional Coordinator by the 30th Session of the Commission.

July 4, 2007
Cherl-Ho Lee, Chairman
15th Session, Codex Coordinating Committee for Asia

5th International Symposium on Phytochemicals, Chosun Hotel, Seoul, September 20, 2007

▪ Opening Address ▪

It is my great pleasure and honor to address opening remark to the 5th International Symposium on Phytochemicals. The Korean Society of Food Science and Technology as the representative academic society in this field in Korea organizes important symposia related to food processing technology, physiologically active components in food, food hygiene and safety issues, and etc. in order to stimulate the researches and disseminate the knowledge to the public as well as academic researchers.

For the last five years Amway Korea Company sponsored our society to hold the phytochemical symposium every year and contributed to initiating the discussion on effectiveness and reaction mechanisms of phytochemincals in human body. The theme of the symposium this year is rather cautious to say - ‘Phytochemicals and Beauty’.

Beauty is in fact an instinct desire of human being and satisfied by the product category called as cosmetics. The question on whether we can claim beauty effect in food will cause heavy debate. The ultimate goal of food intake is maintaining health of human body, and nutrition and health is the basis of beauty. However, claiming the effectiveness of a food component to a specific body beauty will cause serious debate. The health functional food regulation of Korea allows to use the term ‘skin health’, but not ‘beauty food’.

With this regulatory difficulties in mind, we are going to discuss the cosmetic effect of phyto-chemicals today. Health functional food has emerged in the 1980's and expanding its position in the boundaries of food and drug, and now it starts to knock the door to cosmetics. For the food scientists it

is a challenging area, but requires cautious approach. We need your active participation to the discussion and critical comments.

I admire today's speakers presenting such a new and controversial subject. Special thanks must be mentioned to the overseas speakers taking long journey to Korea. I would like to express my sincere thanks to President Se-Joon Park of Amway Korea and his collaborators sponsoring the Phytochemical Symposium for the last five years, and hope to continue the support in the future. Finally, not the least, I thank to the members of Secretaries of the Korean Society of Food Science and Technology for their effort to organizing this symposium.

September 20, 2007
Cherl-Ho Lee, President
Korean Society of Food Science and Technology

First Korea-United States Partnering Symposium on Food Technology and Green Chemistry, RDA, Suwon, Korea, October 17, 2007

▪ Opening Remarks ▪

Honorable Administrator Mr. In Sik Kim of the Rural Development Administration of Korea, distinguished invited lecturers and guests, and ladies and gentlemen. It is my great pleasure to address opening remark for the First Korea-United States Partnering Symposium. This symposium is co-organized by the Rural Development Administration, Republic of Korea, Agricultural Research Service of US Department of Agriculture, and Korean Society of Food Science and Technology.

With the increase of living standard, it is clearly shown that public concerns about health and environment have become more important for human life. And the exchange of scientific and technical information have become invaluable to solve the problems laid in international trade of agricultural and food products. Understanding the production environment and technology behind of different regions of the world is needed to facilitate the free trade order under WTO. Especially, Korea has recently completed the FTA negotiation with U.S, and the agricultural and food commodity trade between the two countries will be expanded in the future.

In this regard, I am sure that this partnering symposium on “Food Technology and Green Chemistry” is very timely and essential with respect to the value of information exchange of science and technology in food and environment fields. I am also very sure that this symposium is mutually beneficial for those who lead the science and technology of food and environment fields in Asia and America.

This symposium was made possible by the efforts of Dr. Suk-Hoo Yoon, the international coordinator of KoSFoST, Drs. Hye Kyung Chun and Daeil Kim of RDA, and Dr. John Cherry of

ARS, USDA. I hope the US-Korea Symposium on Food Technology will continue to be held periodically in the future and contribute to the technological advancement and understanding the trade environments of the two countries. I do hope all participants and audiences from United States and Korea to obtain valuable information in science and technology of food and environment, and to enjoy wonderful and nutritious foods and sky-high cool autumn climate in Korea.

I would like to express my sincere thanks to the members of RDA, members of ARS-USDA, and the secretaries of KoFoST for their efforts for organizing this symposium. For those participating from over-seas, I should say special thanks and wish to have wonderful time here in Korea.

Thank you very much.

October 17, 2007
Cherl-Ho Lee, President
Korean Society of Food Science and Technology

Korean Conference on Innovative Science and Technology 2006 on Nutrigenomics, Muju Resort, Korea, July 20, 2006

▪ Opening Address ▪

It is my great pleasure to declare the opening of the Korean Conference on Innovative Science and Technology 2006 on Nutrigenomics here in beautiful Muju Resort. We will stay here in Muju for two nights and will give ourselves up to the sea of nutrigenomics together with the researchers actively working on the subjects of molecular biology, medical science, traditional Eastern medicine, nutritional science and food science and technology.

By the completion of human genome project and the powerful tools of molecular biology, it is now possible to elucidate the effects of nutrients and bioactive food components on the regulation of gene expression, which is called nutrigenomics, and the impact of variations in gene structure on one's response to food components, that is nutrigenetics. The genetic components responsible for the differences in disease and dietary response of individuals have been recognized for long time; for example, humoral pathology in Western Galenism, Ayurvedic three dosas in India and Sasang constitution typology in Korea.

From the late 1980s scientists began to investigate the nutrient-gene interactions, and the review papers on nutrigenomics started to appear in the 1990s. Scientists tried to explain the effect of a dietary component on a specific phenotype, for example, plasma lipid concentration, obesity, or glycemia, by one or more genetic polymorphism. Attempts have been made by investigators to relate the individual genetic variation with the single nucleotide polymorphism. The most rapid development of gene-diet interaction researches has been achieved in the area of cardiovascular disease risk, which can be easily quantified by plasma cholesterol as a biomarker.

However, the preliminary results regarding gene-diet interactions are for the most part inconclusive because of the limitations of current experimental design. In addition, most cases of obesity, cardiovascular disease, diabetes, cancer and other chronic diseases are resulted by the complex interactions between several genes and environmental factors. Therefore, the integrated researches of various disciplines designed to work on large population studies are required in order to accumulate data necessary for systems biology.

This conference is aiming at the communication and knowledge exchange of various disciplines regarding nutrigenomics and nutrigenetics. Emphasis has laid on the dialog between molecular biologists/genomic researchers and food and nutrition scientists/traditional Eastern medicine doctors. If we are able to find a channel to relate the Western analytical science to the Eastern universal observation, we will achieve a great advancement in the human nutrition and biomedical researches. It will allow us to utilize all the data accumulated in the Eastern medicine for predicting health effectiveness of food and biomaterials.

I hope this conference will result in a great advancement in nutrigenomics and nutrigenetics by combining Eastern health knowledge to the nutrigenomic research. I would like to express my sincere thanks to all the invited lecturers and chairs, poster presenters and industry participants for their contribution and enthusiasm to the conference. A great appreciation should be given to the Korean Federation of Science and Technology Societies for selecting this subject for the KCIST 2006 program.

July 20, 2006
Cherl-Ho Lee, Co-chair
KCIST 2006 on Nutrigenomics

61st General Assembly and International Conference on Microorganisms and Human Well-being, Korea University, Seoul, June 30, 2005

▪ Opening Address ▪

Good morning ladies and gentlemen, Respected President Yun-Dae Oe of Korea University, distinguished invited lecturers, and members of the Korean Society of Microbiology and Biotechnology, It is my great pleasure to open the 61st General Assembly and International Conference of the Society this morning. The theme of this conference is Micro- organisms and Human Well-being, which reflects today's social demands on more safe and healthier life.

Microorganisms can be a threatening matter causing diseases and toxins, but it can be also a valuable living matter to produce food and medicines. Therefore, control of microorganism is very important for human survival and well-being.

In this conference we are going to discuss industrial biotechnology, so called white technology, producing valuable fine chemicals by using microorganisms. The completion of human genome read-out and advanced molecular biology today make us to produce many valuable substances from microorganisms and expand its potential beyond our imagination.

The Korean Society of Microbiology and Biotechnology established in 1973 has continued its effort to collect and disseminate the knowledge on industrial microbiology. The society's effort is now internationally recognized, and our Journal of Microbiology and Biotechnology recorded the impact factor 1.66 in the Scientific Citation Index this year. This kind of achievements is only possible by the continuous innovative research work and active communication with internationally renown scientists of the society members.

I would like to express my sincere thanks to the invited lecturers of this conference, and especially those oversea's participants taking all the trouble to come to this Far Eastern country, Korea.

Special thanks is given to Korea University allowing us to hold the General Assembly and International Conference in this beautiful campus of centennial anniversary. I hope this event marks a cornerstone in the development of microbial white-technology of our time. Thank you very much.

June 30, 2005
Cherl-Ho Lee, President
Korean Society of Microbiology and Biotechnology

International Meeting of the Federation of Korean Microbiological Societies, Kyoyuk Munhwa Hoekwan, Seoul, October 13-14, 2005

▪ Welcome Address ▪

Good morning ladies and gentlemen, distinguished invited lecturers and participants. It is my great pleasure to address welcome remark for the opening ceremony of 2005 International Meeting of the Federation of Korean Microbiological Societies.

The Federation of Korean Microbiological Societies, established in the year 2000, is a collaborative entity of five microbiological societies in Korea: three societies in the field of medical science, The Korean Society for Microbiology, Korean Society of Virulogy, Korean Society of Mycology, and one for basic science, Korean Society of Microbiology, and another for applied science, Korean Society for Microbiology and Biotechnology. The aim of the Federation is to expand academic information transfer between adjacent fields, and to strengthen and enhance the public recognition on the importance of microbiological science and its application.

In the last June this year, the Federation organized a Discussion Forum on the Development Policy for Microbiological BT as the National Strategic Industry together with the Korean Federation of Science and Technology Societies. The Federation will continue this line of efforts for the enforcement of microbiology R&D work in Korea. This Meeting is one the important activities of the Federation, and I am pleased to meeting you in this successful opening. I wish all of you enjoy this meeting and acquire valuable informations for your research.

I must express my sincere thanks to the Organizing Committee, headed by Prof. Chul-Su Shin, for their labor and effort. We also thank to all the sponsors and exhibition companies for their support for this Meeting.

In this opening ceremony, we are pleased to hold a special celebration for Hantan Award, commemorating the distinguished research work of Prof. Ho-Wang Lee on Hantan virus. The award will be presented by the members of the Korean Society of Virulogy.

Again I congratulate all of you for the successful opening of the Meeting, and wish all of you have wonderful time. Thank you very much.

October 13, 2005
Cherl-Ho Lee, President
Federation of Korean Microbiological Societies

Workshop on Nutritional and Safety Assessments of Foods and Feeds Nutritionally Improved through Biotechnology, Seoul, May 27, 2005

▪ Welcome address ▪

It is my great pleasure and honor to open the ILSI International Food Biotechnology Committee Workshop here in Seoul today. International Life Science Institute, ILSI, is a non-governmental organization made for the improvement of safety, nutrition and human health through scientific and educational activities. ILSI headquarter is located in Washington DC, USA, and ILSI Korea is one of the 14 local branches.

The International Food Biotech Committee of ILSI has been working actively to enhance scientific understanding of the public on the safety and benefit of genetically modified products made by modern biotechnology. The controversy over the safety of GM food and feed is influencing greatly the use of modern biotechnology. The scientific rationale of the one part of the world is pushing the use of GM food, while the other's precautionary stance based on social rationalism prevents their distribution. The regulatory principles are divided into two edges; regulation on the nature of the products, so called substantial equivalence principle, versus regulation on the manner in which they are produce. With the world-wide dispute on GM food safety, people in the developing countries are confused and the benefit of modern biotechnology is fading. The incidence of GM tofu(soybean curd) raised by the Korean consumer groups in November 1999 demonstrates the severeness of the problem.

In spite of the public acceptance problems on GM food, the modern biotechnology researches are continuing, and the first generation GM crops which are focused on input agronomic traits, such as insect protection, disease resistance, herbicide tolerance ant etc., are touching baton to value-added output traits, such as ripening modification and modification of chemical composition for nutritional and functional improvements. This workshop is concerned on the second generation GM products, and, particularly, the nutritional and safety assessment of foods and feeds nutritionally improved through modern biotechnology.

Korea imports over 2 million tons of wheat, one million tons of soybean and 3 million tons of corn annually from outside, mainly from USA, where GM crops are becoming their major products. Therefore, the safety and quality of GM crops are utmost importance for the Korean people. I hope this workshop contribute to expanding the knowledge of Korean experts as well as the public to evaluate the safety and quality of GM food on the basis of sound scientific data.

May 27, 2005
Cherl-Ho Lee
President of ILSI Korea

KOICA International Workshop on Food and Biotechnology Transfer, Korea University, Seoul, April 9-28, 2001

▪ Welcome Address ▪

Dear participants to the KOICA International Workshop on Food and Biotechnology Transfer at Korea University. It is my pleasure to welcome you to Korea, and especially to Korea University. Korea University was founded in 1904, and is one of the oldest and largest Private University in Korea. We have presently 20,000 undergraduate students and 10,000 graduate students in 12 Colleges and 12 Graduate Schools.

The Graduate School of Biotechnology of Korea University was formed 6 years ago as a National Strategic Research and Education Institute. It was supported by the government 3 million dollars per year for 5 years for its facilities and research activities. It has presently 45 Professors and 400 graduate students in 5 research areas, Biochemistry, Molecular Biology, Medical Biotechnology, Food Science and Biotechnology, and Bioengineering.

The Center for Advanced Food Science Technology(CAFST) of Korea University was established in 1995 as a Research Center of Encouragement designated by the Korea Science and Engineering Foundation (KoSEF). During its encouragement period of 3 years supported by KoSEF, The Center laid the foundation for collaborative research within Korea University and international cooperation in the field of food science and technology. In 1997 CAFST was designated as a university research institute and in 1988 it was approved as a Testing Laboratory for Food Quality Assessment by Korea Food and Drug Administration. The Center takes leadership in Korea Traditional Food Industrialization Research Group founded in 1999.

As the Director of the Center, I am very much pleased that we have launched the KOICA International

Workshop on Food and Biotechnology Transfer this year. You are the first team of this international course, and very fortunately you will be able to participate to the 11th IUFoST World Congress of Food Science and Technology which will be held in COEX Convention Center from April 22-27.

I am grateful to Prof. Dong-Hoon Shin, the training coordinator of CAFST, Mr. HunPyo Ha and lecturers of this workshop, and also the program officers of KOICA for their efforts to materialize this workshop. Lastly, I wish all of you to have fruitful and enjoyable stay in good health here in Korea.

Thank you.

April 9, 2001
Cherl-Ho Lee, Director
Center for Advanced Food Science Technology(CAFST), Korea University

11th IUFoST World Congress of food Science and Technology, COEX, Seoul, April 22-27, 2001

▪ Final Report ▪

The IUFoST 11th World Congress of Food Science and Technology organized by the Korean Society of Food Science and Technology was held at COEX Convention Center in Seoul, Korea, in April 22-27, 2001. The total number of participants was 2,151 from 58 countries (See the attached statistics).

Scientific program: One founder's lecture, 9 plenary lectures, 48 symposia consisting of 293 oral presentations, 7 round table discussions consisting of 46 panelists and 14 poster sessions posted with a total of 741 research papers.

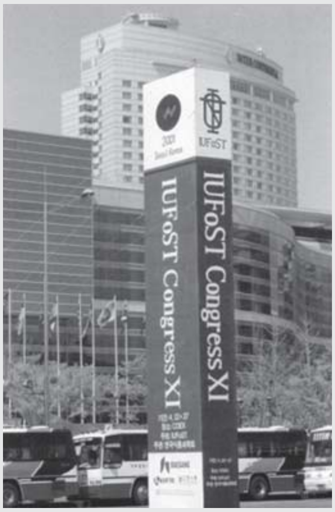
Pre-congress short courses: Four short courses were held prior to the congress and the total number of attendants were 210(SC1 Food lipid 75 persons, SC2 Sensory 41 persons, SC3 Biopolymer 59 persons, SC4 Food extrusion 35 persons).

Technical tour program: A total of 159 people participated to the technical tours (TT1 Soy sauce plant 10 persons, TT2 Kimchi & soymilk 75 persons, TT3 Soybean curd 13 persons, TT4 Rice winery 38 persons, TT5 Instant noodle 23 persons).

Pre-congress Internet conference: A total of 193 abstracts were posted from 22 countries (425 authors were involved) and over 5,000 people visited the site. Three sessions in Congress XI were formed from the Internet Conference

Special events: Opening ceremony and Welcome reception - ca. 800 participants, Korean Night hosted by the Mayor of Seoul Metropolitan City - ca. 800 participants, Congress Banquet - ca. 450 participants.

Student program: Three symposia were held for student presentations. 14 overseas students from 12 countries were invited by the IUFoST student travel grants(See the attached list). 13 students from USA participated by the support of IFT.



Publications: Program Book, Abstract Book, and Internet Conference Proceedings.

Closing accounts:

Congress XI epilogue

"Last Sunday we have launched the ship of Congress XI, and after a long voyage we are approaching to the Harbour of Achievement." It was the opening statement of Congress Banquet on the Thursday evening of April 26, 2001. Indeed, the distance from the start to the end of Congress XI was not so long comparing to the four years of preparation.

April 27, 2001
Cherl-Ho Lee, Secretary General
Organizing Committee of IUFoST 11th World Congress

The 4th CAFST Seminar on Acceptance and Trading on Irradiated Foods, Korea University, April 30, 1998

▪ Introductory Remark ▪

Last year we have experienced a great public scandal on the incident of pathogenic *E. coli* contamination on imported beef from the USA. And soon after the contamination of Listeria in the imported ice cream product was reported. The recent incidents are occurred in the refrigerated or frozen products, which have been considered very safe against bacterial contamination. It seems like that we are faced to the new attack of hazardous food microorganisms, which are once considered being conquered by the modern technology of the 20th century. The new strains of hazardous bacteria are particularly able to grow in the low temperature generally believed as safe for food preservation. Because of active international trade and long distance transportation of food today, this kinds of food hazard spread all over the world, and a country like Korea, who imports 2/3 of their food from outside, is fully exposed to the risk. Although the government authorities, the Ministry of Health and Welfare and Korea FDA, do their best controlling food hygiene of the country in order to protect the people from such kinds of risks, new technologies of food preservation, which can eliminate these hazardous strains and protect foods against their recontamination are urgently needed as a fundamental provision. The conventional thermal process is not adequate to apply for the sterilization and pasteurization of the products sold in fresh and uncooked state, since it changes the texture, color and flavor of the fresh foods. For instance, the fresh meat can not be sold after heating, and ice cream cannot be consumed after boiling. Food irradiation is one of the few methods which are able to solve this problem, and now the world is accepting this technology.

The food irradiation technology, which is able to sterilize the microorganisms in the food without significant changes in texture, color and flavor of fresh foods, has been well established already 20 years ago. However, the consumers, not only in Korea but also other countries, are reluctant to buy irradiated foods because of their fear related to the atomic bomb. Here lies the misunderstanding and prejudice of consumers on irradiated food. People imagine that foods are mixed or contaminated with radioisotope by irradiation. But it is not true. Food irradiation utilizes the high frequency energy irradiated from radioisotope to kill the germs, same as we utilize thermal energy from coal for cooking. When we cook rice by coal, we do not mix coal to the rice, and it is same in food irradiation. When foods are irradiated excessively, the color and flavor changes, same as excessive heating burns the foods.(see Figure 1) Excessively irradiated foods, which are irradiated far more than sensory quality deterioration occurs, may contain hazardous radiolytic products, same as charred foods may contain carcinogens. There is no reason to irradiate food so excessively as to the extent of being inedible due to sensory quality deterioration, same as we do not cook food until it burns out. The recent development of food irradiation technology makes it possible to control the process to yield acceptable germ-free fresh foods without the formation of harmful radiolytic products.

It has been proved by the numerous research results reported during the last half century that food irradiation is the most clean and safe method of food preservation we know presently. On the basis of these studies, the UN organizations, IAEA, FAO and WHO, recommend and advocate this technology through out the world as a means of solving world hunger problem and improving the sanitary conditions of the developing countries. The 14th Annual Meeting of the International Consultative Group for Food Irradiation (ICGFI) held in Mexico last October made a resolution to hold a workshop on the harmonization of regulations on food irradiation in Asia and the Pacific in Seoul this year. The FAO/IAEA/ICGFI Regional (RCA) Training Workshop on Harmonized Procedures and Regulations on Irradiated Food was held in 27-29 April in Seoul by this resolution. The delegates from 15 countries in this region working in the field of food hygienic control and food irradiation technology participated and discussed on the related regulations and quarantine procedures of this region. The food regulations related to irradiation procedures, safety control rules, labelling requirements, quarantine procedures and marketing regulations of each country were reviewed. It is clear that food irradiation is becoming a common practice in international food trade and we have to be prepared for it.

The US Parliament approved the irradiation of beef for sterilization December last year, right after the Korean case of pathogenic *E. coli* O-157 contamination on their exported beef, and it is anticipated that we are going to import irradiated beef from USA soon. China has more than 40 food irradiation plants around their eastern coast facing to Korean peninsular. It is therefore necessary to educate Korean consumers to understand the technology and to know correctly the risk and benefit of irradiated foods. For this purpose, two worlds renowned experts participated to the RCA Workshop in Seoul and two experts in Korea were invited to this seminar to give us their knowledge on food irradiation in order to initiate our debate.

Prof. Myng-Chul Lee, Associate Dean for Research Affairs of Seoul National University College of Medicine will present the present status of nuclear energy use in non-power generating area, such as medicine, agriculture and other industries as well as food irradiation, especially in Korea. Mr. Paisan Loaharanu from IAEA, Vienna, will introduce the wholesomeness of irradiated foods and the present status of their international trade and utilization. Dr. Myung-Woo Byun of Korea Atomic Energy Research Institute will introduce the research activities and regulatory status on irradiated foods in Korea. Dr. Alicia Lustre of Food Development Center, Philippines, will present the international trading and control practices on irradiated foods, particularly, in Asia Pacific region. After the lectures we will have general discussion on irradiated food with the invited debaters representing both groups, for and against of food irradiation, and the audiences.

We are in the stage of requiring an open discussion on the pros and cons of food irradiation. I am grateful to the Korean Society of Food Science and Technology (KoSFoST) and Korea Atomic Energy Culture Foundation for their sponsorship with great sympathy and understanding on this seminar. I would like to express my sincere thanks to Prof Myung-Chul Lee, Dr. Myung-Woo Byun, Mr. Paisan Loaharanu and Dr. Alicia Lustre for accepting their invited lectures, and the invited debaters representing different groups for their participation. Special thanks should be expressed to Prof. Hyo-Sun Shin, President of KoSFoST, and Dr. Jong-Sei Park, Director of Korea FDA, for their words of encouragement, and Prof. Se-Young Lee, Prof. Hyun-Jin Park, Prof. Joong-Ho Kwon and Dr. Young-Kyung Lee for their chairmanship. I would also like to express my special thanks to Prof. Seung-Taik Lim and his colleagues for their efforts to preparing this seminar.

April 30, 1998
Cherl-Ho Lee, Director,
Center for Advanced Food Science and Technology(CAFST), Korea University
Chairman, ICGFI Workshop on Harmonization of Procedures and
Regulations on Food Irradiation for Asia and the Pacific,
Victoria Hotel, Seoul, 27-29 April, 1998

Major Review Articles

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Internet Discussion: Fermentation Technology

Creative Fermentation Technology for the Future

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Introduction

Fermentation technology is one of the oldest food technology appplications that has been developed and utilized for survival. The origin of Asiatic fermentation technology evolved as early as the littoral foragers period of the Primitive Pottery Age (8000-3000 B.C.), which led the Neolithic culture of agriculture in Northeast Asia. The importance of the Primitive Pottery Age for the dietary culture of the region was discussed during the 11th IUFoST World Congress in Seoul (Lee 2001a). Fermentation technology has developed indigenously all around the world by using natural products from the respective region to produce required food materials, from which the characteristic taste and aroma of each cultural society have been made. Steinkraus(1993) classified fermentation technology of the world, responsible for man's survival, into six groups: alcoholic, lactic acid, leavened breads, meat substitutes, meat flavored sauces/pastes, and protein/flavoring agents.

The meat-eating habit of Western culture needed food preservation technology in order to keep perishable meat and milk edible for longer periods. Meat sausage, cheese, and acid-fermented milk making were important food preservation technology methods until the time when refrigerators were available in homes. On the other hand, people who ate cereals as staple food in the East wanted to have meat-flavored and salty condiments, which make the bland taste of cereal foods more palatable. This demand led Asian people to develop soybean sauce and fish sauce fermentation procedures.

Consumer perception of food has changed through history. Until the 20th century, the food situation of the world was always problematic. Food shortages could occur any time, even in affluent societies. Therefore, humankind mostly lived for food, and we may call this earlier period the "survival food age." In the 20th century access to food no longer was a problem in most of the affluent societies, but there was little time for leisure. People wanted to save time cooking and obtaining food. Consequently, convenience food became the major item in the food market. Now, we all notice that the 21st century is the "functional food era." Health-oriented food and nutraceuticals have become major consumer concerns.

Fermentation technology has adapted itself to social demands. During the survival food age, fermentation was used mainly for food preservation and production of condiments. In the convenience food age, it was used for flavor production and other ingredients useful for industrial mass production of food. The 21st century is called the era of tailor-made goods satisfying personal demands and, together with health benefit demands, fermentation technology now finds new challenges in the marketplace. Many of the traditional fermented foods are receiving new attention for their health promoting or disease preventing/curing effects. Scientific evidence for their physiological functions are accumulating and the technologies enhancing the beneficial effects are developing rapidly by using modern biotechnological and genetic engineering techniques. Some of the recent developments and future prospects are discussed below.

Lactic acid fermentation for probiotics

Yogurt and sour milk products are now well known in Western society as probiotic foods. Similar products made with rather inexpensive raw materials are found as many indigenous fermented foods around the world. Korean kimchi is one example. It is made from vegetables, lightly salted (about 3%), and fermented by lactic acid bacteria, mainly *Leuconostoc mesenteroides*. The lactic acid bacteria grown in kimchi could survive in gastric acid and bile juice thus reaching the large intestine (Lee 1997). More important is that kimchi contains various functional components either originating from the ingredients or formed during fermentation, as shown in Table 1. The same beneficial effects can be expected from African cereal gruels like ogi and uji, Nigerian gari, and Asian vegetable foods like dhamuoi in Vietnam, dakguadong in Thailand, and burong mustala in the Philippines, as well as from acid-fermented seafoods mixed with cereals (Lee 1994). In addition to the probiotic effect, these vegetable products have excellent prebiotic function.

Combining Western milk fermentation technology and Eastern cereal processing skills led to the creation of fusion foods like soybean yogurt and rice yogurt. Risogurt is an example of a lactic acid-fermented vegetable drink studied in Korea and made from a mixture of rice and soybean protein (Mok 1994). Many of the vegetable yogurt products are now found in markets of the USA and Japan.

The antimicrobial activity of some lactic acid bacteria against *Helicobacter pylori*, which is known to cause stomach cancer, is well applied to acid-fermented milk beverages and highly accepted by consumers in Korea (Park and others 2001). The anti-diarrhea effect of lactic acid bacteria like *Lactobacillus acidophilus* is enhanced by protein-coating (Chung and others 2001). The freeze-dried bacterial cells coated with protein are added to food for preventing diarrhea and also for other health benefits; and this market is increasing rapidly.

Table 1—Biologically active compounds in kimchi (Oh and others 1994)

Chemical compounds	Occurrence	Possible effect
Benzylisothiocyanate, indole compound, thiocyanate, flavonoid	Chinese cabbage, allium vegetable, red pepper	antibiotic, anticarcinogenic, immune stimulant
Sistosterol	Chinese cabbage	reducing the cholesterol level
Diallylsulfide, diallyltrisulfide, diallylmethylsulfide	allium vegetable	anticarcinogenic, antioxidant, fibrinolytic
Gingerol, gingerin	ginger	antibiotic, fibrinolytic
Capsaicin	red pepper	laxative, secretion of neuropeptides
Lactic acid bacteria	kimchi	antagonistic
Bacteriocin	kimchi	antibiotic
L-(+)-lactic acid	kimchi	modulation of T-cell function
Acetylcholine	kimchi	laxation
Dextran	kimchi	laxation
α-aminobutyric acid	kimchi	laxation
Acetate	kimchi	antibiotic

Soybean fermentation for cancer and degenerative disease prevention

The physiological function and health benefit of soybean is widely recognized today. The blood cholesterol level reduction activity of soybean protein and its hydrolysate and the pseudoestrogenic effect of soybean isoflavones have been experimentally verified. In addition to flavor formation, soybean fermentation increases the digestibility and the nutritional value, and it also produces functional compounds of health benefit (Lee 2001b).

Soybean fermentation for soybean sauce and paste, such as Korean chongkukjang and Japanese natto, involves the process of enzymatic hydrolysis of protein to make peptides and amino acids. Some peptides in soybean sauce and paste are known to have ACE inhibition and anti-thrombotic and anti-cancer effects(Kim 1995; Shin and others 1995; Shon and others 1996). Fermentation with Aspergillus and Rhizopus molds converts the glycoside form of isoflavones, daidzin, and genistin to aglycones, which have a higher potency of estrogenic effect. Production of mucous polysaccharides and enzyme kinase during bacterial (Bacillus) fermentation of soybean is related to the fibrinolytic and immune modulating activity of chongkukjang and natto (Sumi and others 1987; Lee and others 1991). By enforcing these components through molecular breeding of the microorganisms involved and novel fermentation skills and improved downstream processes, numerous health-oriented food products are now being produced and are in trial stages in East Asia and will be launched into world markets in the near future.

The advantage of mixed culture fermentation

Industrial yogurt production in the West and soybean sauce production in the East were achieved by pure starter culture isolation techniques. However, many of the traditional fermentation starters in the East are naturally fermented mixed culture systems. Consumers often prefer the traditional fermented products made by a naturally fermented starter culture. The deep and bountiful aroma of Korean rice wine, chongju, and the sharp, strong flavor of Korean soybean sauce, kanjang, are more preferred by Korean people than others. The anti-cancer activity of doenjang made from theKorean traditional mixed culture starter meju was reported to be higher than that of the industrial product made from koji. The physiological characteristics of microbial strains isolated from traditional fermentation starters and their interactions for growth and biosynthesis of functional compounds are now under investigation. More studies on the interaction of different species of microorganisms in a fermentation system are needed. Computer-aided analysis of microbial interaction will make this sort of study possible and manageable.

Safety issue of fermented products

Since fermentation makes raw food materials edible without cooking, the risks of hazardous microbial contamination always exist in fermented food, especially naturally fermented traditional foods. The uneven distribution of salt in lactic acid-fermented fish products and contamination of *Aspergillus flavus* in traditional starter cultures for rice wine and soybean sauce may result in severe food poisoning outbreaks (Lee 1989; Lee and Lee 2002).

On the other hand, most of the traditional fermentation methods have their own built-in safeguard mechanisms. Dangerous microorganisms contaminating the vegetables and other raw materials of kimchi are killed within one week of the fermentation period mainly due to acid formation and bacteriocin production (Lee 1997). Also, large amounts of nitrate and secondary amines in vegetable products are reduced by fermentation (Lee 1986). The importance of fermentation technology for the improvement of hygienic conditions in regions where cold-chain systems are not well established, was discussed at the FAO/WHO Workshop on the Assessment of Fermentation as a Household Technology for Improving Food Safety held December 11-15, 1995, in Pretoria, Republic of South Africa (WHO 1996).

Conclusion

Fermentation technology has met a new challenge in the era of functional foods with its efficient biosynthesis potential. Research for useful strains from traditional fermented foods continues worldwide and relevant information is accumulating. Exchange of knowledge and skills of fermentation technology of the West and the East will accelerate technology innovation and new product development. Considering the importance of fermentation technology in the era of functional foods, the public sectors and international bodies should pay attention to the relevant R&D efforts of academic institutions and industrial research groups. The R&D support of national and international funding organizations should include the following research priorities:

1. Nationwide search for useful microbial strains from indigenous fermented products and characterization of their physiological properties
2. Establishment of a global network on fermentation technology and microbial strains and starter culture information
3. Studies on mixed culture fermentations and the interaction of microorganisms in a fermentation system

4. Evaluation of physiological functions and health benefit mechanisms of the metabolites obtained during fermentation processes
5. Evaluation of safety of fermented products, the microorganisms involved, and the metabolites
6. Evaluation and dissemination of fermentation technology for the improvement of hygienic condition in developing countries

References

Chung MJ, Cho YC, Hong UP, Kim D. 2001. Improvement of stability in protein-coated LAB(PROLAC) and dual-coated LAB(DUOLAC) using soy protein and polysaccharides. Presented at the First Asian Conference on Lactic Acid Bacteria for Industrial Application and New Technology, October 27-28, Suwon, Korea.
Kim SE. 1995. Tumor suppressive peptides derived from traditional Korean soy sauce. MS Thesis, Seoul National Univ., Suwon, Korea.
Lee BY, Kim DM, Kim KH. 1991. Physico-chemical properties of viscous substances extracted from chongkook-jang. Korean J Food Sci Technol 23(5):599-604.
Lee CH. 1986. Kimchi: Korean fermented vegetable foods. Korean J Dietary Culture 1(4):395-402.
Lee CH. 1989. Fish fermentation technology. Korean J Appl Microbiol Bioeng 17(6):645-54.
Lee CH. 1994. Importance of lactic acid bacteria in non-dairy food fermentation. In: Lactic acid fermentation of non-dairy food and beverages. Lee CH, Adler-Nissen J, Barwald G, editors. HarnLimWon, Seoul. p 132-50.
Lee CH. 1997. Lactic acid fermented foods and their benefits in Asia. Food Control 8(5/6):259-69.
Lee CH. 2001a. The importance of Primitive Pottery Age (8,000-3,000 B.C.) of northeast Asia in the history of food fermentation. Presented at the 11th World Congress of Food Science and Technology, April 22-27, 2001, Seoul, Korea.
Lee CH. 2001b. Fermentation technology in Korea. Seoul: Korea Univ. Press. p 70-91.
Lee CH, Lee S S. 2002. Cereal fermentation by fungi. In: Applied mycology and biotechnology. Vol. 2. Agriculture and food production. p 151-70.
Mok CK. 1994. Lactic acid fermentation of rice and its quality improvement strategy. In: Lactic acid fermentation of nondairy food and beverages. Lee, CH, Adler-Nissen J, Barwald G, editors. Seoul: HarnLimWon. p 132-50.
Oh YJ, Hwang IJ, Leitzmann C. 1994. Nutritional and physiological evaluation of kimchi. p.226 In: The science of kimchi. Seoul: Korean Society of Food Science and Technology.
Park MJ, Kim JS, Yim JY, Jung HC, Song IS, Yu E, Lee JJ, Huh CS, Baek YJ. 2001. The suppressive effect of a feremented milk containing Lactobaculli on Helicobacter pylori in human gastric mucosa. Korea J Gastroenter 38(4):233-40.
Shin ZI, Ahn CW, Nam HS, Lee HJ, Lee HJ, Moon TH. 1995. Fractionation of angiotensin-converting enzyme (ACE) inhibitory peptides from soybean paste. Korean J Food Sci Technol 27(2):230-4.
Shon DH, Lee KE, Ahn CW, Nam HS, Lee HJ, Shin JK. 1996. Screening of antithrombotic peptides from soybean paste by the microplate method. Korean J Food Sci Technol 28(4):684-8.
Steinkraus KH. 1993. Comparison of fermented foods of the East and West. In: Fish fermentation technology. Lee CH, Steinkraus KH, Reilly PJA, editors. United Nations Univ. Press, Tokyo. p 1-12.
WHO. 1996. Fermentation: Assessment and research. WHO/FNU/FOS/96.1.

Cherl-Ho Lee has been teaching Food Engineering and Food Preservation at Korea Univ. since 1979. He received his Ph.D. at the Royal Veterinary and Agricultural Univ. of Denmark and postdoctorate training at MIT, U.S.A., under the supervision of Prof. Chokyun Rha and Prof. Anthony Sinskey. He was project coordinator of the Fish Fermentation Technology Network of United Nations Univ., and project director of Industrialization of Lactic Acid Fermentation Technology of Cereals and Its Dissemination to the Developing Countries for UNIDO. He was appointed Secretary General of the 11th IUFoST World Congress of Food Science and Technology which was held in Seoul 2001, and for this occasion he published a book on Fermentation Technology in Korea. Professor Lee has been a member of the National Food Hygiene Advisory Committee of Korea since 1988 and received the National Merit Medal (Seokryujang) for his achievements in national health promotion and activities including writing a book "Food Hygiene Incidences White Paper." He has published over 200 research papers and 10 books on food science and technology.

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Comments on Fermentation Technology:
Creative Fermentation Technology for the Future

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Cherl-Ho Lee raises a most welcome discussion on how to adapt traditional food fermentation technology to the challenges of food production in the future. Among other things, he points to the fact that many traditional food fermentations are carried out as mixed culture systems. Like Cherl-Ho Lee, I find that this is a key issue to be studied systematically (see item 3 in Lee's conclusion).

It is a fact that most of these mixed culture fermentations are robust, in the sense that they generally yield the desired product, day after day, year after year. Most of them are not inoculated with controlled cultures. Instead, back-slopping is used to start the fermentation, or it may start spontaneously by the growth of the microorganisms naturally present in the raw material. Despite the obvious and inevitable fluctuations in the "starter" culture, the fermentations usually proceed predictably, apparently controlled by the proper choice of substrate and the prevailing environmental process parameters, such as temperature, oxygen tension, humidity, and substrate water activity. Projections of simple, unregulated exponential growth would under these conditions lead to widely different compositions of the culture at the end of the fermentation, and such growth models are obviously not representative for the development and growth in these systems. There must therefore be an internal regulation mechanism in mixed culture systems if they are to be reproducible. This phenomenon is well-known in, for example, the mixed-culture fermentation of European-style yogurt.

Many mixed food fermentations take place on solid or semisolid substrates. The interaction between microorganisms in, for example, biofilms is one of the current hot topics in general microbiology, and it is probable that much of this new knowledge of signal compounds and feed-back mechanisms can be of direct relevance to mixed culture food fermentations. However, other mechanisms may also play a role such as local access to substrate (this may be diffusion-controlled) and competition between colonies of the film-forming organisms for the substrate.

Attempts to transform in a predictable manner a traditional food fermentation process to a set of new process conditions will be much of a trial-and-error enterprise, unless backed up by theory. Qualitative mechanistic studies like the above are essential but cannot stand alone. They should be supplemented with quantitative, structured models on a par with the approach in the study of industrial fermentation processes. Such quantitative models find extensive use in the design and optimization of industrial fermentation processes.

This response is therefore also a general call to food biotechnologists to graze widely in the fields of biotechnology and microbiology. Two relevant references in this context are:

Christensen BB, Haagensen JAJ, Heydorn A, Molin S. 2002. Metabolic commensalism and competition in a two-species microbial consortium. Appl Environ Microbiol 68:2495-502.
Nielsen J, Villadsen J, Liden G. 2002. Bioreaction engineering principles, 2nd. ed. New York: Kluwer Academic/Plenum.

Jens Adler-Nissen is Professor in food technology and biotechnology at the Technical Univ. of Denmark, since 1986. He has functioned as leader for a number of research centers since 1987 and has served on the board of a couple of companies and research institutions. At present, he is member of the central research committee of the university and chairman of the research advisory group of the Institute of Food Safety and Nutrition, Ministry of Food. His main scientific interests are food product technology, heat processing of food, and enzyme processes in the food industry. Before joining the Technical Univ. of Denmark, Jens Adler-Nissen was a researcher with Novo Industri A/S (now Novozymes).

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Comments on Fermentation Technology:

Creative Fermentation Technology for the Future

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With the memories of the 11th World Congress in Seoul still in mind, I was very pleased to read the above-named paper by the chief organizer of the wonderful 2000 Congress. Indeed, the history of fermentation technology is impressive and it is of interest to note that food fermentation is of relevance at both the sophisticated industrial level as it is in rather "down-to-earth" family settings in the household. Professor Lee provides us with some of his expectations for the future, focusing on health and safety aspects. I fully agree with him that the recent years have shown the potential of incorporating probiotic cultures in (fermented) foods such as yogurt, and of the health-promoting effects of fermented soybean foods (Brouns 2002) and lactic-fermented cereal products (Jaskari and others 1998; Kiers and others 2000). In order to stimulate further discussion I would like to add some challenges that some of us, food technologists, should address.

Mycotoxins: Aflatoxins and fumonisins are the most toxic and carcinogenic, as well as chemically stable molecules. Whereas it is known that some microorganisms, for example, *Flavobacterium aurantiacum* (D'Souza and Brackett 2001) are able to degrade the lactone ring and detoxify aflatoxins, the common fermentation starters (lactic acid bacteria, yeasts) are not up to that task. With the present state of the art in biomolecular and genetic science it must be attempted to construct food fermentation starters that are able to detoxify the most relevant mycotoxins.

Anti-nutritional substances: Plant-derived foods have poor digestibility and bio-availability of macro- and micro-nutrients, even after fermentation! Taking into consideration the widespread occurrence of anemia and other symptoms of micronutrient deficiencies, it is a challenge for us to reduce levels of mineral-complexing natural substances such as phytic acid and tannins. Whereas conventional milling and extraction procedures can reduce the levels of these anti-nutritional factors, their residues are still negatively affecting mineral bio-availability. Can appropriate food fermentation starters be modified to serve a wholesome diet?

In conclusion, genetic engineering could help to achieve functionalities that hitherto were unthinkable. My personal opinion is that the public health advantages of such derived GMOs outweigh fears for gen-food, and that research should be done to prospect new miracles!

References

Brouns F. 2002. Soya isoflavones: a new and promising ingredient for the health food sector. Food Res Int 35:187-93.
D'Souza DH, Brackett R E. 2001. Aflatoxin B-1 degradation by *Flavobacterium aurantiacum* in the presence of reducing conditions and seryl and sulfhydryl group inhibitors. J Food Protec 64(2):268-71.
Jaskari J, Kontula P, Siitonen A, Jousimies Somer H, Mattila Sandholm T, Poutanen K. 1998. Oat beta-glucan and xylan hydrolysates as selective substrates for Bifidobacterium and Lactobacillus strains. App Microbiol Biotechnol 49(2):175-81.
Kiers JL, Nout MJR, Rombouts FM. 2000. In vitro digestibility of processed and fermented soya bean, cowpea and maize. J Sci Food Agric 80(9):1325-31.

Robert Nout has been teaching in the Dept. of Agrotechnology and Food Sciences at Wageningen Univ. in The Netherlands since 1983. He has an interest in food microbiology (food fermentations, microbial ecology, food safety), and cereal technology. In the area of food fermentations his research includes fungal solid-state fermentations and microbial ecology of mixed communities of yeasts and lactic acid bacteria, with a particular interest in the functionality of the fermentation processes. His key research issues include chemical and microbiological safety as well as nutritional functionality.

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Comments on Fermentation Technology: Creative Fermentation Technology for the Future

ROSA ROLLE, AGRICULTURAL INDUSTRIES OFFICER, AGRICULTURAL SUPPORT SYSTEMS DIVISION OF THE FAO OF THE UNITED NATIONS ROME

I am in agreement with Dr. Lee that a research and development focus is required in the area of food fermentations. This focus must not, however, be restricted to microbiological and safety issues. While it is true that a better understanding of microbial interactions during fermentations will lead to improvements in quality, safety, and consistency of fermented products, as well as more diversified uses of fermentation technologies, a more holistic approach which integrates considerations for upgrading the level of fermentation technologies, and process controls in order to increase efficiency, yields, and the quality and safety of fermented foods, is required. Consumer education on the benefits of consuming fermented foods is also required, particularly in developing countries where these foods are being displaced by economic and cultural changes. There is also a need for more comprehensive documentation of fermentation technologies, since a number of these technologies are being lost as populations migrate.

Efforts to exploit the functional properties of fermented products and their microbial properties should be used as a catalyst for improving the level of technology and the quality and safety of food fermentations, since fermented foods contribute substantially to the food security of millions in the developing world.

Rosa Rolle is an Agricultural Industries Officer in the Agricultural Support Systems Division of the Food and Agriculture Organization (FAO) of the United Nations, in Rome. She holds a M.Sc. and a Ph.D. in Food Science from the Ohio State Univ. Over the past seven years, she has been actively working on food fermentations in developing countries. She coordinated the preparation of four FAO Agricultural Services Bulletins on Food Fermentations, and served as the editor of these bulletins. At the 1999 Annual Meeting of the Institute of Food Technologists, in collaboration with IFT's Biotechnology Division, she conducted a Symposium on Small- Scale Fermentations in Developing Countries. The background papers presented at that Symposium were recently published in a special issue of the International Journal of Food Microbiology, of which she is a co-editor.

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Summary of Invited Lee Paper and Responses to Fermentation Technology: Creative Fermentation Technology for the Future

PAMELA TOM (UNIV. OF CALIFORNIA, DAVIS) AND DARYL LUND (UNIV. OF WISCONSIN, MADISON)

White Paper overview

The past (survival), present (convenience, condiments, and functionality), and future (safety and health) aspects of fermentation technology were excellently outlined by Cherl-Ho Lee (Korea Univ., Seoul). Jens Adler-Nissen (Technical Univ. of Denmark), Robert Nout (Wageningen Univ., The Netherlands), and Rosa Rolle (FAO, Rome) responded with additional and supporting comments on the topic.

Lee traces the evolution and applications of fermentation technology from the "survival food age" (food preservation and condiment production) through the "convenience food age" (flavor and industrial mass food production) into the 21st century known as the "functional food era." Lee discusses adapting traditional food fermentation technology to the challenges of food production in the future. Many traditional fermented foods are gaining attention for their health promoting or disease preventing/curing effects. Scientific data supporting their physiological functions are mounting and biotechnological and genetic engineering techniques are enhancing the beneficial effects.

Lee covers 4 key areas on fermentation developments and future prospects:
lactic acid fermentation for probiotics,
soybean fermentation for cancer and degenerative disease prevention,
the advantage of mixed culture fermentation, and
safety issues of fermented products.

Based on the key role fermentation technology has in the "functional food era" Lee suggests global research with 6 priorities to facilitate the exchange of Eastern and Western fermentation technology knowledge and skills to accelerate innovation and new product development:
1. worldwide search for useful microbial strains from indigenous fermented products and characterization of their physiological properties,

2. establishing a global network on fermentation technology, microbial strains, and starter culture information,
3. studies on mixed culture fermentation and the interaction of different species of microorganisms in a fermentation system,
4. evaluation of physiological function and health benefit mechanisms of the metabolites obtained during the fermentation process,
5. evaluation of safety of fermented products, the microorganisms involved, and the metabolites,
6. evaluation and dissemination of fermentation technology for improving the hygienic situation in developing areas where expensive cold-chain systems are not well established.

Summaries of Invited Responses

Item number 3 above is the focus of Adler-Nissen's response in which he emphasizes the need for an internal regulation mechanism in mixed culture systems if they are to yield reproducible results. In transforming a traditional food fermentation process to a set of new process conditions, Adler-Nissen notes that quantitative models have their place in the design and optimization of industrial fermentation processes. In his concluding remarks, Adler-Nissen calls upon food biotechnologists to "graze widely in the fields of biotechnology and microbiology."

Robert Nout briefly sets forth three challenges for food technologists to address in food fermentations: mycotoxins, anti-nutritional substances, and genetic engineering. Nout notes that with the current state-of-the-art in biomolecular and genetic sciences, attempts should be made to design food fermentation starters that can detoxify the most relevant mycotoxins (for example, aflatoxins and fumonisins which are toxic, carcinogenic, and chemically stable). Nout states that genetic engineering could help to achieve new functionalities in fermented foods.

In agreement with Lee, Rosa Rolle affirms that research and development in food fermentations are required. Rolla emphasizes a holistic approach to integrate upgrading the levels of fermentation technologies, and process controls in order to increase efficiency, yields, quality, and safety of fermented foods. She discusses the need for consumer education, particularly in developing countries, where these foods are being displaced as a result of economic and cultural changes. Rolla further notes the need for increased comprehensive documentation of fermentation to ensure that these technologies are not lost as populations migrate.

Summary of Creative Fermentation Technology Internet Forum

The forum discussion topics among the mailing list subscribers were limited in scope to:

A predominant discussion focusing on several attributes of quorn. The subscribers discussed without going into any great detail the following aspects of quorn: history, composition, and food products, labeling, marketing, controversy, and allergenicity.

A question on practical examples concerning the nutritional benefits of fermented foods based on genetically modified materials. No examples were mentioned by the subscribers; one provided additional comments on the need for quantitative models; global public awareness of GM food products, significance, and safety; as well as functional food processing regulations.

A question on whether pretreated substrates could sustain nutritional value and purity of product yield. No discussion followed.

A subscriber posting 40 philosophical questions designed to stimulate critical thinking on current fermentation issues (processing, trends, and research and development). Although no discussion on the 40 questions ensued, another subscriber suggested making a distinction between well known fermentations (such as alcohol and organic acids), fermented foods, and biomass production.

A subscriber questioned why fermentation technology has attracted so little research attention. The reply by another subscriber may explain why this forum has been very quiet and limited to the participation of a few posters. There are big companies conducting significant research in the field; however, the information is commercially valuable and proprietary.

This forum had 42 subscribers from approximately 17 countries.

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History of Fermented Foods in Northeast Asia

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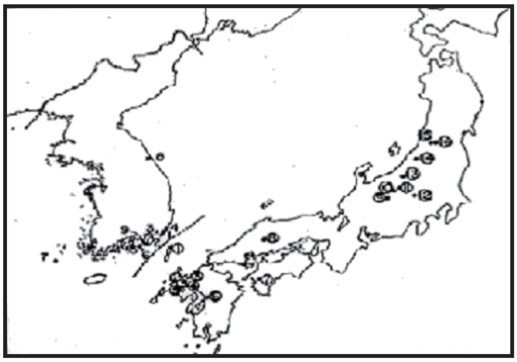
A brief outline of prehistoric era of Northeast Asia

Northeast Asian culture, generally known to Western society as Chinese culture, is comprised of the cultures of many segments of ethnic groups that have developed their own identities and distinctive cultures throughout history. At present, these cultures are grouped according to the names of countries; China, Mongolia, Korea, Japan and part of Russia (Siberia). But until fifteen centuries ago, the ethnic group (or tribes) was more important than the nation in distinguishing the way of life of the people (Nahm, 1988). The early existence of human beings in this region is evidenced by some Early Paleolithic remains (1,800,000-300,000 years ago, B.P.) of the Early/Middle Pleistocene period on the Northern Chinese Mainland and Korean peninsula (Lee, 2001). Several Middle Paleolithic (350,000-40,000 B.P.) remains were also found on the Korean Peninsula and South Manchuria, and numerous Late Paleolithic (40,000-10,000 B.P.) sites were found on the Korean Peninsula, South Manchuria, and Japanese Islands as well as the Chinese Mainland. These sites indicate the increase in population and the spreading out of the people in this region in the Paleolithic Age (Lee, 1983).

Until the end of Late Paleolithic Age, the northeast Asians lived with mobile hunting and mountain foraging. They preyed on deer, wild-pig, bison and roe. These animals provided men with meat, gut and blood. In addition they may have eaten plants like acorn, chestnut, wild grape, arrowroot and other wild roots and vegetables. Animal meat, intestine and blood were probably the main foodstuff for these people, and the use of vegetable supplements, such as grass seeds, tree nuts and wild fruits and roots, increased at the later stage of paleolithic era. The people probably lived in mountain caves at the beginning, and gradually moved to the lower plains and river banks at the Late Paleolithic Age (Lee, 1998). Gradually they developed skills of food storage by drying. From that moment they knew that, they could obtain lots of food around the previous dwelling sites, so they could stay longer in these areas. As long as they habited in one place, they reduced mobile hunting practice, and instead more food was obtained by collecting seeds of grass and barnyard grass, millet and wild beans. Step by step they were accustomed to collecting mollusks like frog and snail in damp ground and clams and shellfish in river or beach.

Western archaeology distinguishes Neolithic Age from the Paleolithic by the use of polished stone tools and the start of agriculture, since these two events appear to take place at the same period around 8000 B.C. in Europe. However, this chronicle is suggested to be unsuitable to that of Northeast Asia, where indications of the use of ground stone tools of 30,000 years old exist, and the primitive earthenware of 12,000 years old are discovered, while the oldest evidence of agriculture is only ca. 5000 year old (Barnes, 1993).

The migratory forager's life of paleolithic men following the periodical and seasonal movements continued until the use of textured pottery. Textured pottery was probably invented by the people in the Far Eastern region, comprising the southern parts of the Japanese Islands, the Korean Peninsula, and the *Bohai* (*Balhae*) Corridor in the years between 10,000 and 6,000 B.C. The oldest earthenware in the world was found at Fukui cave in Kyushu and it was estimated to be 12,000 years old (Barnes, 1993). As shown in Figure 1, the early primitive pottery remains are found around Korea Strait coastal area including southeast of Korean Peninsula and northwest of Kyushu Island. Korean Peninsula functioned as a land-bridge connecting the seasonal movements of paleolithic hunters from north of Manchuria to the south of Japanese archipelago, and Korea Strait was an obstacle interfering their journey. Consequently people must be gathered around the coastal region of Korea Strait, by which it became the cultural center to create the Primitive Pottery Age (Lee, 2001).



Dongsamdong 2. Dadaepo 3. Chukgok 4. Sinamri 5. Sangnodaedo 6. Yokjido 7. Sohuksando 8. Osanri
<Japanese Archipelago> ① Kosijima ② Fukui ③ Nisikaratsu ④ Iwasita ⑤ Senpukuji ⑥ Todoroki ⑦ Kamikuroiwa ⑧ Mawatari ⑨ Yangimata ⑩ Isigoya ⑪ Hasitate ⑫ Tazawa ⑬ Ozawa

Figure 1. The early primitive pottery age remains in the coastal region of Korea Strait (Han, 1983).

The use of *chulum* (Korean) or *jomon* (Japanese) pottery had spread over the region by 6,000 B.C., and it gradually changed the migratory hunter's life into littoral forager's life along the coastal line. The littoral foragers using textured pottery as the main tools for food processing and storage might be existed in the Korea Strait region between 6,000-3,000 B.C., prior to neolithic agricultural settlement. The author suggest to name this period "Primitive Pottery Age" in order to distinguish it from the European Mesolithic culture (Lee, 1999). The numerous shell mounds excavated along the coastline and major rivers in Korean Peninsula indicate that the people were engaged in hunting with bow and arrow and fishing with carved bone tools and fishing equipments. Tree nuts, acorns, wild grains, fruits, vegetables and roots were also used as foodstuff. The storage of wet cereals, meats, fish and vegetables in earthen pot might naturally produce fermented foods, and the invention of fermentation technology could provide relatively abundant nutrients to the people compared to the previous periods, and it must be resulted in sudden increase in population (Lee, 2001).

In about 3,000-2,000 B.C. which is known as Late Neolithic Age to Korean archeologists, polished stone tools were substituted with chopped stone tools, and by using them, farming agriculture began. This period is actually considered as Neolithic age in the sense of European standard. Human civilization was actually started at this moment in Northeast Asia, and tribal states based on agriculture and fishery settlements emerged. The neolithic period was followed by the Bronze Age in Korean Peninsula around 1,200 B.C. when the megalithic culture represented by dolmens and menhirs developed.

The Iron Age began in Korea around 500 B.C., and many iron tools, including weapons manufactured in the southern region played a significant role in trade with China and Japan, in agricultural development, and in the pattern of changes in military affairs.

Development of Korean dietary culture

As mentioned in the beginning, the animal meat eating habit of the early men in the Northeast Asia and Korean Peninsula appears to have gradually changed to omnivorous culture by the end of paleolithic age. The utilization of tree nuts and acorns, wild fruits, berries and grapes, grass seeds, roots, and young buds of trees and ferns increased gradually by noticing that abundant plant materials were growing around the previously inhabited caves and dwellings. The appearance of the pollen of grass, rice (*Gramineae*) and beans (*Leguminosae, Papilionoidiae*) increases at the Late Paleolithic remains (Lee, 1998). By the increase of plant food in the diet, the dwelling sites gradually moved from the mountain to the plains near river.

The use of marine products expanded by the use of earthenware at the beginning of Holocene. The food life of Northeast Asian people in the Primitive Pottery Age can be characterized by the abundant use of shell fishes and marine products together with animal foods from hunting, as evidenced by the numerous shell mounds along the coastal line of Korean Peninsula and Japanese Islands. Cooking of fish and vegetables in sea water in earthenware, so called *chigae* today, must be used from this period (Lee, 1999). Before man knew salty taste by using marine foods, people used to take mineral ingredients from either animal blood or intestine. They came to know that salty taste made them eat more vegetables and plant foods, and they could survive on plant foods when games were scanty. The people in Primitive Pottery Age who knew the salty taste and the source, lived near the seashore so seawater and seafood were used to make food with vegetables, roots, and grains. This must be the origin of *chigae* culture, which is the most characteristic Korean food culture. In fact the primitive people in Papua New

Guinea living in the coastal region today still use seawater as salty ingredient for cooking (Ishige 1976).

The existence of salt should be naturally discovered in the process of boiling seafood in pottery. Although we do not know exactly when the making of salt started, we can presume that people knew about salt from the beginning of *chigae* culture from the white powder left around c*higae* bowl when seawater or seafood were boiled.

When the horse riding people of the north, *Yemaek* tribe of northeastern *Dong-yi*, came to south of Korean Peninsula to become a agricultural farming settler, they needed to have a stable protein source to replace for their meat from the animal herds. They invented the use of wild soybean as food by soaking in water and cooking them properly to eliminate the antinutritional factors in the bean. It is considered that *Maek* tribes are the first user of soybean as food in the history (Lee, 1984). In a Bronze Age remain in Paldang, near Seoul, a smooth earthen vessel having the traces of soybean on the surface was excavated. Botanists believe that the origin of soybean is the line from South Manchuria to Korean Peninsular where most abundant varieties of wild soybeans are found. The first record on soybean appears in *Shyjing*, a Chinese literature written in the seventh century B.C.

The early cereal grains cultivated and utilized by the people in the Northeastern Asia and Korean Peninsular appears to be millet, which is the native plant in this region. The origin of short grain rice in this region is obscure, but numerous carbonized rice dated to be of the Bronze Age or earlier have been excavated. Soybean played important role not only in supplementing protein but also providing palatability in the form of fermented soybean products to the bland cereal and vegetable diet. The production of soysauce by *Maek* tribe, who were originally meat eating nomads, created a typical Korean dish, *Bulgoki* or *Maek-chok*, the roast meat marinated with soybean sauce.

The introduction of Buddhism, in A.D. 372 (*Koguryo*), A.D. 384 (*Baekje*) and A.D. 528 (*Silla*), accelerated the reduction of animal food consumption and encouraged the spread of vegetarian food habits. According to *Samguksaki* (1145), the oldest document of Korean history, rice, wine, oil, honey, soysauce, soybean paste, dried meat and fish sauce were the important food items that were prepared for a wedding in the royal family in *Silla* in the year of 683 A.D. The people of unified *Silla* and succeeding *Koryo* dynasties were strong Buddhists. During this thousand years of period, nomadic animal food habits disappeared. The extensive use of salted vegetables and of the soybean as the major source of protein resulted from this change. The technologies of soysauce fermentation and rice-wine making were well developed and transferred to neighboring countries (Lee, 1984).

The rout of the propagation of red pepper into Korea is unknown. Korean literature describes how it was introduced from Japan during the Korean-Japanese war in the 1600s, while some Japanese literature records that it was introduced through Korea into Japan. With the introduction of red pepper, the traditional salted-vegetable dish was transformed into today's *kimchi*. *Kochujang*, a typical hot soybean-paste of Korea, also developed through the introduction of red pepper.

The ideal diet for Koreans was standardized between the fifteenth and the nineteenth centuries. Records of an ideal standard meal for Koreans appear in much of the literature of the *Choson* kingdom, for example, in Shiui *Chonso*, written in the nineteenth century. The book written between the seventeenth and the nineteenth centuries outline a standard meal consisting of a bowl of cooked rice, a bowl of soup, and a dish of *kimchi* as the basic constituents. To this basic menu, side dishes are added, forming a three-dish meal (*samchop bansang*), a five-dish meal (*ochop bansang*), a seven-dish meal (*chilchop bansang*), and so on (Yoon, 1993).

Korean thought on life and health is based on the shamanistic folk religion, Taoism, which sets as the ultimate goal a healthy eternal life. The established Taoism, as developed by early Chinese philosophers teaches that this goal can be achieved by discipline, mainly by the control of breath, sex, and food. The principle of control is the harmony of *yin* and *yang*, the negative and positive nature of the universe (Lee, 1992). The basic idea of traditional Korean nutrition is to harmonize properties and tastes in the diet on the basis of *yin* and *yang* and the *Five Phases*. A diet that emphasizes one property or extreme taste is considered to be unhealthy. Korean meals are prepared to harmonize the properties and tastes through selecting proper ingredients and process. The basic meal consisting of a bowl of cooked rice, a bowl of soup, and a dish of *kimchi*, could supply 40 percent of the energy and 48.7 percent of the protein of the Recommended Dietary Allowance for an adult man (Lee, 1995).

Origin of Northeast Asian fermentation technology

The invention and the use of earthenware evoked the littoral foragers major advancements in the method of food acquirement before agriculture began. The marine foods obtained from the coastal regions and river sides were difficult to dry, and easily decomposed by autolysis and rapidly spoiled by microbial growth, so they consumed them instantly without storage, and therefore was unable to rely much on them. At this moment, crockery was invented and the event changed the primitive people's dietary life greatly. Earthenware enabled them to cook perishable foods easily, handle the wet materials and store them longer for eating.

The invention of earthenware could be enough to create revolutionary impact that dramatically changed the production and processing of food of the Paleolithic men. It is evidenced by numerous old shell mounds near the seashore or riverside in this region. This cultural trend of sea food preceding farm products still remains at present time; Korean and Japanese are the only people in the world who consume seaweed and laver as daily food and eat more fish and shell fish than meat.

Since the use of earthenware for the storage, cereals, vegetables, meats and marine products could naturally result in the fermentation. Cereal alcoholic beverages, vegetable pickles, and fermented fish and meats were probably made prior to the beginning of agriculture in this region. The long history of fermented food use is the most important factor characterizing the dietary culture of Koreans today.

(1) Origin of cereal alcoholic fermentation

In areas with high temperature and high humidity, mold growth is a natural process in a container storing wet starchy materials, for example, plant seeds, millet, barnyard millet, nuts, beans and tubers. Some molds like *Rhizopus* species produce enzymes which can hydrolyze raw starch and convert into sugars. When sufficient amount of moisture is provided, the sugar is transformed into alcohol by the yeast existing in nature. The alcoholic food or beverage having attractive aroma is produced in 3-4 days in summer after adding small amount of water to cooked starchy material in a crock. This is a natural process which can be easily observed even by the primitive people. When useful microorganisms are grown dominantly on the wet seeds and grains, it is *nuruk*, the traditional fermentation starter of cereal alcoholic beverage used in Northeast Asian countries. When *nuruk* is mixed with cooked rice and water in about 1:1:4 ratio, alcoholic fermentation takes place and is normally completed within one week in summer days. When it is strained with sieve into turbid liquid, it is called rice-beer, *makkolli* or *takju*, and when filtered with fine filter cloth into clear liquid it becomes rice-wine, *chongju*. It appears that the beginning of cereal alcoholic fermentation was made by uncooked starchy ingredients, thus the use of pottery may mean the start of cereal alcoholic fermentation (Lee, 2001).

Alcohol fermentation is considered one of the oldest food processing technology man have ever had, and some believes that alcoholic food or beverages existed from the time human being appeared on earth. The oldest archeological evidence considered of alcohol fermentation is the rice-wine crock found in a remain of Shang period around 2,000 B.C .(Lee 1984).

(2) Origin of *kimchi* fermentation

It is possible to observe lactic acid fermentation of vegetables yielding sour taste by keeping withered cabbage or turnip slices immersed in 2% brine for 3-4 days. This condition resembles that of primitive men putting foraged vegetables into a jar holding sea water, and with almost no exception the result would be lactic acid fermentation. In such condition, *Leuconostoc mesenteroides* will be the suitable candidate dominating the system at the initial stage of fermentation (Lee 1994). It is a heterofermentative bacteria producing both lactic acid and acetic acid from sugars in vegetable and grow actively until the pH goes down to 4.8. When *L. mesenteroides* stop growing at the lower pH, other homofermentative bacteria like *Lactobacillus plantarum*, which produce mainly lactic acid only, start to grow, and the vegetable becomes very sour like sauerkraut of Germany.

Many of the lactic acid fermented vegetables are made in anaerobic condition by packing vegetables in sealed container like ensilage making, and the resulting products are very sour. The vegetable pickles described as "*Zer*" in Chinese old literatures appeared to be this type of product. On the other hand, the vegetable pickles traditionally made in Northeast Asia including Korean Peninsula are made by salting and subsequent lactic acid fermentation, and are not so strong in sour taste. It indicates that the Korean style pickle, *kimchi*, is originated from the natural fermentation of withered vegetables stored in seawater made in the Primitive Pottery Age (Lee, 2001).

(3) Origin of fish fermentation

If one mixes the seafood, which easily putrefies, with lactic acid fermented vegetables and lower the pH to under 4.5, one can prevent the proliferation of harmful microorganisms, and therefore it can be stored over a long period of time and be consumed. Under this condition, because of the low salt concentration, the fish decompose rapidly by autolysis with its own intestinal enzymes, and a strong flavor or putrid stench is formed. The smell and taste created in this process would be unacceptable to modern men, but to the people of primitive era, who relied on rough plant materials like acorns, plant roots, grass seeds etc., it reminded them of the savory taste of stored animal meats and intestines. In fact, some fermented fish products made in different regions of the world have too strong flavor to be consumed by other people. Therefore under conditions where harmful microorganisms do not prevail, the putrefaction and fermentation are distinguished only according to the subjective judgment of consumers.

Seen from such perspective, the mixture of low-salt cured seafood with lactic acid fermented vegetables would be an essential condiment for the people at the transitory stage between meat diet and vegetarian diet, and can be an archetype of lactic acid fermented fish products, like *sikhae* in Korea, which are widely consumed in East Asia today. High-salt fermented fish products, like *joetkal* in Korea, must be developed at the later stage, when abundant salt production was possible. At an even later stage, when having raised the salt concentration, people came to add *nuruk* in order to achieve rapid decomposition of fish as well as to reduce strong putrid stench by the action of the enzymes in *nuruk*. This is the origin of jang (醬) which has been used widely in Northeast Asia and China as the major preserved food and condiment.

The first description on *jang* appears in Juolii written in 200 B.C. in China. It describes that *jang* has two types, *hae* (醢) and *hie* (醯), and records the methods of preparation. *Hae* is made from sun dried meats of foul, beast and fish, and ground into powder, mixed with rice-wine, salt and *nuruk* made from millet, and packed in a jar and sealed and aged for 100 days. *Hie* is made from same materials as *hae*, but acidic plum juice is added to give sour taste. It is apparent that *jang* was originally made from meat, and is a kind of meat sauce, not fermented soybean products which is commonly called as *jang* today (Lee 1984). It can be said that *jang* is a high class condiment developed by thousands years of experience, and applies the same principle of fish fermentation which might have been developed by the people in Korea Strait region during the Primitive Pottery Age.

(4) Origin of soybean fermentation

According to the botanists, the region covering South Manchuria and Korean Peninsula is the origin of soybean, because this area has the most abundant wild varieties (Kwon et. al. 1999). Archeologists consider that the history of soybean cultivation is about 4,000 years long, and the traces of soybean use are found in the Bronze Age (ca. B.C. 1500) remains in Korean Peninsula (Lee, 1992). Soybean appears to be first introduced to China in the Spring and Fall Warrior Period of 7th century B.C., and further transferred to southern China, southeast Asia and Japan in the period of B.C. 3rd century and A.D. 7th century. Accordingly, the people in Korean Peninsula and South Manchuria, so called *Dong-yi*, were the first user of soybean as food by using earthen vessel as cooking facilities. By using earthen vessel they were able to boil seeds in water, and could solve the problem of trypsin inhibitor of soybean.

At the early stage of soybean utilization the Northeastern *Dong-yi* had probably first invented *shi* (豉), the old Chinese term of Korean *meju*, by keeping cooked soybean packed in straw mat or cloth in hot summer. The needs for condiments to replace meaty flavor to the bland cereal diet would be the most probable motivation for the northern nomads settled in Korean Peninsula to produce fermented soybean products (Lee, 2001). According to Huang (2000), there are no references to *shih* in the pre-Chhin(-221 to 209) literature, but there is no doubt that by late Western Han, *shih* had become a major commodity in

China. The books written in Late Han and Tang periods (A.D. 100-800), for instance Bowuzhi and Xintangshu, describe the letter *shi* (豉) denoting *meju* as a dialect came from northern region and a special product of Bohai, a nation founded by the refugees from defeated *Kokuryo* (37 B.C.-668 A.D.) (Lee 2001, Lee 1984). Therefore, we can conclude that the origin of fermented soybean products is the Bronze Age in Korean Peninsula and South Manchuria by Northeastern *Dong-yi*. The written record on soybean sauce and paste utilization in Korean literature appears at much later years, like the records on a princess marriage in King Sinmun period (A.D. 683) of *Silla*. According to S. W. Lee (1990), fermented soybean products were first introduced to China in 1st century B.C., and to Japan in 6th century A.D. as shown in Figure 2.

Fermented soybean products

(1) Korean *kanjang* and *doenjang*

Meju is prepared from cooked soybean. Soybeans are soaked in water overnight, cooked for 2-3 hours and mashed by pounding. It is shaped like a brick or a ball, and dried in the sun and kept in a stack covered during the night for several days. For this period, the surface is grown with mold, especially *Aspergillus oryzae* and the inside with bacteria, typically *Bacillus subtilis*. The enzymes from mold and bacteria convert the soybean proteins into amino acids, and the carbohydrates into sugars and organic acids. The amino acids and sugars interact each other for browning reaction, resulting to form the characteristic dark brown color and meaty flavor. Well fermented *meju* is immersed in the brine in an earthen jar and ripened for several months. The brown color and meaty flavor leach out into brine. During this period, salt tolerant yeasts grow in the mash, especially *Saccharomyces rouxii*, which produces the aroma of soy sauce. The liquid part is soy sauce (*kanjang*) and the precipitates are soybean paste (*doenjang*). Soy sauce such produced is boiled once and stored in an earthen jar for years. The flavor of soy sauce gets richer as the storage time goes, same

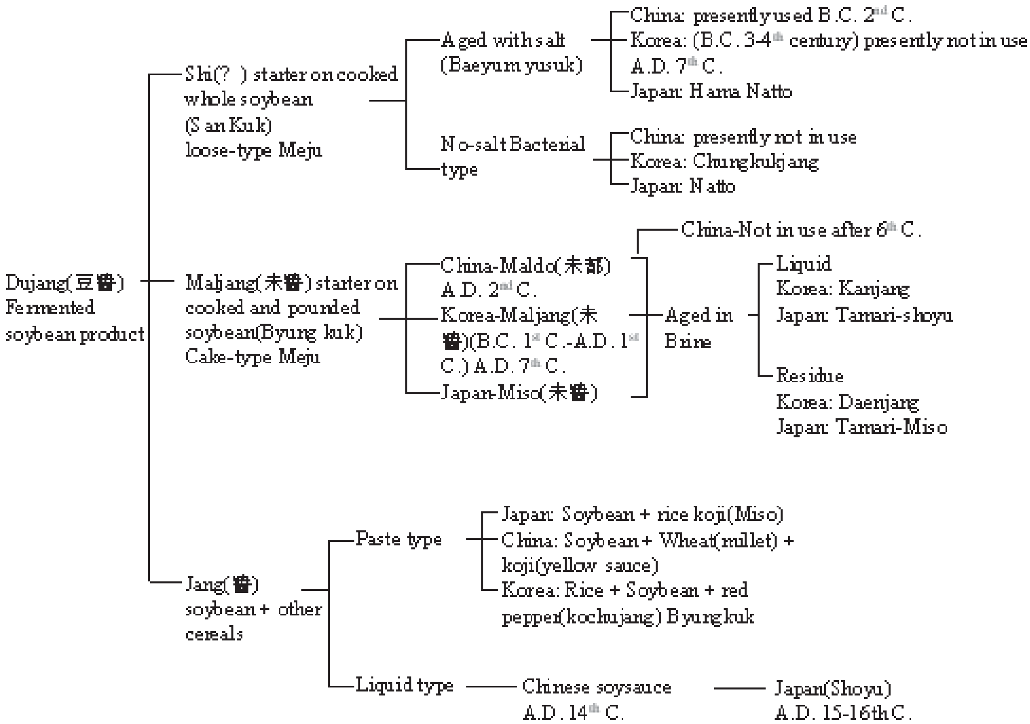


Figure 2. The origin and interchange of Dujang(fermented soybean products) in East Asia(Lee. 1990)

as the flavor of wine became smoother as it get old. It has been said in Korea that the taste of food in a household is decided by the taste of their fermented soybean products.

(2) Japanese shoyu and miso

Japanese people modified *silla* preparation method in 1904 by controlled fermentation technology using pure culture of mold isolated from the traditional starter (Shurtleff and Aoyaki, 1976). The mold, normally *Aspergillus oryzae*, is grown on cooked rice or cooked wheat grits, to make *koji*. It is mixed with cooked soybean for further fermentation, and then ripened in the brine. Soybean paste (*miso*) and soy sauce (*shoyu*) are made separately; for *shoyu*, *koji* is made with cooked defatted soybean flake and wheat grits and then mixed brine for aging. After 4-6 months aging, it was filtered to obtain *shoyu*, the liquid part, and the solid part is discarded. Miso is prepared by using *koji* made by cooked rice or other cereals and mixed with cooked soybean and salt, and then mashed into paste and ripened. These processes are easy for industrialization of the products. The flavor of Japanese *shoyu* and miso is mild and sweet compared to the Korean counterparts. Korean people prefer the strong flavor of traditional soy sauce and soybean paste, same as European people distinguish Roquefort from processed Cheddar cheese.

(3) Korean *chongkukjang*

Soybean is cooked and covered with straw mat or cloth, and placed on the warm stone floor, *ondol*, for 3-4 days until the mucous string is formed. It is mixed with chopped ginger, chopped garlic and salt, and pounded slightly until the bean kernels are separated into halves, and stored in an earthen jar (Figure 3). The strong smell of fermented soybean is partially masked by ginger and garlic smell, and creates characteristic *chongkukjang* flavor. The spicy seasoning is thus prepared in 3-4 days, while ordinary soybean paste, *doenjang*, which uses *meju* as fermentation starter, takes over 6 months for complete ripening. The mucous substance in *chongkukjang* is peptido-polysaccharides produced by *Bacillus subtilis*.

Japanese *natto* is a modified form of *chongkukjang*. *Natto* is fermented soybean grown with *Bacillus subtils* on cooked soybean. The fermented soybean with mucous string is consumed directly without further processing, so it is a non-salt fermented product. However, *natto* is not generally accepted by Korean people. It is always mixed with spices and used for the cooking of vegetable stew as a meaty flavored condiment. The amount of *chongkukjang* added to the stew is large enough to supplement protein to the diet significantly. The fermented bean halves floating and mixing in the vegetable stew gives healthy sign of the dish.

Soybean
↓
Soaking in water overnight
↓
Cooking for 2-3 hrs
↓
Cover with rice straw and put on warm floor
(ca. 40) for 2 days
↓
Mucous string formed
↓
Crushed by mixing salt
↓
Pack in an earthen jar
↓
Chongkukjang

Figure 3. Flow chart for *chongkukjang* making

In the urbanized life style today, so called apartment culture, what the Korean elderlies are mostly missing is the stimulating savory smell of *chongkukjang* from their kitchen. Since Korean young people do not like the smell, the neighbor conscious apartment life do not allow the preparation of *chongkukjang* stew at home. Consequently, *chongkukjang* stew is an important menu of traditional Korean food restaurants, where elderly people prefer to go. *Chongkukjang* was also called as *Jeonkukjang* in the old days. "*Chongkuk*" means the Chinese kingdom "*Qing*", while "*Jeonkik*" means "a country in war" or combat zone. What all these names imply is that this product was made for extraordinary situation, for example war time or famine conditions, for the urgent supply of nutritious savory food ingredient.

(4) Korean *kochujang*

The basic tastes of European people are sweet, sour, bitter and salty and Japanese people add here *umami*, the meaty taste. Korean people add here another one, hot or pungent taste. The most remarkable difference of Korean food comparing to those of neighboring Japan and China is the strong pungent taste of the pepper in most of Korean dishes. *Kochujang* is a unique hot bean paste seasoning popular in Korea. It is made from fermented soybean starter, *meju* and malt made from barley. As shown in Figure 4, malt powder is mixed with cereal porridge made from rice, glutinous rice or barley. The enzymes in malt hydrolyzes convert the starch into sugars and reduces the consistency of the mixture. *Meju* powder, red pepper powder and salt are added to the partly saccharified porridge with thorough mixing to make paste and put in an earthen jar. The top is covered by salt in order to prevent mold growth. The jar is placed in sunny place for further fermentation. The proteins in soybean and cereals degraded into amino acids to produce meaty flavor. During the fermentation a wonderful harmony of the meaty flavor from hydrolyzed proteins and the sweet taste of hydrolyzed starches with the pungent taste of red pepper and salty taste is achieved, and a new characteristic flavor stimulating the appetite of Koreans is formed.

Kochujang is the queen of fermented soybean products in Korea. The shiny red color, rich and smooth consistency and stimulating hot-sweet-meaty aroma are enough to capture your central nerve to cry for a bowl of warm rice. One can empty a bowl of rice with *kochujang* alone as side dish. It is a good source of protein, essential fatty acids and vitamins, especially vitamin A. A bowl of cooked rice and a fresh cucumber with enough amount of *kochujang* for dressing is an excellent lunch menu in the summer for Korean people, just like a hot-dog covered with tomato ketchup for European people.

Cereal flour (rice, wheat or barley)

↓

Make into porridge by heating and then cool to 50

↓

Add malt powder and stirring in warm state

↓

Add *meju* powder, red pepper powder and salt to make paste

↓

Put the paste in earthen crock

↓

Spread salt on the top and seal with net and cover to keep from fly

↓

Put the crock in sunny place for 3-4months

↓

Kochujang

Figure 4. Flow chart of *kochujang* making

Role of fermented food in traditional Korean Society

The traditional Korean diet is composed of rice as staple food supplemented with soybean, *kimchi* as side dish and fermented soybean products (*jang*) and fish products (*jeotkal*) as main condiments. Thus fermented foods are the major condiment providing the taste and palatability to Korean meal. *Kimchi* was an important vitamin and fiber source for Korean during winter when the green vegetables were not available. Korean rice wine was an essential item for ancestor-memorial service (*Charye*), wedding ceremony and religious and communal rituals as a medium for spiritual realm. Many of the founding myths of old nations in Northeast Asia phrase the affairs related with rice-wine drinking, and the communal and religious rituals used to end up with drinking and dancing overnight.

Since the taste of foods in a household was heavily dependent on the taste of soybean sauce and paste, *jang* fermentation was considered one of the most important annual event in a family. People believed that the taste of *Jang* is related to the family's well-being. Since the rice-wine for *Charye* and other religious ritual should be brewed at home, each district and household had their unique method of rice-wine brewing and numerous kinds of rice-wine were produced. A number of books describing rice-wine brewing were published and sold in the 17th-19th centuries of *Chosun* Kingdom. As the origin of the Northeastern fermentation technology, the advanced Korean *Jang* and rice-wine brewing technology were transferred to China and Japan. Mathuya-shinsa of Kyoto, Japan, keeps the tablet of Master Jin from *Silla* as the God of rice-wine.

In East Asia a crude starter culture, *nuruk*, has been used for the cereal fermentation. It was made by solid fermentation grown mold on cereal substrate. Table 1 lists the fermentation starters used in East Asia. Although the names are different in each country, the microorganisms involved and processing methods are similar. The microflora and substrate varies with the climate and geographic conditions. Figure 5 compares the processing methods of Korean *nuruk*, Japanese *koji*, Indonesian *ragi* and Philippino *bubod* (Lee 2001).

Japanese *koji* is made by pure culture of *Aspergillus oryzae*, and the enzyme activity is relatively

Table 1. Names of fermentation starters in different countries and the major ingredients (Lee, 2001).

Country	Name	Ingredients commonly used	Shape	Microorganism
China	*Chu*	wheat, barley, millet, rice(whole grain, grits or flour)	granula or cake	*Rhizopus* *Amylomyces*
Korea	*Nuruk*	wheat, rice, barley(whole grain, grits or flour)	large cake	*Aspergillus* *Rhizopus,*
	Meju	soybean(whole seed)	large bal	*Aspergillus* *Bacillus*
Japan	*Koji*	wheat, rice	granular	*Aspergillus*
Indonesia	*Ragi*	rice(flour)	small cake	*Amylomyces*
Malaysia	*Ragi*	rice(flour)	small cake	
Philippines	*Bubod*	rice, glutinous rice (flour)	small cake	*Muor,Rhizopus*
Thailand	*Loogpang*	bran	powder	*Amylomyces*
India	*Marchaa*	rice	flat cake	*Hansenular, Mucor*

high. It produces light and bland taste of rice wine, which is preferred by women and young people. On the other hand, Korean *nuruk* is made by natural mixed culture fermentation, and the resulting rice-wine has deep and complex flavor. In the case of soybean sauce, the pure culture Japanese *koji* produces mild and sweet taste sauce suitable for dipping sauce on table, while naturally fermented Korean *meju* produces strong and sharp flavor which is useful for soup and other cooking dishes

Whole wheat flour or grits
↓
Add water to 30-40% moisture
↓
Wrap in a cloth and press in a molder to make cakes
(5 cm thick, 10-30 cm diameter)
↓
Incubate 10 days at 30-45 C.
↓
Incubate 7 days at 35-40 C.
↓
Dry 2 weeks at 30 C.
↓
Age 1-2 months at room temp.
↓
***Nuruk* (Korea)**

Polished rice
↓
Soak in water 17 hr. at 25C.
↓
Drain excess water
↓
Steam for 70 min and cool to 35C
↓
Inoculate with *A. oryzae*
↓
Incubate at 27-28C for 50 hrs
↓
Dry
↓
***Koji* (Japan)**

Rice flour
↓
Moisten with water or sugar
cane juice to form a thick paste
↓
Inoculate with *Ragi* powder from a former batch
↓
Flatten into cakes or mold into hemispheres
↓
Place on a bamboo tray and cover with muslin
↓
Incubate at 25-30C for 2-5 days
↓
Dry
↓
***Ragi* (Indonesia)**

Glutinous rice
↓
Wet ground
↓
Mix with water, unwad roots and ginger
↓
Mold into flattened cakes or balls
↓
Sprinkle with powdered *bubod*
↓
Incubate 3 days
↓
Dry
↓
***Bubod* (Philippines)**

Figure 5. Flow charts for the preparation of solid-fermented starters made in different countries in Asia-Pacific region.

References

Barnes, G. L. (1993) China, Korea and Japan. The Rise of Civilization in East Asia. Thames and Hudson, London

Han, Y. H. (1983) Regional comparison, in Korean History 12, Archeology of Korea I, National History Editorial Committee, 479-521(in Korean)

Huang, H. T. (2001) Science and Civilization in China, Vol. VI:5, Fermentations and Food Science, Cambridge University Press, UK

Ishige, N. (1976) Salt of Kumupa, Research Report of National Ethnic Museum of Japan, 1(2), 357-372

Kwon, T.W., Kwon, S.H., Lee, C.H., and Hong, E. H. (2001) Studies on the justification of soybean museum construction in Korea, J. Soybean Research Society, 18(1), 1-25

Lee, C. H. (1994) Importance of lactic acid bacteria in non-dairy food fermentation, in Lactic Acid Fermentation of Non-dairy Food and Beverages, Ed. C.H. Lee, J. Adler-Nissen and G. Barwald, Harn Lim Won, Seoul, 8-25

Lee, C. H. (1995) "Changes in the dietary patterns, health, and nutritional status of Koreans during the last century, Korean and Korean American Studies Bulletin, 6(1) 32-47.

Lee, C. H. (1998) The food ways of paleolithic man in the Northeast Asia and Korean Peninsula, Korean Culture Research 31, 415-458

Lee, C. H. (1999) The Primitive Pottery Age of Northeast Asia and its importance in Korean food history, Korean Culture Research 32, 325-457

Lee, C. H. (2001) Fermentation Technology in Korea, Korea University Press, Seoul

Lee, K. B. (1992) “Oriental Medicine,”in Korean Dietary Culture, International Course for Food Fermentation Technology, Korea University, Seoul, p. 123.

Lee, S. W. (1984) Korean Dietary Culture (Korean), Kyomunsa, Seoul

Lee, S. W. (1990) A study on the origin and interchange of *Dujang* (also known as soybean sauce) in Ancient Asia, Korean J. Dietary Culture, 5(3), 313

Lee, Y. C. (1983) “A chronicle,”in Hankuksaron (Korean History) vol. 12, Korean Archeology Ia. pp. 367-414.

Nahm, A. C. (1988) Korea, Tradition and Transformation, Holly International Corp., Efozabeth, N. J.

Shurtleff, W. and Aoyaki, A., (1976) The Book of Miso, Autumn Press Inc., Japan

Yoon, S. S. (1993) *Hankuk Sikpumsa Yongu* (Korean Dietary Culture Studies), Shin Kwang Publish Co., Seoul, p. 28.

This paper was prepared for the 3rd edition of Dr. Keith H. Steinkraus' ‘Handbook of Indigenous Fermented Foods’ to be published by Taylor & Francis Press in July 2008. Dr. Steinkraus passed away before completing this book, and I herewith express my deep sorrow of his leaving and admire of his works.

Photo: From left to right, Dr. P. J. Alan Reilly, Prof. Keith H. Steinkraus and Prof. Cherl-Ho Lee, at IFS workshop in Bangkok, Thailand, Nov. 12-17, 1989

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PAPER

Lactic acid fermented foods and their benefits in Asia

Cherl-Ho Lee

This paper reviews many types of the world's lactic acid fermented foods and discusses the beneficial effects of lactic acid fermentation of food by focusing on two examples taken from Korean cuisine, kimchi and sikhae.

Sikhae is the generic name for a class of Korean lactic acid fermented fish products that contain 6–8% salt and generally are at pH 4–5. Koreans are able to preserve fish for 1–2 months at ambient temperatures by this method. Due to the low salt content, sikhae contributes much-needed protein to the Korean rice-based diet. Kimchi is the generic name for a class of Korean lactic acid fermented vegetables that contain 3–4% salt and generally are at pH 4.0–4.5. Kimchi is an important source of vitamins and minerals especially during the wintertime. It is a popular side-dish and provides a source of intestinal lactic acid bacteria. The physiological effects of kimchi have been studied widely in Korea and recent results are summarized in this paper. © 1997 Elsevier Science Ltd.

Keywords: lactic acid; fermented foods; kimchi; sikhae; Korean food

INTRODUCTION

The fermentation of dairy products in Europe has been widely studied over the past century, and the processes have been highly standardized and industrialized to ensure efficient production of safe and nutritious food products. Cocasian yogurt and Middle-Eastern cheese have become everyday food for people in Europe, America and Oceania and they are considered as gourmet foods for wealthy people in Asia and Africa. Little scientific research has been carried out on other types of fermented foods, which have contributed greatly to diets in East Asia and Africa.

The East-Asian diet is characterized by large amounts of rice and small amounts of dairy products. Since rice has a low protein content and bland flavor, protein and flavor supplements are added to the diet. Soybean fermentation produces a meaty flavor from plant materials by using microbial action in high salt concentration. Fish fermentation produces another type of savory flavor from marine products by using both endogenous enzymes in fish and salt-tolerant microorganisms in the environment. Fish fermentation is also a method of preserving perishable fish and marine products in a high salt concentration (Lee *et al.*, 1993).

Lactic acid fermentation in East-Asia has been applied for various other purposes. It is used to prepare savory acidic dishes with vegetables and cereals, to ensure the quality of rice wines, and to make beverages from plant materials. However, the most important role of lactic acid fermentation in the Asian diet is the preservation of perishable vegetables and fishes in sanitary and safe conditions. The organic acids, mainly lactic acid and acetic acid, produced by lactic acid bacteria are effective antimicrobial agents, and they reduce the pH in the foods to prevent the growth of most hazardous food microorganisms (Lee *et al.*, 1994).

This paper reviews many types of the world's lactic acid fermented foods and describes the processing methods and properties of kimchi and sikhae, two Korean lactic acid fermented foods.

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TYPES OF LACTIC ACID FERMENTED FOOD

Steinkraus (1983) established the following classifications of lactic acid fermented food products: acid-fermented vegetables, acid-fermented bread and pancakes, acid-fermented cereal gruels, acid-fermented seafood/rice and meat/rice mixtures, and acid-fermented milk and milk/cereal foods. Lactic acid fermentation is also important in the fermentation of traditional alcoholic and non-alcoholic beverages. Examples of lactic acid fermented products, excluding dairy products, are outlined below (Lee, 1994).

Acid-leavened bread and pancakes

Table 1 lists various types of sourdough bread and pancakes from different regions. Lactic fermentation of bread dough improves the keeping quality and flavor of the baked products. It also enhances the palatability of bread made from low-grade flours and under-utilized cereals. Acid-fermented breads and pancakes are still an important staple food for people in Africa and some parts of Asia (Lee, 1994).

The Indian idli bread types (idli, dosa, dhokla, khaman) are important staple foods of the Indian and Sri Lankan people and they are consumed three or four times a week at breakfast and supper. Idli is a small, white, acid-leavened and steamed cake made by bacterial fermentation of a thick batter prepared from rice and dehulled black gram.

Similar products are made from rice in the Philippines (puto) and in Korea (kichudok). Puto is made using year-old rice and the batter is neutralized in the course of fermentation.

In Sri Lanka, hopper is prepared from acid-fermented dough made with rice or wheat and coconut water. In hopper fermentation, a very large inoculum of baker's yeast or coconut toddy, which includes acid-producing bacteria, is added.

Acid-fermented cereal gruels and beverages

Acid porridges prepared from cereals are eaten in various regions of the world, particularly in Africa, where porridges may represent the basic diet (*Table 2*). Nigerian ogi, Kenyan uji and Ghanan kenkey are examples of porridges prepared by the acid fermentation of maize, sorghum, millet or cassava, followed by wet-milling, wet-sieving and boiling.

Sweet/sour alcoholic fermented porridges are also utilized by many people as their staple food. *Table 3* shows examples of alcoholic porridge beverages involving acid fermentation. Korean Takju, Philippino Tapuy, and Indonesian Tape Kekan are examples from Asia and are similar to African Merrisa, Busaa, Kaffir and Bantu beer.

In traditional cereal beer fermentation, lactic acid bacteria play an important role in suppressing the growth of putrefactive and harmful microorganisms during the initial stages of alcohol fermentation. However, the growth of lactic acid bacteria is soon suppressed by the alcohol formed by yeast.

Table 1 Examples of acid-leavened bread and pancakes used in different regions of the world (Lee, 1994)

Product name	Country of use	Major ingredients	Microorganisms	Appearance and usage
Sour bread	Germany	Wheat	Lactic acid bacteria, yeast	Sandwich bread
Rye bread	Denmark	Rye	Lactic acid bacteria	Sandwich bread, bread
Idli	India, Sri Lanka	Rice, black gum	*L. mesenteroides*, *S. faecalis*	Steamed cake
Puto	Philippines	Rice	*L. mesenteroides*, *S. faecalis*, yeast	Steamed cake
Kichudok	Korea	Rice		Steamed cake
Enjera	Ethiopia	Tef or other cereals	*L. mesenteroides*, *P. cerevisiae*, *L. plantarum*, *S. cerevisiae*	Pancake
Kisra	Sudan	Sorghum, millet	*Lactobacillus* sp., *Acetobacter* sp., *S. cerevisiae*	Pancake
Kishk	Egypt	Wheat+milk	*L. casei*, *L. brevis*, *L. plantarum*, *S. cerevisiae*	Dried balls
Hopper	Sri Lanka	Rice+coconut water	Yeast, lactic acid bacteria	Stake-baked pancake

Table 2 Examples of acid fermented cereal gruels and non-alcoholic beverages produced in different regions of the world (Lee, 1994)

Product name	Country	Major ingredients	Microorganisms	Appearance and usage
Ogi	Nigeria	Maize, sorghum, or millet	*L. plantarum*, *Corynebacterium* sp., *Acetobacter*, yeast	Sour porridge, baby food, main meal
Uji	Kenya, Uganda, Tanzania	Maize, sorghum, millet or cassava flour	*L. mesenteroides*, *L. plantarum*	Sour porridge, main meal
Mahewu	South Africa	Maize+wheat flour	*S. lactice*, *Lactobacillus* sp.	Sour drink, 8–10% DM
Hulumur	Sudan	Red sorghum	*Lactobacillus* sp.	Clear drink
Busa	Turkey	Rice, millet	*Lactobacillus* sp.	

Table 3 Examples of alcoholic beverages involving acid fermentation (Lee, 1994)

Product name	Country	Major ingredients	Microorganisms	Appearance and usage
Bussa	Kenya	Maize, sorghum, malt, finger millet	*Candida crusei*, *S. cerevisiae*, *L. helveticus*, *L. salivarius*, *L. plantarum*	Food, refreshment drink
Mbege	Tanzania	Malted millet, acidic banana juice		Food, refreshment drink
Bouza	Egypt	Wheat, malt	Lactic acid bacteria	Alcoholic thin gruel
Kaffir	South Africa	Malt of sorghum, maize		Beer
Merrisa	Sudan	Millet, cassava	*S. cerevisiae*	Bantu beer
Takju	Korea	Rice, wheat	Lactic acid bacteria, *S. cerevisiae*	Turbid drink
Tapuy	Philippines	Rice, glutinous rice	*Saccharomyces*, *Mucor*, *Rhizopus*, *Aspergillus*, *Leuconostoc*, *L. plantarum*	Sour/sweet alcohol
Tapekekan	Indonesia	Glutinous rice	*A. rouxii*, *E. burtonii*, *E. fibulinger*	Sweet/sour alcoholic paste

Acid-fermented starch ingredients

Acid fermentation is also used to produce food starches with extended shelf-life, resistance to infectious microorganisms, and palatable flavor in different regions of the world. *Table 4* shows that Nigerian Gari, Ethiopian Kocho, Chinese mungbean starch and Mexican Pozol are important acid-fermented starch ingredients used for the preparation of porridges, steamed cakes, pastes, noodles, soups and drinks.

Most countries in Asia produce mungbean starch, and mungbean starch noodles are a staple of the Chinese diet. The manufacturing process for mungbean starch involves acidic bacterial fermentation. The mungbeans are hydrated by soaking in water inoculated with 12-h steep-water from a previous fermentation to ensure acidification of the beans. The principal microorganisms found in the steep-water are *Leuconostoc mesenteroides*, *Lactobacillus casei*, *Lactobacillus collobiosus* and *Lactobacillus fermentum*. The lactic fermentation, which reduces the pH to about 4.0, protects the beans from spoilage and putrefaction that would otherwise occur in ground bean slurries (Steinkraus, 1983).

Thai rice-noodle, Khanom Jeen, is also made from acid-fermented raw rice. Soaked rice is drained and fermented for at least 3 days before grinding, and *Lactobacillus* sp. and *Streptococcus* sp. are involved in the acid fermentation.

Acid-fermented vegetables

Table 5 shows examples of acid-fermented vegetables produced in different regions of the world. The difference between sauerkraut and kimchi is the preferred end-point of fermentation. The best-tasting kimchi is attained before overgrowth of *Lactobacillus brevis* and *Lactobacillus plantarum* with an optimal product pH of 4.5. The overgrowth of *Lac. brevis* and *Lac. plantarum* diminishes product quality, but sauerkraut production depends on these organisms. The fermentation is manipulated by the salt concentration and temperature. The optimal range of salt concen-

Table 4 Examples of acid-fermented starch ingredients produced in different regions of the world (Lee, 1994)

Product name	Country	Major ingredients	Microorganisms	Usage
Gari	Nigeria	Cassava	*Leuconostoc*, *Alcaligenes*, *Corynebacterium*, *Lactobacillus*	Staple, cake, porridge
Mungbean starch	China, Thailand, Korea, Japan	Mungbean	*L. mesenteroides*, *L. casei*, *L. cellobiosus*, *L. fermenti*	Noodle
Khanomjeen	Thailand	Rice	*Lactobacillus* sp., *Stretptococcus* sp.	Noodle
Pozol	Mexico	Maize	Lactic acid bacteria, *Candida*	Porridge, molds
Me	Vietnam	Rice	Lactic acid bacteria	Sour food ingredient

Table 5 Examples of acid-fermented vegetables produced in different regions of the world (Lee, 1994)

Product name	Country	Major ingredients	Microorganisms	Usage
Sauerkraut	Germany	Cabbage, salt	*L. mesenteroides*, *L. brevis*, *L. plantarum*	Salad, side-dish
Kimchi	Korea	Korean cabbage, radish, various vegetables, salt	*L. mesenteroides*, *L. brevis*, *L. plantarum*	Salad, side-dish
Dhamuoi	Vietnam	Cabbage, various vegetables	*L. mesenteroides*, *L. plantarum*	Salad, side-dish
Dakguadong	Thailand	Mustard leaf, salt	*L. plantarum*	Salad, side-dish
Burong mustala	Philippines	Mustard	*L. brevis*, *P. cerevisiae*	Salad, side-dish

tration of sauerkraut is 0.7–3.0% while that of kimchi is 3.0–5.0% (Lee, 1994).

Acid-fermented vegetables are important sources of vitamins and minerals. *Leu. mesenteroides* has been found to be important in the initiation of the fermentation of many vegetables – e.g. cabbages, beets, turnips, cauliflower, green beans, sliced green tomatoes, cucumber, olives and sugar beet silages. In vegetables, *Leu. mesenteroides* grows more rapidly and over a wider range of temperatures and salt concentrations than any other lactic acid bacteria. *Leu. mesenteroides* produces carbon dioxide and acids which quickly lower the pH, thereby inhibiting the development of undesirable microorganisms and the activity of their enzymes, which may soften the vegetables. The carbon dioxide produced replaces air and provides anaerobic conditions favorable for the stabilization of ascorbic acid and the natural color of the vegetables. The growth of this species modifies the environment, making it favorable for the growth of other lactic acid bacteria. The high acidity produced by the species and other subsequent lactic acid bacteria inhibits the growth of *Leu. mesenteroides*. *Leu. mesenteroides* converts glucose to approximately 45% levorotatory D-lactic acid, 25% carbon dioxide, and 25% acetic acid and ethyl alcohol. Fructose is partially reduced to mannitol and is then readily fermented to yield equimolar quantities of lactic acid and acetic acid. The combination of acids and alcohol is conducive to the formation of esters that impart desirable flavors.

Acid-fermented fish and meat

The storage life of perishable fish and meats can be extended by acid-fermentation with added carbohydrates and salt. Rice, millet, flour and even syrup or sugar are used as carbohydrate sources. *Table 6* shows the acid-fermented fish and meat products of different countries. Both salt-water fish and fresh-water fish are preserved by acid production from added cereals. The amount of added carbohydrate and the salt concentration primarily control the extent of acid fermentation and the keeping quality. Fermented sausages, similar to salami in Europe, are made in some Southeast Asian countries. Starter cultures for salami fermentation are isolated from fermented fish products in Korea as well as other Asian countries (Tanasupawat *et al.*, 1991; Um and Lee, 1996).

PRESERVATION OF FISH BY SIKHAE FERMENTATION

History

The ancient Chinese text *Joulii* (3rd century B.C.) contains letters which indicate the presence of fermented fish products, including the lactic acid fermented fish product, Zha. Sikhae is the generic name for a class of Korean lactic acid fermented fish products. The first record of sikhae in Korea appears in the history of King Sinmun of Silla (683 A.D.) written by Kim Bu-Sik of Samkuksaki (1145 A.D.). Sikhae was once a very common food in Korea, often mentioned in the diaries written by 16th century scholars, but it disappeared from the south and central regions of the Korean peninsula for unknown reasons. Today, it remains a delicacy in the north-eastern coastal region (Lee *et al.*, 1986).

Processing

Whole fish are degutted and stripped, and then ten parts of fish are mixed with one part of salt and cured overnight and then drained. The preparation is mixed with cooked millet (7–8%), minced garlic (3–4%) and red pepper powder (8–9%), and packed in an earthern jar for fermentation at 20°C for 1 week (Lee *et al.*, 1983). After fermentation, the jar is kept in a cool place to maintain optimum taste for 3–6 weeks. It is consumed before it becomes too sour.

Figure 1 shows the microbial and biochemical changes during the fermentation of sikhae at 20°C (Lee, 1989). The salt concentration of the product is generally 8%. The pH decreases rapidly during the first 3–5 days from 6.5 to below 5.0, and softening take place from 3 to 4 days after fermentation. The amino-N concentration increases steadily up to 14 days, and this coincides with the appearance of the optimum taste. The number of lipolytic bacteria decreases rapidly during the initial stages of fermentation, and proteolytic bacteria decrease after 12 days of fermentation. The acid-forming bacteria

Table 6 Examples of acid-fermented seafood, cereal, and meat mixtures (Lee, 1994)

Product name	Country	Major ingredients	Microorganisms	Usage
Sikhae	Korea	Sea-water fish, cooked millet, salt	*L. mesenteroides*, *L. plantarum*	Side-dish
Narezushi	Japan	Sea-water fish, cooked millet, salt	*L. mesenteroides*, *L. plantarum*	Side-dish
Burong-isda	Philippines	Fresh-water fish, rice, salt	*L. brevis*, *Streptococcus* sp.	Side-dish
Pla-ra	Thailand	Fresh-water fish, salt, roasted rice	*Pediococcus* sp.	Side-dish
Balao-balao	Philippines	Shrimp, rice, salt	*L. mesenteroides*, *P. cerevisiae*	Condiment
Kungchao	Thailand	Shrimp, salt, sweetened rice	*P. cerevisiae*	Side-dish
Nham	Thailand	Pork, garlic, salt, rice	*P. cerevisiae*, *L. plantarum*, *L. brevis*	Pork meat in banana leaves
Sai-krok-prieo	Thailand	Pork, rice, garlic, salt	*L. plantarum*, *L. salivarius*, *P. pentosaccus*	Sausage
Nem-chua	Vietnam	Pork, salt, cooked rice	*Pediococcus* sp., *Lactobacillus* sp.	Sausage
Salami	Europe	Pork	*Lactobacillus*, *Micrococcus*	Sausage

increase rapidly and become the dominant organisms after 1 week of fermentation, reaching a maximum after 16 days of fermentation. The taste deterioration is associated with the overgrowth of yeast and acid-forming bacteria.

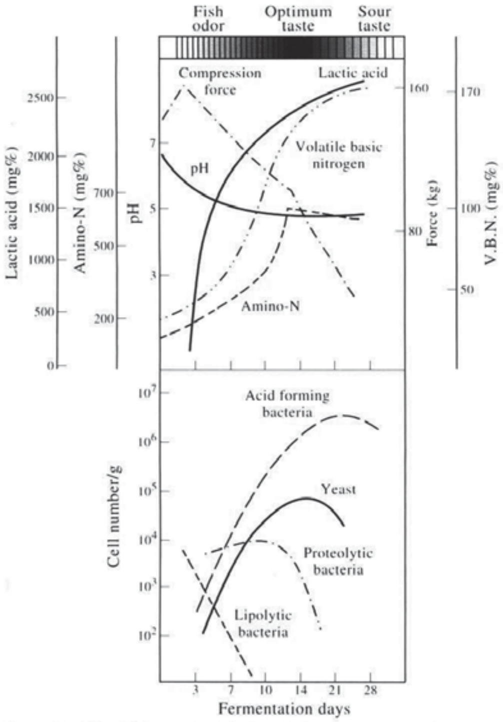

Figure 1 Microbial and biochemical changes during the fermentation of the lactic acid fermented fish product, sikhae (Lee, 1989)

The microorganisms

The important bacteria for sikhae fermentation are *Leuconostoc mesenteroides* and *Lactobacillus plantarum* (Souane *et al*., 1990). Strains of *Leu. mesenteroides*, *Leu. mesenteroides* subsp. *mesenteroides*, *dextranicum* and *cremoris* differ in their ability to grow well in broth containing 6.5% NaCl.

The antimicrobial effects of the ingredients on the microflora of sikhae have been tested (Souane *et al*., 1987). *Table 7* shows that garlic has a broad spectrum of inhibitory activity on most microorganisms in the raw materials and sikhae product, except for lactic acid bacteria. Growth of *Aspergillus* sp. was inhibited by 5% garlic juice, and growth of *Bacillus*, *Micrococcus* and *Pseudomonas* was inhibited by 20% or more. These data may explain why lactic acid bacteria become the dominant flora in sikhae fermentation. Garlic is used in many other fermentations – e.g. 2% in Korean kimchi and 7% in Thai Pla-som – and functions as a selective agent for various microorganisms.

Nutrition and safety

Sikhae contains relatively low concentrations of salt, 6–8%, compared to other types of fermented fish products, which normally contain 20–25% salt. Therefore, sikhae can be consumed in relatively large amounts in a meal; it is common to eat a dish of sikhae made from a palm-size flat fish with a bowl of cooked rice. Sikhae is an important protein source. The red pepper in sikhae is an important source of vitamin A and C. In contrast to soy sauces and fish pastes which are used as condiments, sikhae is a side-dish which adds the nutrients found in fish to rice-based diets. Sikhae fermentation is an excellent method of fish preservation; perishable fishes can be kept in a virtually fresh state for 1–2 months because

Table 7 Antimicrobial activity of garlic (tested by disc method) on the microorganisms found in sikhae and its ingredients (Souane *et al*., 1987)

Microorganism		Pink garlic (Korean native) pure press juice and dilution					
Name	Origin	100%	50%	20%	10%	5%	2.5%
1. *Leuconostoc mesenteroides*	Gajami sikhae						
2. *Lactobacillus* sp.	Gajami sikhae	–	–	–	–	–	–
8. *Lactobacillus* sp.	Gajami sikhae	–	–	–	–	–	–
11. *Micrococcus* sp.	Salted gajami	+++	++	+	(S)	–	–
12. *Pseudomonas* sp.	Gajami sikhae	+++	++	(S)	–	–	–
6. *Bacillus* sp.	Gajami sikhae	+++	++	–	–	–	–
7. *Bacillus* sp.	Gajami sikhae	++	+	–	–	–	–
10. *Bacillus* sp.	Salted gajami	++	+	–	–	–	–
13. *Bacillus* sp.	Millet	++	+	–	–	–	–
14. *Bacillus* sp.	Millet	++++	+++	(S)	–	–	–
15. *Bacillus* sp.	Millet	+++	++	(S)	–	–	–
22. *Bacillus* sp.	Red pepper	+++	++	+	–	–	–
23. *Bacillus* sp.	Red pepper	+++	++	+	–	–	–
16. *Aspergillus* sp.	Red pepper	++++	++++	++++	+++	++	–
18. *Mucor* sp.	Red pepper	+++	++	–	–	–	–
19. *Aspergillus glaucus*	Gajami sikhae	++++	++++	++++	+++	++	–
21. *Aspergillus niger*	Millet	++++	++++	++++	+++	+	–
17. *Monilia* sp.	Millet	+	+	–	–	–	–

Table 8 Maximum sodium chloride concentrations and minimum temperatures, pH values and water activities for growth of food-poisoning bacteria under otherwise optimal conditions (Owens and Mendoza, 1985)

Bacterium	Conditions allowing growth/toxin production			Maximum salt concentration (%, w/w)
	Minimum temperature (°C)	pH value	A_w	
Bacillus cereus	7	4.4–5.5	0.95	8
Staphylococcus aureus				
Growth				
Aerobic	6.7	4.3	0.86	16–18
Anaerobic	6.7	4.7	0.90	14–16
Toxin				
Aerobic	10	4.3	0.90–0.93	12–13
Anaerobic	10	6.5	0.90–0.93	12–13
Vibrio parahaemolyticus	3–13	4.8	0.94	8–10

the low pH ensures freedom from pathogenic microorganisms and the fish can be consumed without cooking.

The low salt content of sikhae may result in an unexpected outbreak of food poisoning if mixing is inadequate and lactic acid production is delayed. As shown in *Table 8*, sikhae is on the borderline for the acceptable growth conditions of *Bacillus cereus* and *Staphylococcus aureus* (Owens and Mendoza, 1985). This risk may explain why sikhae has disappeared from Seoul since the 17th century and has remained only in the cold northern coastal region.

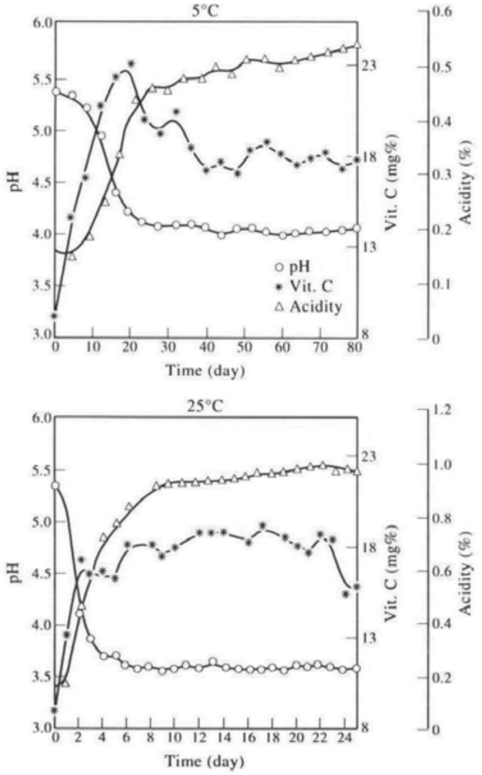

Figure 2 Changes in pH, acidity and vitamin C content during kimchi fermentation at 5°C and 25°C (Shin, 1994)

PRESERVATION OF VEGETABLES BY KIMCHI FERMENTATION

History

Kimchi is a unique traditional fermented vegetable product of Korea. Kimchi fermentation is the Korean method of preserving the fresh and crispy texture of vegetables for consumption during the winter when fresh vegetables are not available. Kimchi has a sour/sweet and carbonated taste and is usually served cold. It is a side-dish served with cooked rice and soup.

Although the history of kimchi fermentation in Korea can be traced to the 3rd and 4th centuries A.D. in written records, the earliest description of the processing methods is found in 17th century works of literature, such as *Umsikdimibang* written by Madam Chang (1598–1680) and *Sanlimkyungje* by Hong Man Sun (1643–1715). *Imwonsibyukji*, written by Seo Yu Ku (1764–1845), lists dishes with 92 kinds of pickled vegetables, including high-salt cured vegetables, acid-fermented fish with cereals and vegetables, pickles in soy sauce and vinegar, pickles soaked in brine and kimchi. *Kyuhapchongseo*, written by Madam Lee (1759–1829), describes in detail the processing methods of various kinds of kimchi, and the use of red pepper in kimchi appears in this book (Lee, 1986; Lee and Ahn, 1995).

Processing

The raw materials for kimchi are divided into three main groups. Korean cabbage and radish are the major materials, and minor ingredients include garlic, red pepper, green onion, ginger and salt. Fermented fishery products and other seasoning agents are optional. A recipe for the simplest kimchi may include 100 g Korean cabbage, 2 g garlic, 2 g green onion, 2 g red pepper powder and 0.5 g ginger, and the optimum salt content of the product is 3%. The fresh cabbage is cut into half or shredded, soaked in brine of approximately 10% salt concentration overnight and then washed and drained. The minor ingredients are chopped and mixed with shredded radish and stuffed between the salted cabbage leaves. The kimchi is packed in an earthern jar, buried in the ground, and pressed with a stone in order to immerse

Table 9 Important microorganisms found in cabbage kimchi after different periods of fermentation (So, 1994)

Fermentation temperature (°C)	Important microorganisms: Before ripening	After ripening	Reference
	Leu. mesenteroides	*Lac. plantarum, Lac. brevis*	Kim *et al.* (1966)
20–30	*Leu. mesenteroides*	*Lac. plantarum, Lac. brevis*	Mheen *et al.* (1984)
14	*Leu. mesenteroides*	*Lac. plantarum*	
5	*Leu. mesenteroides*	*Lactobacillus* (low acid producer)	
25	*Leu. mesenteroides, Leu. cremoris, St. raffinolactis*	*Lac. plantarum, Lac. homohiochii*	Lim *et al.* (1989), Park *et al.* (1990)
15	*Leu. mesenteroides, Lac. sake, Lac. fructosus*	*Lac. maltaromicus, Lac. plantarum*	
5	*Leu. mesenteroides, Leu. paramesenteroides*	*Lac. maltaromicus, Lac. sake*	
20	*Leu. mesenteroides, Lac. leichimanni, Lac. sake*	*Lac. plantarum, Lac. brevis*	Shim *et al.* (1990)
30	*Leuconostoc, Lactobacillus*	*Lactobacillus*	
20	*Leuconostoc, Lactobacillus*	*Lactobacillus*	Lee *et al.* (1992)
5	*Leuconostoc, Lactobacillus*	*Lactobacillus*	
30	*Leu. mesenteroides*		Lee *et al.* (1993)
5	*Leu. mesenteroides*		
5–7	*Leu. mesenteroides, Leu. dextranicum*	*Lac. bavaricus*	So (1994)

the ingredients in the juice. Winter kimchi is fermented for 1–2 months and consumed for 3–4 months until the end of spring. *Figure 2* shows the changes in pH, acidity and vitamin C content during kimchi fermentation. Optimum taste is attained when the pH and acidity reach approximately 4.0–4.5 and 0.5–0.6, respectively. Vitamin C content is maximal at this point. As the fermentation temperature increases, the ripening time decreases: kimchi ripens in 1 week at 15°C and in 3 days at 25°C (Shin, 1994).

Microorganisms

Table 9 shows the important microorganisms present in kimchi before and after ripening as reported by different investigators. Before ripening, *Leu. mesenteroides* is the dominant microorganism, while *Lactobacillus* spp. are the major organisms in over-ripened kimchi. The dominant species of *Lactobacillus* at later stages of kimchi fermentation vary with the fermentation temperature: *Lac. plantarum* and *Lac. brevis* at 20–30°C and *Lac. maltaromicus* and *Lac. bavaricus* at 5–7°C. *Leu. mesenteroides* grows slowly at low temperature (5–7°C), but *Lac. planatarum* and *Lac. brevis* cannot. *Lac. plantarum* is homofermentative and is the highest acid-producing species of this group, yielding three or four times more DL-lactic acid than leuconostocs (Lee, 1994). Low temperature is preferred in kimchi fermentation to prevent the production of strong acid and over-ripening and to extend the period of optimum taste.

The bacteria isolated from kimchi are identified in *Bergey's Manual*, but their physiological characteristics seldom match exactly with those characterized in the manual. *Leu. mesenteroides* and *Lac. barvaricus* isolated from kimchi showed many discrepancies in sugar fermentation and vitamin requirements. All the *Leuconostoc* spp. isolated from kimchi can grow at pH below 4.8 and grow in media containing 7% ethanol or 6.5% NaCl (So, 1994). An interesting observation is that the *Leu. mesenteroides* subspp.

Table 10 Change of concentrations of intestinal pathogens in kimchi during fermentation at 20°C (Ha, 1994)

Fermentation time (day)	pH	*Cl. perfringens*	*Staph. aureus*	*Salm. typhimurium*	*L. monocytogenes*	*V. parahaemolyticus*	*E. coli*	Lactic acid bacteria	Total bacteria
0	5.44	4.3×10^4	2.9×10^4	3.6×10^4	6.3×10^4	2.3×10^4	5.2×10^4	2.0×10^5	4.4×10^4
1	5.12	2.7×10^2	4.5×10^4	2.2×10^4	3.7×10^4	2.1×10^4	3.3×10^4	7.3×10^6	3.6×10^7
2	4.11	–	2.8×1^3	5.8×1^3	4.5×1^3	7.3×1^3	2.9×1^3	2.8×10^8	9.3×10^8
3	3.86	–	5.0×10	1.1×10^2	2.6×10^2	5.5×10^2	3.3×10^2	5.7×10^8	1.2×10^9
4	3.76	–	–	–	4.0×10	9.0×10	3.0×10	6.1×10^8	1.5×10^9
5	3.70	–	–	–	–	–	–	5.6×10^8	1.4×10^9
6	3.66	–	–	–	–	–	–	5.8×10^8	1.6×10^9
7	3.63	–	–	–	–	–	–	6.0×10^8	1.4×10^9

The bacterial numbers are expressed as CFU/ml.
–, no growth detected.

Table 11 Antimicrobial spectrum of bacteriocins[a] produced by isolates (Ha, 1994)

Bacteriocin producer	Indicator strain																											
	L. plantarum IAM 12477	*L. plantarum* DU 3003	*L. sake* JCM 1157	*L. sake* DU 3011	*L. brevis* KCTC 3102	*L. brevis* JCM 1159	*L. brevis* DU 3025	*E. faecalis* JCM 5803	*E. faecalis* DU 2103	*E. faecium* KCTC 3095[b]	*E. faecium* JCM 5804	*E. faecium* DU 2102	*P. pentosaceus* IAM 12300	*P. pentosaceus* DU 2203	*P. acidilactici* IAM 1233	*Leuc. mesenteroides* subsp. *mesenteroides* IAM 1046	*Leuc. mesenteroides* subsp. *mesenteroides* JCM 6124	*Leuc. mesenteroides* subsp. *mesenteroides* DU 1003	*A. hydrophila* KCTC 2358	*B. cereus* KCTC 1012	*B. subtills* KCCM 11914	*C. perfringens* ATCC 132124	*E. coli* KCTC 1039	*L. monocytogenes* ATCC 19111	*M. buteus* KCCM 11455	*S. typhimurium* KCTC 1925	*S. aureus* KCTC 1621	*V. parahaemolyticus* ATCC 27519
Lactobacillus plantarirum																												
DU 0247	0[c]	80	5120	0	0	0	0	0	40	640	0	20	0	20	40	0	0	20	0	0	0	0	0	0	0	0	0	0
DU 0256	0	20	81 920	0	0	0	0	160	20	20	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lactobacillus curvatus																												
DU 0162	0	0	2560	0	0	0	0	80	0	160	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DU 0182	0	0	2560	0	0	0	0	160	0	160	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lactobacillus brevis																												
DU 0241	0	40	20 480	0	0	0	10	160	20	1280	0	20	160	20	160	0	0	20	0	0	0	0	0	0	0	0	0	0
DU 0242	0	80	160	0	0	0	20	0	80	40	0	20	0	160	0	0	40	0	0	0	0	0	0	0	0	0	0	0
Enterococcus faectum																												
DU 0216	320	20	10 240	40	160	160	20	40	40	80	320	20	80	40	80	320	320	40	0	0	160	320	0	40	320	0	0	0
DU 0230	160	40	10 240	40	320	160	20	40	40	160	320	20	160	40	80	1280	320	40	0	0	160	200	0	10	160	0	0	0
DU 0237	320	20	10 240	40	160	160	20	40	40	80	320	10	160	20	160	640	160	20	0	0	100	200	0	10	200	0	0	0
DU 0253	320	80	10 240	20	320	80	20	20	80	80	320	40	160	320	160	640	80	40	0	0	100	200	0	10	200	0	0	0
DU 0255	320	20	10 240	40	160	160	20	40	80	40	160	20	160	20	80	640	80	20	0	0	100	100	0	10	160	0	0	0
DU 0267	320	40	5120	20	320	80	40	20	80	40	160	40	160	160	80	640	40	40	0	0	100	200	0	40	200	0	0	0
Leuconostoc mesenteroides subsp. *mesenteroides*																												
DU 0243	0	0	320	0	0	0	0	0	0	80	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0
Lactobacillus sp.																												
DU 0180	0	40	81 920	20	160	0	10	320	20	1280	0	20	160	10	320	0	0	20	0	0	0	0	0	0	0	0	0	0
DU 0181	0	40	81 920	40	160	0	10	320	20	1280	0	20	160	20	160	0	0	20	0	0	0	0	0	0	0	0	0	0
DU 0183	0	40	40 960	40	160	0	10	320	40	5120	0	20	160	20	160	0	0	20	0	0	0	0	0	0	0	0	0	0
DU 0238	0	80	163 840	0	320	0	10	320	80	5120	0	40	320	80	160	0	0	40	0	0	0	0	0	0	0	0	0	0
DU 0240	0	80	81 920	0	160	0	20	160	40	1280	0	10	320	80	160	0	0	40	0	0	0	0	0	0	0	0	0	0
DU 0259	0	10	5120	0	0	0	0	80	0	640	0	0	40	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0

[a]Neutralized cell-free supernatant fluid was used for the assay.
[b]Indicator strain used for the isolation of bacteriocin-producing lactic acid bacteria in this study.
[c]Bacteriocin activity was measured by the agar well diffusion assay and expressed in AU/ml.

Table 12 Inhibitory effect of kimchi ingredients on the growth of lactic acid bacteria in comparison with those of antimicrobial food additives (Ha, 1994)

Substance	Concentration (mg/kg)	Mean inhibition ratio (%)
Sorbic acid	3000	98
Benzoic acid	500	26
Sodium acetate	100 mM	Not affected
Sodium dehydroacetate	300	24
Sodium propionate	300	6
Nisin	500	19
Onion essential oil	500	46
Garlic essential oil	500	73
Ginger essential oil	500	28

showed tolerance in an artificial digestive fluid at pH 3.0 and also could grow in media containing 10% or 40% bile. These properties are similar to those of intestinal microorganisms, such as *Lac. acidophilus* and *Lac. casei*, and faecal microbial strains. The observations suggest that the major microorganisms in kimchi have adapted to the special environment in Korea over a long time, as a part of the food cycle from soil to vegetable, to kimchi, to the human intestine, to faeces and to soil again. Adaptations of microorganisms to the special environmental conditions have been reported in other fermented foods, such as, for example, *Leu. mesenteroides* in cane juice (Tilbury, 1975), *Leu. oenos* in grape juice (Amerine *et al*., 1980), *Ped. halophilus* in soy sauce (Yokotsuka, 1985) and, as discussed above, *Leu. mesenteroides* in sikhae (Souane *et al*., 1990).

Antipathogenic and antimicrobial activities

In an inoculation test, the strong antipathogenic activity of kimchi was demonstrated. As shown in *Table 10*, *Clostridium perfringens* disappeared after 2 days of kimchi fermentation, *Staphylococcus aureus* and *Salmonella typhymurium* after 4 days, and *Listeria monocytogenes*, *Vibrio parahaemolyticus* and *Escherichia coli* after 5 days, while the number of lactic acid bacteria increased from 10^5 to 10^8 (Ha, 1994).

Several strains of microorganisms which produce bacteriocin were isolated from kimchi. *Table 11* shows that *Enterococcus faecium* in kimchi has a broad spectrum of bacteriocin activities, and several *Lactobacillus* spp. have been shown to have an antimicrobial effect (Ha, 1994). The inhibitory effects of kimchi ingredients were compared to those of conventional antimicrobial food additives. *Table 12* shows that onion essential oil, garlic essential oil and ginger essential oil have strong inhibitory effects on the growth of lactic acid bacteria. The combined effects of the organic acids and bacteriocin produced during fermentation and the antimicrobial activity of the ingredients are the controlling factors of microflora found in kimchi, and they control the growth of pathogenic microorganisms without costly treatments and packaging.

Physiological effects of kimchi

The possibility of nitrosamine formation during kimchi fermentation has led to extensive studies on this matter. Fresh cabbage contains large amounts of nitrate varying from 55 to 2500 ppm, but it is reduced rapidly after 1 week of kimchi fermentation. Nitrite content in kimchi ingredients is very low, ranging from 0 to 0.56 ppm, and increases slightly during the first 3–5 weeks of fermentation at 5°C and then decreases rapidly. *N*-Nitrosodimethylamine was not detected for the first 3–4 weeks and then appeared at a level of 0.001–0.004 ppb (Park and Choi, 1994). It can be concluded that kimchi fermentation reduces the risk of nitrosamine formation in vegetables.

The physiological effects of kimchi ingredients have been studied widely and are summarized in *Table 13* (Oh *et al*., 1994). The antitumor activities of cabbage and garlic have been reported by many investigators (Park *et al*., 1991, 1992; Hwang *et al*., 1990). Extracts of red pepper powder show inhibitory effects against aflatoxin B_1 mediated mutagenesis (Kim *et al*., 1991). kimchi has high enough concentrations of fiber to prevent constipation and colon cancer, and the probiotic effect of lactic acid bacteria grown to 10^8/ml in kimchi assists in digestion and intestinal functions. In addition to these physiological effects, the salty taste, fresh carbonated sensation and crispy texture have made the product the most

Table 13 Biologically active compounds in kimchi (Oh *et al*., 1994)

Chemical compounds	Occurrence	Possible effect
Benzyl isothiocyanate, indole compound, thiocyanate, flavonoid	Chinese cabbage, allium vegetable, red pepper	Antibiotic, anticarcinogenic, immune stimulant
Sitosterol	Chinese cabbage	Reducing the cholesterol level
Diallyl sulfide, diallyl trisulfide, diallylmethyl sulfide	Allium vegetable	Anticarcinogenic, antioxidant, fibrinolytic
Gingerrol, gingerin	Ginger	Antibiotic, fibrinolytic
Capsaicin	Red pepper	Laxative, secretion of neuropeptides
Lactic acid bacteria	Kimchi	Antagonistic
Bacteriocin	Kimchi	Antibiotic
L-(+)-Lactic acid	Kimchi	Modulation of T-cell function
Acetylcholine	Kimchi	Laxative
Dextran	Kimchi	Laxative
γ-Aminobutyric acid	Kimchi	Laxative
Acetate	Kimchi	Antibiotic

favored and indispensable food for Koreans for hundreds of years.

Currently, around 190 different types of kimchi are produced in households in Korea. The per capita daily consumption of kimchi in Korea has been estimated to be 100 g for the last 20 years. The amount of exported kimchi has increased steeply, a 13.3% per year increase for the last 10 years, the major export market being Japan. In 1993, the total production of kimchi in Korea was estimated at 1.5 million M/T, and 10% was produced in factories. By the year 2000, the factory supply of kimchi is predicted to increase to 20% of total production (Choi, 1994).

CONCLUSION

Lactic acid fermentation of cereals, vegetables and marine products is an important technology, which has ensured the suppression of the growth of hazardous microorganisms in foods in regions where adequate means of preservation are lacking. Fermentation has great potential to improve the hygienic condition of foods in poor and underdeveloped regions of the world by simply teaching the people, giving them the knowledge to maximize the benefit of the technology. The cereal fermentation technology of Africa can be transferred to Asian countries, and the fish and vegetable fermentation methods of Asia can be introduced to Africa in order to improve the nutrition as well as the food hygiene of the people in these regions. More research on fermented foods is needed, and mechanisms to exchange knowledge between these regions should be established in order to stimulate regional research and expand the benefits of new findings.

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REFERENCES

Amerine, M. A., Kunkee, R. E. and Singleton, V. L. (1980) *The Technology of Wine Making*, pp. 557–581. AVI Publishing Co., Westport

Choi, T. D. (1994) The market structure and promotion strategy of kimchi industry. In *The Science of Kimchi*, pp. 400–413. Korean Society of Food Science and Technology, Seoul

Ha, D. M. (1994) Suppression of acidic deterioration of kimchi during the fermentation process. In *The Science of Kimchi*, pp. 43–61. Korean Society of Food Science and Technology, Seoul

Hwang, W. I., Lee, S. D., Son, H. S., Baik, N. G. and Ji, R. H. (1990) Effect of fresh garlic extract on the tumor cell growth and immunopotentiating activity. *Journal of the Korean Society of Food and Nutrition* **19**(5), 494–508

Kim, S. H., Park, K. Y. and Suh, M. J. (1991) Inhibitory effect of aflatoxin B1 mediated mutagenicity by red pepper powder in the *Salmonella* assay system. *Journal of the Korean Society for Food and Nutrition* 156–161

Kim, H. S. and Chun, J. K. (1966) Studies on the dynamic changes of bacteria during kimchi fermentation. *Report of Atomic Energy Research* **6**,112

Lee, C. H. (1986) kimchi: Korean fermented vegetable foods. *Korean Journal of Dietary Culture* **1**(4), 395–402

Lee, C. H. (1989) Fish fermentation technology. *Korean Journal of Applied Microbiology and Bioengineering* **17**(6), 645–654

Lee, C. H. (1994) Importance of lactic acid bacteria in non-dairy food fermentation. In *Lactic Acid Fermentation of Non-dairy Food and Beverages*, eds. C. H. Lee, J. Adler-Nissen and G. Barwald, pp. 8–25. Harn Lim Won, Seoul

Lee, C. H., Adler-Nissen, J. and Barwald, G. (1994) *Lactic Acid Fermentation of Non-dairy Food and Beverages*. Harn Lim Won, Seoul

Lee, C. H. and Ahn, B. S. (1995) Literature review on kimchi, Korean fermented vegetable foods. 1. History of kimchi making. *Korean Journal of Dietary Culture* **10**(4), 311–319

Lee, C. H., Cho, T. S., Lim, M. H., Kang, J. W. and Yang, H. C. (1983) Studies on the Sik-hae fermentation made by flat fish. *Korean Journal of Applied Microbiology and Bioengineering* **11**(1), 53–58

Lee, C. H., Lee, E. H., Lim, M. H., Kim, S. H., Chae, S. K., Lee, K. W. and Koh, K. H. (1986) Characteristics of Korean fish fermentation technology. *Korean Dietary Culture* **1**(3), 267–278

Lee, C. H., Steinkraus, K. H. and Reilly, P. J. A. (1993) *Fish Fermentation Technology*. UNU Press, Tokyo

Lee, C. W., Ko, C. Y. and Ha, D. M. (1992) Microbial changes of the lactic acid bacteria during kimchi fermentation and identification of the isolates. *Korean Journal of Microbiology and Biotechnology* **20**, 102

Lim, C. R., Park, H. K. and Han, H. U. (1989) Reevaluation of isolation and identification of Gram-positive bacteria in kimchi. *Korean Journal of Microbiol.* **27**, 464

Mheen, T. I. and Kwon, T. W. Effect of temperature and salt concentration on kimchi fermentation. *Korean Journal of Food Science and Technology* **16**, 443

Oh, Y. J., Hwang, I. J. and Leitzmann, C. (1994) Nutritional and physiological evaluation of kimchi. In *The Science of Kimchi*, pp. 226–245. Korean Society of Food Science and Technology, Seoul

Owens, J. D. and Mendoza, L. S. (1985) Enzymatically hydrolysed and bacterially fermented fishery products. *Journal of Food Technology* **20**, 273–293

Park, H. K., Lim, C. R. and Han, H. U. (1990) Microbial changes of kimchi by temperature. *Report of Science Research of Inha University* **11**, 16

Park, K. Y. and Choi, H. S. (1994) The anti-mutagenic and anticarcinogenic activity of kimchi. In *The Science of Kimchi*, pp. 205–225. Korean Society of Food Science and Technology, Seoul

Park, K. Y., Kim, S. H., Suh, M. J. and Chung, H. Y. (1991) Inhibitory effect of garlic on the mutagenicity in *Salmonella* assay system and on the growth of HT-29 human colon carcinoma cells. *Korean Journal of Food Science and Technology* **23**(3), 370–374

Park, K. Y., Lee, K. I. and Rhee, S. H. (1992) Inhibitory effect of green–yellow vegetables on the mutagenicity in *Salmonella* assay system and on the growth of AZ-521 human gastric cancer cells. *Journal of the Korean Society of Food and Nutrition* **216**(2), 149–153

Shin, D. H. (1994) Physicochemical and microbial properties of market kimchi during fermentation in different containers. In *The Science of Kimchi*, pp. 82–136. Korean Society of Food Science and Technology, Seoul

Shim, S. T., Kyung, K. H. and Yeo, Y. J. (1990) Lactic acid bacteria isolated from fermenting kimchi and their fermentation of Chinese cabbage juice. *Korean Journal of Food Science and Technology* **22**, 373

So, M. H. (1994) Characteristics of psychotropic lactic acid bacteria isolated from kimchi. In *The Science of Kimchi*, pp. 62–81. Korean Society of Food Science and Technology, Seoul

Souane, M., Kim, Y. B. and Lee, C. H. (1987) Microbial characteristics of Gajami Sik-hae fermentation. *Korean Journal of Applied Microbiology and Bioengineering* **15**(3), 150–157

Souane, M., Kim, Y. B. and Lee, C. H. (1990) Microbial characterization of Gajami Sik-hae fermentation. In *Post-harvest Technology, Preservation and Quality of Fish in Southeast Asia*, eds. P. J. A. Reilly, R. W. H. Parry and L. E. Barile, pp. 35–44. IFS, Stockholm

Steinkraus, K. H. (1983) *Handbook of Indigenous Fermented Foods*. Marcel Dekker, New York

Tanasupawat, S., Hashimoto, Y., Ezaki, T., Kozaki, M. and Komagata, K. (1991) Identification of *Staphylococcus carnosus* strains from fermented fish and soy sauce mash. *Journal of General and Applied Microbiology* **37**, 479–494

Tilbury, R. H. (1975) Occurrence and effect of lactic acid bacteria in the sugar acid industry. In *Lactic Acid Bacteria in Beverages and Food*, pp. 177–191. Academic Press, London

Um, M. N. and Lee, C. H. (1996) Isolation and identification of *Staphylococcus* sp. from Korean fermented fish products. *Journal of Microbiology and Biotechnology* **6**(5), 340–346

Yokotsuka, T. (1985) Traditional fermented soybean foods. In *Comprehensive Biotechnology*, Vol. 3, pp. 395–427. Pergamon Press, Oxford

Soy Sauce

Korean Soysauce Vs. Japanese Soysauce

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A few years ago, one of the richest man in Korea, the chairman of a leading business group, was invited to the dinner prepared at the house of the chairman of another multinational business group in Korea. He found the food prepared in the house was very tasty, so he asked to the housemistress the secret. She said the secret was soysauce she had. She was using soysauce ripened for over 10 years for such a special dinner preparation. In her backyard, she was keeping dozens of earthen jar filled with soysauce made at home every year. Returning to his company, the chairman asked to the directors of his company research institute about the reason why years old home-made soysauce could give such a savory taste to the food, which can not be expected from using industrially made soysauce. But no one could explain explicitly the reason.

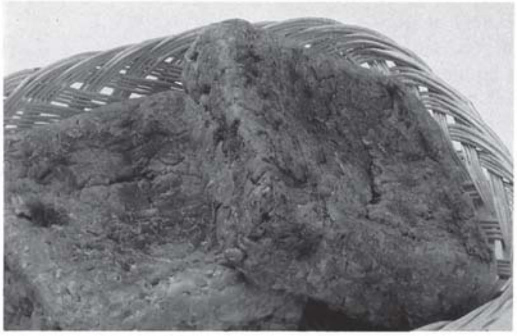
What's the Difference?

What is the difference between the home-made Korean soysauce and the industrially-made Japanese style soysauce? Of course, there are differences in the processing methods and the tastes, but what compounds and what combinations of materials are responsible for the delicate harmony of taste in a dish used this home-made stuff is not known. The differences start from the preparation of the fermentation starters, Meju and Koji. Both are made by the typical solid state fermentation, but the materials and fermentation conditions are different.

The Starter for Korean Soysauce Is Meju

Meju, the fermentation starter for Korean soysauce, is made from soybean only. Soybean is soaked in water overnight and cooked for 2-3 hours until the whole kernel is easily crushed by finger press. The cooked soybean is poured in a sack and crushed by stepping on the sack or pounded in a mortar. The crushed soybean is molded into a brick, a cone or a ball shape. It is placed on the rice straw, dried in the sun and stacked under a cover during the night for a week. When the outside is dried, it is tided with rice straw and hung under the ceiling of warm living room. Normally Meju preparation starts in October, the beginning of Korean autumn, and the slow drying process undergoes for 10 weeks in the room.

During this periods, molds grow on the surface of Meju ball, and bacteria, especially Bacillus species, grow in the inside of the ball. When fully dried, the Meju ball hung in the room is taken into a sack made by rice straw and kept



in the storage room. It is periodically taken out in the sun for a half day drying.

In the next spring, Meju balls are taken out from the straw sack and brushed out the surface mold and straw dirts, and put in a large earthen jar washed with boiling water and filled with brine. The mixing ratio of Meju, water and salt is 2 : 4 : 1.2 in volume, which makes the salt concentration of the mash around 20%. Small amounts of charcoal, dried whole red-pepper and dried date are added to the jar, which is placed in the sunny place and covered with fine net in order to protect from flys. The ripening of soysauce mash in the brine is ended in 1-2 months.

During this period, the amino acids and sugars formed by the enzymic hydrolysis of soybean proteins and carbohydrates exude out to the brine and they undergoes Maillard reaction to produce dark brown color. The halophilic yeasts, mainly Saccharomyces rouxi, grow in the mash and produce alcohols and other organic compounds to add the flavor of the sauce. At the end of the ripening the mash is filtered and the liquid part is boiled and kept in the earthen jar for longer periods of storage.

The precipitates remained after filtration is mixed with small amounts of Meju powder and rice porridge, packed in a small earthen jar with additional salt spread on the top, and kept in the sunny place for several weeks to make soybean paste.

The Starter for Japanese Soysauce Is Koji

On the other hand, the fermentation starter for Japanese style soysauce, Koji, is made by controlled fermentation of a inoculated mold, Apergillus oryzae, on the mixture of roasted brocken wheat and cooked soybean or defatted soybean meal. Koji is mixed with brine to make soysauce mash for ripening. The mixing ratio of Koji, water and salt is 1: 7 : 1.8, and the higher soybean content in the mash results in stronger meaty flavor but less sweet taste. The mash is stirred once in a day, and ripening continues normally for 1-2 months, but the longer period of ripening, for example 6 months or one year, produces better quality of soysauce. After ripening the mash is filtered to separate clear liquid and the residue which are discarded. The clear liquid is sterilized by boiling and then bottled for sale. Soybean paste is made separately in Japanese style soybean fermentation. Rice Koji is mixed with cooked soybean and salt, and ground to make paste. It is packed in a container and ripened for several weeks. The pure culture of mold excluding the growth of Bacillus and the use of cereals in the starter render the products milder aroma and sweeter taste.

Korean soysauce making is a natural fermentation having various microflora incorporated sequentially in the processing steps. Although the amylolytic and proteolytic activities of the mold grown on the surface is high, much stronger enzyme activities are expected from the anaerobic bacteria grown inside the Meju. At the end of Meju fermentation, the inside of Meju ball is dark brown and has strong smell.

During the ripening in the brine, this smell turns more acceptable and savory nature by complex chemical and biochemical reactions, and further chemical reactions including the esterification of organic compounds with alcohols take place during the long periods of storage after filtration and boiling. The biochemical reactions taking place during the fermentation and storage of Korean soysauce are very complex and not fully understood yet.

Due to the action of Bacillus species and the raw material using soybean only, Korean soysauce has stronger meaty flavor, less sweet and sharper smell compared to Japanese style soysauce.

Korean people prefer to use home-made soysauce as the condiments for soup and dip ping sauce for various dishes, especially for boiled pork. The strong and sharp flavor of Korean soysauce became smoother and deeper during the long period of storage in the earthen jar, and the dishes made with 10-year old soysauce can produce extraordinary harmony of taste. K

CHONGKUKJANG; A fermented soybean product as instant military food of old days.

Chongkukjang stew is an important menu of Korean food restaurants, where elderly people prefer to go.

by Lee Cherl-ho
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Korea University, Seoul, Korea

In the urbanized life style today, so called apartment culture, what the Korean elderlies are mostly missing is the stimulating savory smell of Chongkukjang from their kitchen. Since Korean young people do not like the smell, the neighbor conscious apartment life do not allow the preparation of Chongkukjang stew at home. Many TV drama in Korea deal with the episode of Chungkukjang smell and the desire of elderly parents for the savory stew as an example of generation conflict between the young and elders. Consequently, Chongkukjang stew is an important menu of Korean food restaurants, where elderly people prefer to go.

Chongkukjang was also called as Jeonkukjang in the old days. Chongkuk means a Chinese kingdom "Ching", while Jeonkuk means "a country in war" or combat zone. The name Chongkukjang is said to be used from the early 17C during Byungjahoran, the Manchu invasion in 1636, because the Ching army used to carry the instant fermented soybean as military ration. What all these names imply is that this product was made for extraordinary situation, for example war time or famine conditions, for the urgent supply of nutritious savory food ingredient.

The Health Beneficial Physiological Functions

The first written record on the preparation of Jeonkukjang is appeared in Jeungbosanlimkyungje written by Yoo Jung Im in 1765. Newly harvested soybean is cooked and covered with straw mat, and placed on the warm Ondol, typical Korean stone floor heated by fire underneath, for 3 days until the mucous string is formed with strong fermented smell. It is mixed with decoupled and roasted soybean powder, and pounded in a stone mortar with the addition of salt, and sun dried. The mixing ratio of fermented soybean and roasted soybean powder is 2 to 1, and the amount of salt addition is determined by taste. The product appears to be dried form, easy for storage and transport, and suitable for the military use. This process is slightly different from the method practiced today.

Today, the process is very simple. Soybean is cooked and covered with straw mat or cloth, and placed on the warm Ondol for 3-4 days until the mucous string is formed. It is mixed with chopped ginger, chopped garlic and salt, and pounded slightly until the bean kernels are separated into halves, and stored in an earthen jar. The strong smell of fermented soybean is partially masked by the ginger and garlic smell, and creates

characteristic Chongkukjang flavor. The spicy seasoning is thus prepared in 3-4 days, while ordinary soybean paste, Doenjang, which uses Meju as fermentation starter, takes over 6 months for complete ripening.

Japanese Natto is a Modified Form of Chongkukjang.

The mucous substance in Chongkukjang is peptide-polysaccharides produced by Bacillus subtilis. Recent studies discover the health beneficial physiological functions of some mucous polysaccharides produced by the bacteria in Chongkukjang. Bacillus subtilis produces strong proteolytic enzymes, and soybean proteins are partially hydrolyzed into peptides in the short fermentation period. The soybean peptides has strong angiotensin reducing activity, and thus suppress the incidence of high blood pressure. The isoflavonoides in soybean support estrogen hormone function and relieve the malfunction of human menopause. It is not surprising to find that fermented soybean products have been used as medicine in many Oriental medicine subscription, such as those in Dongeuibogam, a Classic of Oriental medicine written by Hur Kyun in 1611.

Japanese Natto is a modified form of Chongkukjang. Natto is fermented soybean grown Bacillus subtilis on cooked soybean. The raw fermented soybean with mucous string is consumed directly without further processing, so it is a non-salt fermented soybean food. However, Korean people do not like the raw flavor of fermented soybean with the bacteria. It is always mixed with spices and used for the cooking of vegetable stew as a meaty flavored condiment. The amount of addition to the stew is large enough to supplement protein to the diet significantly. The fermented bean halves floating and mixing in the vegetable stew gives healthy sign of the dish. The strong desire on Chongkukjang of Korean elderlies may be not only the sensory nostalgia, but the physiological demands for their better health. K

SERIES [3]

Foods that go well together

Steak and Pineapple

The beef cooking differs from country to country or from region to region. However, the most common beef cooking may be the beef steak. In order to make a beef steak, a small amount of sweet potato, carrot, pea, corn, etc., will be added to a lump of well-roasted beef. People should feed the cattle well and even massage them in an effort to get good beef. Some farmers have the cattle listen to music or drink beer.

Meanwhile, in order to soften the meat people use a softener. In Korea pears or radishes have been used as meat softener. However, pineapple will soften the meat more effectively than these traditional softeners. The bromeline, a protein-dissolving enzyme contained in pineapple will, efficiently soften the meat. This softening effect can be easily proved if we spray a small amount of bromeline over the meat and see the result.

When you cook a steak, you do not have to soften the meat with the bromeline necessarily, but instead, you can eat the meat together with a slice of pineapple or eat the slice after the meat. Then, the meat will be well digested in your stomach. Moreover, pineapple contains 0.5%-3.0% citric acid and the same portion of apple acid which will facilitate the secretion of various digesting enzymes. Besides, as pineapple also contains calcium, it is deemed to be most ideally combined with the meat. And the fruit consists of 88.5% water, 1.7g protein, 0.4g fat, 8.7g sweet and 31mg vitamin C.

Although the beef contains many essential amino acids evenly and thus can be categorized as high nutrient food, it has little vitamins and high ph value. Therefore, beef had better be taken with vegetables or fruits such as pineapple. K

COVER STORY

Clear Rice-Wine, Cheongju the Lost spirit of Korean

The traditional Korean alcoholic beverages can be largely divided into two groups.

(The manufacturing process of Hongju)

by Lee Cherl-Ho
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Invention of wine making is one of the most important God-blessed events of human being. Wine has been used as a central part of the social life of mankind. It is the medium to share one another the joy and sorrow in the life, to sacrament belief and friendship, and to worship the God and ancestors. It goes with all kinds of rituals in human life, birth, marriage and funeral ceremonies. It is therefore in the central part of human culture, so the English word "spirit" means both soul and the essence of wine, the distilled alcohol.

All the major old cultures in the world have their own God of wine; Osiris in Egypt, Bacchus in Greece, Soma in India and Yidi, the princess of Yu, in China. There is no God of wine in Korea, probably because the technology was transferred from China long before the era of written history. According to Samkuksaki, written by Kim Bu-Sik in 1145, the legendary story of the birth of Jumong, the founder of Kokuryo Kingdom in BC 37, involves rice-wine. The son of God, Haemosu, served rice-wine to Habaek until he got drunken, and then took his daughter, Yuhwa, who became the mother of Jumong. During the period of Samhan and Kokuryo, rice-wine was used for the rituals and festivals. The use of *nuruk*, the fermentation starter made by

Korean folklore wines produced by traditional methods boast of unique tastes and flavors.

broken cereals grown with mold, and malt for the saccharification of rice before alcohol fermentation was already practiced in this period, and the brewing technology appeared to be well established.

The old Japanese history book, Kojiki, describes that in the period of Emperor Oojing(AD 270-310) Inburn, a Korean man from Baekje, brought new technology of rice-wine making to Japan. It must be the use of *nuruk* for rice-wine making. Today in Kyoto, Japan, a shrine named Matsuo Taisha is keeping the tablet of the god of rice-wine, who is Korean origin. Once in a year, all the Japanese *sake* brewers gather in this shrine to pray for their successful brewing. In fact, the rice wine brewing technology was well advanced in the Unified Silla (AD 668-918), and transferred to the neighboring countries. Korean rice-wine was exported to Tang of China, and Silla brewery was famous in the region.

Rice-Wine Making Was an Important Hausehold Activity

Eumsikdimibang, the first Korean cook book written by Madam Lee in 1670, contains 132 methods of cooking, and among them 51 are the various methods of alcoholic beverage processing. It implies that rice-wine making was an important household activity at that time. Jubangmun and many other monographs for rice-wine making methods were written during the 17-19C in Korea. Sanlimkyungje, the agricultural encyclopedia written in 1715 by Hong Man-Sun, describes 61 kinds of rice-wine brewing. Imwonsibyukji, another encyclopedia written in 1827 by Seo Yu-Ku, classifies Korean alcoholic beverages into 11 classes according to the processing methods and usage. Considering all the names appeared in the classic cook books, encyclopedia and other literatures like poems and novels written before 20C, over 300 different kinds of alcoholic beverages were made in Korea before the Japanese colonial period.

The traditional Korean alcoholic beverages can be largely divided into two groups; rice-wine, *gokju*, and distilled liquor, *soju*. *Gokju* means fermented alcoholic beverage made from cereals. Rice is the predominantly used raw material, although maize, barley and sorghum are sometimes used. Therefore, *gokju* is translated to "rice-wine" in English term. Steamed rice is mixed with *nuruk*, the fermentation starter, and clean water in an earthen jar, and placed in the room for three days. It is called *mitsul*, the mother brew. Another portion of steamed rice and clean water is added to the mother brew to make double-brew rice-wine. According to the number of the addition of steamed rice and water, triple-brew or quadratic-brew is made. Double-brew rice-wine is the most commonly made one, but the more·brew and the longer fermentation period at lower temperature are considered to produce better quality of rice-wine. The fermented mash is separated into clear wine, *cheongju*, and turbid beer, *takju*, by placing *yongsu*, the wooden filter net, into the mash. *Cheongju* is high quality beverage containing 12-18% alcohol, and served to the master or the upper class people. The turbid residue is mixed with water and strained out through rough sieve, with which the name *makgolli* is coined, to make *takju*, the turbid beer containing 6-8% alcohol, and consumed by the lower class people. Various herbs, flowers, fruits and fragrant plants are added to the fermentation mash to brew the numerous types of medicinal or flavored rice-wines.

In 1907, the Japanese colonial regime proclaimed the wine tax law, and forbidden all the unauthorized wine production. Later in 1916, they standardized brewing methods, and gave regional licence for the production and sale to those who make only three types of products, *takju*, *yakju* and *soju* in accordance to their standard methods. *Yakju* is differentiated from Japanese *sake* by not allowing the removal of the impurities in clear rice-wine. Korean people were allowed to make only low quality rice-wine, *yakju*, for the 30 years of colonial period. During this period, the turbid rice-beer, *takju*, became common drink for Korean. The high quality *cheongju* was forgotten by the people, and the low quality *takju*, which was consumed by lower class people, became the national drink of Korea, while the clear rice-wine became Japanese national drink.

Korean Rice-Wine Was Almost Forgotten for More than Two Decades.

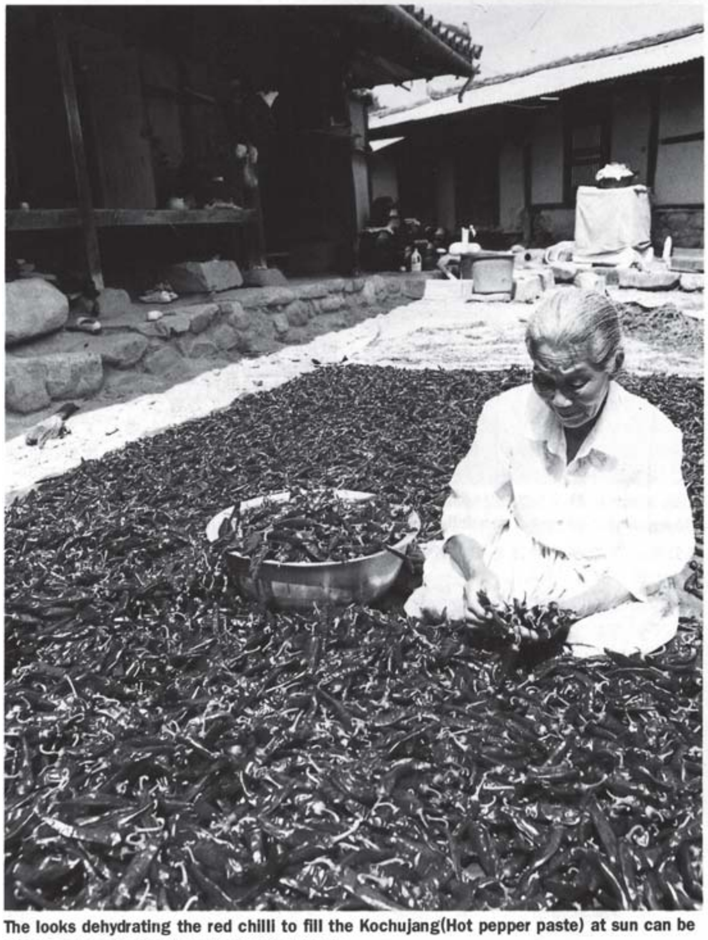
The disgracing tax law continued to exist for the half century after rehabilitation. The Korean government copied the colonial tax law by not knowing the hidden plot. In addition, the use of rice for alcohol fermentation was forbidden in 1966, due to the severe shortage of food grain, and substituted by wheat flour. Thus, Korean rice-wine was almost forgotten for more than two decades. Fortunately, the era of rice surplus came in the late 1980's, and rice use for brewery was allowed again. The removal of impurities from *yakju* was permitted. At the same time, movements to restore Korean spirit were arisen among the people and spread over the country in various fields including dietary culture. People who keep the brewing skill were licensed to produce traditional rice-wines. Over 40 different traditional rice-wines and distilled liquors have been revived today, and the number is increasing. Application of pasteurization and aseptic packaging extended the shelf-life of *takju* and *yakju* over 6 months, which allowed the export of Korean rice-wine to Japan, USA and even France. The glory of Silla rice-wine is going to be restored in the 21 Century. K

Kochujang; A Wonderful Harmony of Hot, Sweet, Meaty and Salty Tastes

Kochujang is the queen of the fermented soybean products in Korea.

The basic tastes of European people are sweet, sour, bitter and salty, and Japanese people add here *umami*, the meaty taste. Korean people add here another one, hot or pungent taste.

The most remarkable difference of Korean food comparing to those of neighboring Japan and China is the strong pungent taste of red pepper in most of Korean dishes



The looks dehydrating the red chilli to fill the Kochujang(Hot pepper paste) at sun can be often seen on Korean farm villages in Autumn.

Kochujang is a unique hot bean paste seasoning popular in Korea. It is made from fermented soybean starter, *Meju*. Dried *Meju* is ground into powder and mixed with cereal porridge made from rice, glutinous rice or barley. The enzymes in the starter *Meju* hydrolyzes the starch into sugars and reduces the consistency of the mixture. Red pepper powder and salt are added with thorough mixing and put in an earthen jar. The top is covered by salt in order to prevent mold growth. The jar is placed in sunny place for several months for further fermentation. The proteins in soybean and cereals degraded into amino acids to produce meaty flavor. During the fermentation a wonderful harmony of the meaty flavor from hydrolyzed proteins and the sweet taste of hydrolyzed starches with the pungent taste of red pepper and salty taste is achieved, and a new characteristic flavor stimulating the appetite of Koreans is formed.

Kochujang is the queen of the fermented soybean products in Korea. The shiny red color, rich and smooth consistency and stimulating hot-sweet-meaty aroma are enough to capture your central nerve to cry for a bowl of warm rice. One can empty a bowl of rice with *Kochujang* alone as side dish. It is a good source of protein, essential fatty acids and vitamins, especially vitamin A. A bowl of rice and a fresh cucumber with enough amount of *Kochujang* for dressing is an excellent lunch menu in the summer for Korean people, just like a hot-dog covered

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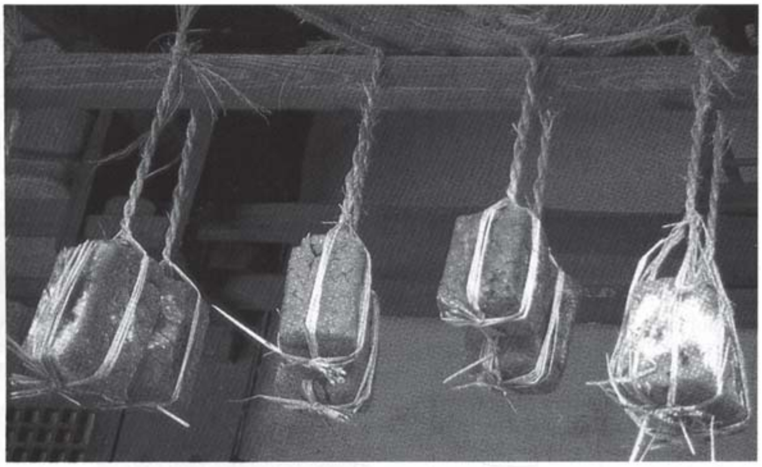


Meju, the material of Kochujang, dehydrated under the eaves.

with tomato ketchup for European people. In fact, Koreans living in America and Europe prefer to put *Kochujang* on hamburger and sandwich instead of tomato ketchup. Meat/fish and vegetable stew seasoned by *Kochujang* is the most popular side dish enjoyed by Korean at least once in a day.

History of Kochujang

The first record on *Kochujang* is found in *Chungbo-sanlimkyungje* written by *Yoo Chung-im* in 1765. It describes several varieties of fermented soybean products, including Jeubjang and *Chongkukjang* besides *Kochujang*, and their processing methods practiced in Korea at that time. According to this book, *Kochujang* was made by mixing *Meju* powder, glutinous rice powder and red pepper powder in the ratio of 10:1:0. 3 and then by adding good quality of Kanjang soy sauce, to make paste having desired consistency. It was put into an earthen jar and placed in the sunny place for ageing. It says that too much glutinous rice produces objectional sour taste, and advises not to use too much red pepper. However, today we use much more red pepper than that was suggested in this book.

Kochujang preserved at the jar.

The fermentation starter, *Meju*, is appeared to be made specially for *Kochujang* in the old days. Kyuhabchongseo written by Madam *Binghurgak Lee* (1759-1824) recommends to mix 10 parts of cooked soybean with 2 parts of rice cake during pounding for the molding of *Kochujang Meju* ball. Mixing of rice, barley or wheat to soybean for *Meju* preparation is often found in the old Korean literatures, such as Kuhwangchwalyo written in 1554. It has been faded out during the last 2-3 centuries in Korea by unknown reason, but maintained in Japan.

It is said that red pepper was first introduced into Korea during Yimjin-Oeran, the Japanese Korean war in the 17th Century. However, the use of fermented hot soybean paste exsisted in Korea long before that time. *Domundaejak* written by Hur Kyun in 1611 describes Choshi, a hot bean paste added with Choncho, the hot spice widely used in Korea before the introduction of red pepper. Addition of dried spices and medicinal herbs to soybean paste fermentation was a common practice in Korea. Sashichanyo written by Kang Hie-maeng(1423-1483) describes soybean paste fermented with powders of wild ginseng and broad bellflower roots. After the introduction of red pepper, Korean people were so much addicted to the taste, it became the major ingredient for the preparation of Korean side dishes. The hot and sweet taste of red pepper adds the richness and stimulating sensation to Korean foods, especially fermented foods such as *Kochujang*, *Kimchi* and Joctkal, the fermented fish products. It is also increasing to note that both Korean and Hungarian people, who are in the same language group, Ural-altai, but live in the opposit side of the globe, show commonly exceptional preponderance to red pepper.

interesting

Kochujang is used as a popular preservation medium for fresh vegetables, same as soybean sauce. Perilla leaves, green peppers, bellflower roots, ginseng roots and other green vegetables are stored in *Kochujang*. With its high salt concentration, vegetables mixed with *Kochujang* in an earthen jar can be stored for several months and, at the same time, attain the savory flavor. It is also used as a base of hot and sour sauce, *Chojang*. Say sauce and vinegar are added to *Kochujang* to make more fluidable sauce, which is used for the dipping material, especially for raw fish dishes. *Chojang* has quite different flavor from that of Wasabi sauce, ground horse radish in soy sauce, used in Japanese raw fish meal. It is used as hot salad dressing with fresh vegetables, and marination sauce for roasted pork and other meats. It may resemble to *Tabasco* sauce in European dinner table today, but has more deep and rich flavor.

It is hard to image how to prepare the savory stews, raw crab pickles, root and vegetable salads, *Bibimbab*, *Bibimnaengmyon* and all the gourmet foods in Korea without *Kochujang*. If you examine carefully the Korean travellers to overseas, you will probably find a bottle of *Kochujang* invariably in their baggage. K

Faculty Forum

Maggolli Reevaluation

Lee Cherl-ho
(Dept. of Food Technology)

The consumption of Maggolli is decreasing drastically in recent years. The market share of Maggolli went down from 55% of total production of alcoholic drink in korea in 1980 to below 30% today, whereas that of beer increased from 22% to over 40% during the same period.

The rapid downfall of Maggolli is mainly caused by the governmental allocation of sales region, which allowed the breweries to monopolize in their territory. In this circumstances, there was no incentives for the product development and quality improvement. Without free market competition, there has been no need for research and development in Korean Maggolli industry during the last three decades. Consequently, they lost the market to beer industry, and the value of a Maggolli brewery in 1970's was 200 million won, and today it costs only 50 million won.

The taste and appearance of maggolli are not attractive to the consumers of modern society. It turns rapidly to sour taste during the distribution channel and forms unpleasant stomach gas after consumption.

The fame of representative Korean alcoholic drink given to Maggolli is also seriously challenged by some scholars of dietary culture. They claim that the name of typical korean drink given to Maggolli was intentionally coined by the Japanese invaders, who took all the efforts in underestimating Korean for their colonial policy. Traditionally, Maggolli was produced as a by-product of Yakju or Chongju Cooked rice was fermented by Nuruk, and Yongsu, a kind of filter basket made with bush-clover, was placed in the center of the jar. The stagnated clear liquid was taken as Yakju and served to the masters, and the residue was mixed with water to make Maggolli, which was enjoyed by the servants. During the colonial period, Maggolli production was encouraged in this country, while Chongju was introduced as Japanese rice wine. In fact, the origin of Japanese sake was founded from korean Yakju which was transferred from Baekje to Japan in the 6th century.

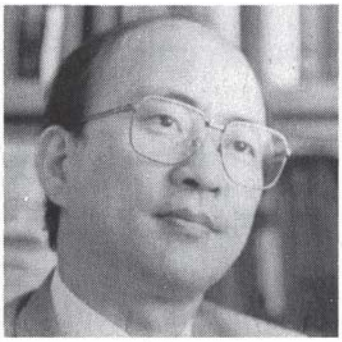
Maggoli is a symbol of manly, casual, and nationalistic image, especially for the students of Korea University. It reflects the energy surviving the harsh life of Korean through the feudalism, colonialism and war of their 20th century. It has nourished the graduates of Korea University to hold the spirit of intelligence and wildness, which contributed greatly to the country for her independence and the miraculous economic growth.

However, at the corner of the century, we realize that the taste of Maggolli dose not appeal to the young generation. They do not like the thick, turbid and sour character of Maggolli, same as they do not understand the harsh life of their parents. They prefer the clearly refined and pleasantly carbonated taste of beer. The fate of typical Korean alcoholic drink stands at the cross-road to choose either enforcing the people to drink Maggolli as the patriotic gesture or abandoning it as the false national drink and develop an authentic one instead.

Ironically, the fate of Korea University stands at the same situation. The fame of famous nationalistic university under the slogan of "Education to Save the Nation" is fading out. If we stick on the dream of good old days, we will soon be the outcaster of the coming 21 century. We are facing to the emerging new order of the world. The century-old ideological struggle is ending, and the pragmatic nationalism led by commercialism and technocracy is ruling the globe. And we are standing in the center of establishing the new international order. Should Korea University continue to enjoy with the turbid, wild and falsely coined drink, or take pains to renovate with highly refined aristocratic Yakju?

Faculty Forum

The Ecology of Water



Prof. Lee Cherl Ho
(Dept. of Food Technology)

The term 'ecology of water' may sound strange, because water is not a living matter. However, we are getting used to hear of *Saengsu,* which means living water or bio-water, without any irritation. It is probably due to the cultural background we have. In fact, the Korean scientists in the 18-19 centuries considered water as the most essential material for life and attempted to classify it on the basis of the source and usage. *Seo YuGu,* the author of old agricultural encyclopedia, *Imwonsibyukji* written in 1827, described 11 different kinds of water, including underground water, stream water, lake water, valley spring water, rain water etc.

The well-known physician, *Hur Jun*, classified water into 33 kinds according to the medicinal effect in his medical book, *Dongeuibogam* written in 1715.

He pointed out that drinking water is the most important material for health, and all diseases should be first treated with proper water intake before the use of any other medicine. Customarily, we often recommend to go for a change of water for the treatment of many chronic diseases.

The World Health Organization (WHO) recognized the importance of keeping water quality of the world and put forward to a clean water campaign since 1955 under the slogan of 'Clean Water means Better Health.'

The structure of water has been a hot issue of scientific research for many years. The cluster theory, which explains well some of physicochemical properties of water, implies the existence of various three-dimensional structures of water. Recently, some scientists claim that the structure of water is changed by temperature and pressure. It is said that the water treated at high pressure over 4000 atm possesses special physiological function. With this water plants can grow faster, and some of chronic diseases can be curred, but the special physiological function disappears when water is heated or exposed to the atmospheric pressure for long time.

Some scientists explain this phenomenon by structural change of water molecule from hexagonal to pentagonal ring form, The natural underground water, so-called saengsu, which is originated from low temperature and high pressure condition of underground is, therefore, considered superior to the surface and boiled waters.

It is the dispensation of the nature that the very necessary things for life is given free of charge. They are, first of all, air and water. But we have sold these invaluable things for the less- or unnecessary things, such as foods, clothes, houses, furnitures, tools, gasolins, cars and weapons.

The Korean people was blessed with plenty of good water all over the country. Clean water flowed through every valley and stream, and ice-cold underground water was drawn-up from every wells in the peninsular.

Unfortunately, we have sold this valuable thing for the unhealthy modern life, just like as Faust bathered his soul to the evil for illusory knowledge and pleasure. During the last three decades, we have imported the heavily polluting industries from the advanced countries under the name of industrialization. From the backyard of the so-called miraculous economic growth, the swamp of stinks and poisons gathered from all over the world is spreading out to the land and kills the biological activity of water in the country.

The immediate action against this urgent situation is to stop intentional release of industrial wastes and animal excrements to the river, to reduce the consumption of detergents and other household wastes, and proper operation of local waste water treatment installations. However, the fundamental solution of this problems is to pass-by the present machine civilization as soon as possible and entering into the regenerable bio-industrial era. The Oriental phylosophy, which emphasizes the organic harmony of human being with the universe, will play important role for the opening of new biotech-civilization.

This time the *Goethe* who changes the tragedy of *Faust* into happy ending will come from the Orient.

Changes in the Dietary Patterns, Health, and Nutritional Status of Koreans during the Last Century

by Cherl-Ho Lee

Introduction

The objective of this study is to examine the changes in the food habits of Koreans in the last century — during which the land has been under the strong influence of Western culture — and to evaluate the consequences of these changes in regard to the food economy, in order to provide the materials for establishing national dietary goals and adequate guidelines for today.

Seven factors are postulated as having caused changes in Korean food habits: (1) changes in religious beliefs or thought; (2) progress in the sciences of health and nutrition; (3) changes in the economic situation; (4) changes in living styles; (5) the long-term period of war and foreign infiltration; (6) the introduction of foreign culture; and (7) the availability of new food materials. The socioeconomic consequences of changes in food habits were categorized into the following four areas: (1) the health status of the Korean people; (2) the patterns of food supply and consumption; (3) food industry; and (4) family and human relationships.

For this study, the century from the end of the Choson dynasty to the present day has been divided into five periods, according to major socioeconomic turning points, and the food habit changes and their consequences in each period have been analyzed in detail. The periods are as follows: (1) last period of the Choson Kingdom (mid-1800s–1910); (2) Japanese Occupation (1910–1945); (3) initial development period (1945–1966); (4) mid-term development period (1967–1976); and (5) late development period (1977–1986).

Since the records of the nutritional status of Koreans and of the economic indexes of the Choson Kingdom and the Japanese Occupation periods are scanty, the food materials described in the ancient Korean sources and the statistical data of the Japanese colonial regime were used for this analysis. The national food balance sheets, food consumption survey reports, and research papers on the food situation, health, and nutritional status of the people since 1945 were also used for this study.

Korean Food Habits in the Last Period of the Choson Kingdom

Imwon sibyuk chi, an encyclopedia written in 1827 by So Yu-Ku, provides an insight into the dietary life of Korea before its opening to Western countries. Part Eight of this book, *Chongjo chi*, is equivalent to a modern food technology textbook. The first chapter, *Sikkam* *chwalyo* lists the food materials that were then available and classifies them in a manner comparable to the present Food and Agricultural Organization (FAO) classifications on food balance sheets. *Sikkam chwalyo* lists 11 kinds of liquids as the most important food material, and classifies 36 kinds of cereals, 72 kinds of vegetables, and 46 kinds of fruits, among other plant food materials. It describes seasonings as an important food category, but does not list milk, fat, or oils.

Siui Chonso, written in the late 1800s, describes in Volume 1 the processing methods for soy sauce, kimchi, and the salt preservation of vegetables, and then lists cooked rice, cereal gruel, salted fish, persimmons, and honey drinks with shredded fruits. Volume 2 lists rice cookies, rice cakes, saccharified rice drinks, fruit jelly, candy, rice wine, dried fish and meat, soybean curd, acorn starch gel, rice jelly, fermented fish, sea plants, fish, and vegetables, and also describes the table settings for different meals.

According to still older literature, the dietary pattern of Koreans in the late Choson Kingdom appears to have been made up of main dishes of cooked rice and cereal gruel, supplemented by side dishes of soup, stew, kimchi, pan-fish/meat, and salads. Noodles, buns, and rice cakes were used as snacks; rice cookies and both alcoholic and nonalcoholic beverages were listed as favorite foods. Characteristic of the food in this period was the use of various kinds of cereals, vegetables, and fruits that are considered wild or famine food today. Therefore, the nutritional status during this period cannot be estimated accurately by using today's food composition tables; the people supplemented substantial portions of their diets with nutrients from wild foods which are not listed in today's food classifications.

Lee and Ryu (1988) calculated the nutritional value of different Korean standard meals, basic meals, *samch'op-*, *och'op-*, and *chilch'op-bansang*, on the basis of the meal compositions as stated in Kim Ho-jik's book (1944). The basic meal, consisting of a bowl of cooked rice, a bowl of soup, and a dish of Kimchi, could supply 995 calories of energy and 36.5 grams of protein, which correspond respectively to 40 percent and 49 percent of the recommended daily intake for a Korean man today. It was interesting to note that the standard Korean meal could supply today's recommended daily intake of protein, minerals, and vitamins, if the size of the meal was enough to supply the recommended daily caloric intake. In addition, the increased number of dishes added energy and protein, but did not significantly increase fat intake.

The Dietary Situation during the Japanese Occupation (1910–1945)

During the Japanese Occupation, from the annexation of Korea to Japan in 1910 to its rehabilitation in 1945, Western food was introduced to the people. This period was also a time of hardship and food shortages for Koreans, due to the extortion of the food sent to Japan and later to the Sino-Japanese war field.

Western concepts of nutrition were introduced to Korea during this period, and Western-style bread and cookies were introduced by Japanese bakers. The first bakeshop in Korea, *Myongch'iok*, was opened in the 1920s in downtown Seoul. By the 1940s, 40 bakery companies and 140 bakeshops had been established in Seoul.

According to the Choson Food Industry Directory, published in 1922 by the Korea-China Industry Survey Committee, the food industries owned by the Japanese were 492 in total, including 208 rice milling plants, 8 flour mills, 44 cookie manufacturers, 3 agar manufacturers, 172 breweries, 6 soft drink makers, 2 ice makers, 21 salt producers, and 19 canneries. This list indicates that a significant change in food processing technology took place during the Japanese Occupation, and that certain amounts of processed foods — for example, flour, breads, noodles, cookies, soft drinks, and canned goods — were always available to some fraction of the people. On the other hand, the majority of people were still ignorant of Western foods and lived by their traditional dietary pattern, governed by Asian rules of health.

Hong Sunpyo (1940) teaches in his *Choson yorihak* (*Studies on Korean Cooking*) four principles of eating, based on Asian rules of health: (1) eat small amounts and only when hungry; (2) eat relatively hard materials with enough mastication; (3) stop eating before satisfaction; and (4) eat more raw foods. His dietary guideline also recommends a minimal use of salt and refined sugar.

Lists of the food materials that were available in this period can be found in *Choson singmul gaeron* (*A Review of Korean Foods*), written by Kim Hozik in 1944. This book lists 17 kinds of cereals, a significant reduction from the 36 kinds listed in *Imwon sibyuk chi*; some of these, however, are classified under wild plants as famine food. It also lists 25 kinds of vegetables, 304 kinds of wild plants, 7 kinds of seaweed, 81 kinds of mushrooms, 11 kinds of fruits, and 204 kinds of fish and shellfish. In the category of meat and eggs, cattle, pig, dog, roe deer, poultry, pheasant, and eggs are listed, but milk does not appear, indicating that milk was not generally considered food until the end of the Japanese Occupation.

The *Colonial Statistical Yearbook* lists 15 kinds of cereals, 6 kinds of beans, 2 kinds of root crops, 13 kinds of vegetables, 5 kinds of fruit, 3 kinds of livestock, and several marine products. It is clear that these numbers are much smaller than the variety of food items actually used by the people. On the basis of the *Statistical Yearbook* (1912–1940), the daily per capita food supply was calculated on the basis of three-year periods, as shown in Table 1.

Food Group	1913-1915	1922-1924	1930-1932	1937-1939
Cereals	454.2	414.4	372.0	436.5
Rice	248.9	196.1	162.4	222.0
Wheat Flour	29.5	31.3	26.0	37.4
Barley	65.7	61.5	65.0	75.0
Others	110.1	125.5	118.6	102.1
Sugar	-	-	-	-
Root Crops	36.4	70.3	70.5	90.1
Beans	94.6	76.8	65.7	52.0
Nuts	-	-	-	-
Seeds	-	-	-	-
Vegetables	95.3	102.7	134.7	127.4
Fruits	0.6	2.6	8.3	12.6
Meat	13.4	15.7	14.2	11.8
Eggs	-	-	-	-
Milk	-	-	-	-
Marine Products	26.3	37.6	73.5	84.0
Fats and Oils	-	-	-	-

Table 1. Korean Daily Per Capita Food Supply during the Japanese Occupation. (unit: gram)

The supply of cereal in Korea diminished gradually during the colonial periods and reached its minimum in the early 1930s. This change was largely due to the extortion of rice from Korea to Japan, which amounted to nearly one-third of the total production in Korea. The estimated daily per capita nutrient supply is shown in Table 2.

The average daily per capita energy supply in the 1913 to 1915 period was 2,089 calories, 97.5 percent of which had plant origins. The total protein supply was 80.7 grams per capita per day, 91.8 percent of which had plant origins. These values indicate that Koreans were heavily dependent on plant food materials. The total energy supply was comprised of 74.1 percent from carbohydrates, 15.4 percent from proteins, and 10.5 percent from lipids. These values are similar to those calculated from Kim Hozik's standard meal composition (Lee and Ryu, 1988). Therefore, it can be concluded that the Korean dietary pattern did not change much during the Japanese Occupation, although the food supply was severely reduced.

The Food Situation in the Initial Development Period (1945-1966)

Korea experienced tremendous changes between 1945 and 1966, during which rehabilitation, the Korean War, and a military coup took place. This great turmoil resulted in profound changes in the food habits of the people. The food shortage caused by the extortion during the Japanese Occupation was aggravated by the massive movement of refugees from the North Korean Communist regime to the South after rehabilitation. The number of refugees from North to South was estimated to be 2 million, which was almost 10 percent of the total population in the South at that time. However, the most important factor causing the rapid changes in food habits was the Korean War.

Nutrients	1913-1915	1922-1924	1930-1932	1937-1939
Total Energy (kcal)	2089.00	1916.00	1775.00	1980.00
Plant origin (kcal)	2083.00	1849.00	1676.00	1875.00
Protein (g)	80.70	72.70	71.70	73.60
Animal origin (g)	6.60	8.90	14.30	15.60
Lipid (g)	24.30	20.40	19.50	18.50
Ca (mg)	314.00	310.00	325.00	311.00
Fe (mg)	23.50	21.40	20.80	22.70
Vitamin A	414.00	591.00	985.00	1076.00
B1 (mg)	1.66	1.63	1.58	1.59
B2 (mg)	0.74	0.72	0.78	0.80
Niacin (mg)	15.60	15.10	15.30	16.00
C (mg)	42.00	51.00	60.00	61.00

Table 2. Korean Daily Per Capita Nutrient Supply during the Japanese Occupation.

Under the extreme conditions of wartime starvation, Koreans were fed with milk gruel made from nonfat dry milk donated by a United States aid program. Traditionally a non milk-eating people, Koreans showed symptoms of lactose intolerance, but eventually learned to tolerate milk. The biscuits, cookies, chewing gums, and canned foods that were offered by United Nations forces attracted the starved people so strongly that they forgot their native foods. After the Korean War, the first food industries established were mainly Western-style confectionery companies. The wheat flour donated by the U.S. food aid program during the War became a staple food for low-income people, and it was the only inexpensive program after the Korean War. Traditional foods, such as rice cookies, rice cakes, and rice wines, all of which used expensive rice, disappeared rapidly. They were replaced by breads, sponge cakes, biscuits, and noodles.

The first ten postwar years in Korea were a period of extreme poverty. As shown in Table 3, the Gross National Product (GNP) of Korea during the period of 1955 and 1965 was in the range of 72 to 130 U.S. dollars, and the Engel's coefficient (the ratio of a household's food expenditures per total expenditure) was 50 to 74 percent for farmers and 41 to 50 percent for city workers.

The food intake of Korea was estimated by using the daily menu example suggested by Pang Sin-young in the thirtieth edition of her cookbook, published in 1957. The first menu example could supply 81.5 grams of protein and 2,065 calories of total energy, of which 73 percent was from carbohydrates, 15.5 percent from protein, and 11.5 percent from lipids. The second menu example contained 98 grams of protein and 2,084 calories of energy, of which 70 percent was from carbohydrates, 18 percent from protein, and 12 percent from lipids. Table 4 shows the daily per capita food supply as estimated during this period. It clearly shows the food shortage after

Year	GNP/Capita (US$)	Engel's Coefficient (%) Farmer	City Worker
1954	72	73.6	41.2
1955	67	72.1	45.5
1956	68	69.5	44.6
1957	77	69.9	43.0
1958	83	58.8	41.6
1959	84	53.9	39.2
1960	82	55.9	38.9
1961	85	58.6	41.3
1962	90	55.9	43.2
1963	104	60.3	45.2
1964	107	59.0	56.7
1965	109	53.2	53.7
1966	130	50.2	49.5

Table 3. The Gross National Product and the Engel's Coefficient during the Initial Development Period.

Food Group	1946-1948	1956	1962
Cereals	334.9	381.1	477.6
Rice	247.9	295.3	331.4
Wheat Flour	15.6	23.8	34.0
Barley	51.0	48.5	104.3
Others	20.4	13.5	7.9
Sugars	-	-	4.7
Root Crops	37.7	46.3	98.1
Beans	23.2	25.5	16.3
Nuts	-	-	0.2
Seeds	-	-	0.2
Vegetables	85.2	92.9	99.0
Fruits	7.0	12.0	15.1
Meats	5.6	9.8	12.9
Eggs	-	-	4.4
Milk	-	-	0.4
Marine Products	22.6	31.4	40.2
Fats and Oils	-	-	0.8

Table 4. Daily Per Capita Food Supply during the Initial Development Period.

Nutrients	Per Capita Daily Supply			Per Capita Daily Consumption			
	1946-1948	1956	1962	1948	1959	1961	1966
Number of Samples (persons)				6054	100-70	340	165-112
Total Energy	1378.00	1579.00	1943.00	2438.00	2502.00	2353.00	2608.00
Plant(kcal)	1345.00	1529.00	1863.00	-	-	-	-
Protein (g)	41.30	48.30	53.20	88.60	77.70	69.10	73.40
Animal (g)	4.60	6.80	7.50	7.40	-	9.30	4.00
Lipid (g)	8.90	11.00	13.10	18.20	14.70	16.40	8.60
Ca (mg)	143.00	164.00	299.00	330.00	360.00	497.00	258.00
Fe (mg)	15.00	17.60	10.80	42.00	16.20	19.60	23.20
Vitamin A (IU)	574.00	662.00	957.00	5218.00	3709.00	3982.00	2269.00
B1 (mg)	.75	.95	1.17	1.30	1.50	1.56	1.09
B2 (mg)	.47	.54	.49	1.00	.98	.91	.80
Niacin (mg)	9.60	10.90	18.2	-	19.00	23.00	-
C (mg)	36.00	40.00	49.00	78.00	121.00	133.00	87.00

Table 5. Comparison of the Amounts of Nutrients Supplied and Consumed during the Initial Development Period.

rehabilitation and during the Korean War. The production of sugars, nuts, seeds, eggs, milk, and fats and oils was meager until the end of the 1950s, but rose in the beginning of the 1960s. In particular, sugars, fats and oils, and milk, which were introduced and commonly consumed during the Korean War, became important food items after the war and played important roles in changing the dietary patterns of the people.

Table 5 compares the nutrient supply, as estimated from the national food balance sheet, with the actual intake, as determined by food consumption surveys. The estimated nutrient supply was very low compared to the real intake. The per capita daily energy supply in this period was estimated to be 1,380 to 1,940 calories and 41 to 53 grams of protein, but the intake level was almost 1.5 to 2.0 times the supplied amounts. The discrepancies may have arisen from inaccurate statistical data and skewed sampling of the survey; more likely, they result from the fact that the official statistics did not take into account the substantial amount of wild and famine foods that were consumed during this period of extreme poverty. In addition, the seasonal fluctuations of food availability and consumption were very large during this period. Lee and Lee (1977) reported that a significant reduction in the amount of nutrient intake in the 1950s and 1960s was observed during the spring time, when the most severe food shortage took place each year. This condition is known as *pori* *koge* (barley hills): in the scarcity of rice, Koreans resorted to eating barley.

A tentative nutritional standard for Koreans was established in 1960 by the Republic of Korea's Ministry of Health and Welfare, and the first official recommended nutrient intake for Korea was prepared by the FAO Korea Association in 1962. This recommended intake greatly overestimated the requirements by copying European standards, however. The Recommended Daily Intake for Korean adult males was 2,900 calories of energy and 70 grams of protein.

According to a biochemical study of the nutritional status of Koreans that was conducted in this period by Yu et al. (1962), the average blood composition and the concentration of Vitamins B1 and B2 in urine were normal but at the lowest limits of the range. Another clinical survey also pointed out that diseases caused by Vitamins A and B2, protein, and calcium deficiencies were observed significantly during this period (Ju, 1968).

Food in the Mid-Term Development Period (1967-1976)

In the period of 1967 to 1976, Korea experienced a rapid economic growth after the successful achievement of the first Five-Year Economic Development Plan, as well as a rapid population movement from the countryside to the cities, because of the industrialization of the country. Table 6 shows some important indexes for the agricultural economy in this period. The GNP increased from $100 to $800. The farm population decreased from 55 percent to 36 percent,

Year	Per Capita GNP (US$)	Engel's Coefficient (%)		Farm Population (%)	Food Self-Sufficiency (%)
		Farmer	City Worker		
1965	109	53.0	53.7	55.2	93.9
1966	130	50.2	49.5	54.0	94.7
1967	147	49.1	45.0	53.5	86.7
1968	175	47.4	43.1	51.7	81.3
1969	218	46.4	40.9	49.6	73.6
1970	252	48.2	40.6	45.0	80.5
1971	288	47.3	41.4	44.7	69.4
1972	318	48.3	38.9	43.8	70.8
1973	395	47.3	39.4	42.9	69.4
1974	540	48.3	43.4	38.8	70.3
1975	590	47.3	49.5	38.2	76.3
1976	797	45.7	49.4	35.7	74.8

Table 6. Per Capita GNP, Engel's Coefficient, Farm Population, and Food Self-Sufficiency during 1967-1976.

and food self-sufficiency dropped to 75 percent. During the initial development period, the food deficiencies were supplemented mainly by the foreign aid program, but in the middle term, the food was imported with the money earned by economic growth.

The small-scale food producers grew into large scale food industries. In particular, the factories producing bulky and sweet-tasting energy foods, such as flours, starch, glucose, fine sugar, and instant noodles, were industrialized and expanded. In addition, the seasoning industries, such as the soy sauce and monosodium glutamic acid industries, expanded rapidly. The powdered milk, chewing gum, cider, and soft drink industries started to appear in this period.

Food Group	1968	1974	1976
Cereals	526.5	543.7	530.4
Rice	322.7	351.4	330.6
Wheat Flour	76.1	70.3	83.7
Barley	117.1	100.5	107.5
Others	10.7	11.6	8.7
Sugars	12.0	15.8	19.3
Root Crops	147.6	81.6	16.4
Beans	17.6	19.0	26.4
Nuts	0.2	0.3	0.5
Seeds	0.2	0.9	3.8
Vegetables	146.3	178.6	186.4
Fruits	24.4	35.6	35.9
Meats	22.2	25.2	26.4
Eggs	5.6	10.6	11.2
Milk	3.8	10.2	14.5
Marine Products	45.3	76.2	81.4
Fats and Oils	3.4	6.2	8.4

Table 7. Changes in the Daily Per Capita Food Supply of Koreans during 1967-1976. (unit: gram)

According to the survey made by Chae and Shin (1972) of the changes in food consumption patterns of Koreans between 1965 and 1970, the consumption of seasonings increased 2.4 times, processed food 3.8 times, confectionery 6 times, and soft drinks 6 times. The rapid increases in the consumption of meat, fish and shellfish, noodles and pastries, processed foods, coffee, and margarine in particular reflect the beginning of the adoption of Western styles into Korean food habits.

Table 7 shows the changes in the food supply during this period. The per capita cereal supply exceeded 500 grams per day; in particular, the supply of flour and barley increased remarkably. The supply of root crops increased at the beginning of the period, but rapidly decreased during the later stages. The food shortage era of Korea ended during this period, and the harsh periods of "barley hills" disappeared. The supply of sugars, vegetables, fruits, meats, eggs, milk, marine products, and fats and oils increased substantially during this period.

Nutrients	Supplied Nutrients			Intake Nutrients		
	1968	1974	1976	1969	1974	1976
Total Energy (kcal)	2276.00	2370.00	2414.00	2105.00	2054.00	1926.00
Plant Origin (kcal)	2165.00	2215.00	2220.00	-	-	1819.00
Protein (g)	62.10	69.40	73.50	65.60	68.00	68.40
Animal Origin (g)	9.70	14.10	17.10	6.80	12.20	12.20
Lipid (g)	18.40	24.00	27.90	16.90	15.50	20.50
Ca (mg)	373.00	529.00	509.00	444.00	444.00	401.00
Fe (mg)	13.50	16.00	18.60	24.80	14.10	12.30
Vitamin A (IU)	1602.00	3561.00	2976.00	4076.00	5213.00	3689.00
B1 (mg)	1.52.00	1.41	1.56	1.76	1.30	1.20
B2 (mg)	0.65	0.79	0.89	1.28	0.90	0.80
Niacin (mg)	22.10	23.90	23.50	27.8	15.00	16.10
C (mg)	71.00	70.00	83.00	89.00	101.00	76.00

Table 8. Comparison of Supplied Nutrients and Intake Nutrients, Measured by Food Consumption Surveys during 1967-1976.

A food consumption survey has been conducted every year since 1969 by the Republic of Korea's Ministry of Health and Welfare. Table 8 compares the amounts of per capita nutrients supplied with the amounts of intake nutrients, as determined by food consumption surveys. The amounts of supplied nutrients estimated from the national food balance sheet were 10 to 20 percent higher than those of the intake nutrients measured by the food consumption surveys. This trend was quite opposite to the period of absolute poverty, 1945-1966, in which the national food balance sheet underestimated the nutrient intake of the people.

Supplying sufficient nutrients to the people was the national priority in the 1960s, and the first amendment of the recommended daily intake for Koreans was made in 1967, raising the intake to 3,000 calories of energy and 80 grams of protein for an adult man per day. However, this recommendation was soon found to be unrealistic, and the second amendment, in 1975, reduced the energy intake to 2,700 calories per man per day.

Food in the Late Development Period (1977-1986)

The late development period accompanied a boom in the Korean economy, in which the per capita GNP grew to over $2,000, while the food self-sufficiency decreased to below 50 percent. Table 9 shows that between 1977 and 1986, the per capita GNP increased from $1,008 to $2,296, the farm population decreased from 33.8 percent to 19.7 percent of the total population, and food self- sufficiency decreased from 64.3 percent to 44.5 percent. The Engel's coefficient for farmers decreased significantly compared to that for city workers, indicating that the living stand-

Year	Per Capita GNP (US$)	Engel's Coefficent (%)		Farm Population (%)	Food Self-Sufficiency (%)
		Farmer	City Worker		
1977	1008	42.8	47.6	33.8	64.3
1978	1392	38.3	44.6	31.3	74.2
1979	1640	37.8	41.6	30.0	59.9
1980	1589	36.8	42.1	28.9	54.3
1981	1719	37.7	41.5	25.8	43.2
1982	1773	33.3	39.2	24.6	53.0
1983	1914	30.4	37.5	23.7	50.2
1984	2044	29.4	36.4	22.2	48.7
1985	2047	-	-	21.1	48.4
1986	2296	-	-	19.7	44.5

Table 9. Changes in Per Capita GNP, Engel's Coefficient, Farm Population, and Food Self-Sufficiency during 1977-1986.

ard of farmers had improved during this period.

Food self-sufficiency had decreased to 44.5 percent by 1986, mainly due to the rapid increase in the demand for imported feed grains for animal husbandry. Food industries achieved rapid growth both in quantity and quality during this period, and various processed foods became available in sufficient amounts. The increase in per capita supplies of processed foods during the period of 1977 to 1986 were as follows: sausage 8 times, powdered milk 2 times, ice cream 1.5 times, city milk 6 times, fermented milk beverages 18 times, canned marine products 3.5 times, soybean oil 21 times, instant noodles 1.5 times, starch 3 times, coffee 8 times, cider 2 times, cola drinks 4 times, fruit juice 1.5 times, and beer 3 times. The production of high- calorie and high-protein animal foods — such as milk products, meat products, and fat products — and of nonnutritious beverages, such as coffee and soft drinks — increased remarkably. This increase suggests that the tendency toward the adoption of Western food habits that started in the middle developmental period accelerated and became more generalized in the late-development period.

The per capita daily consumption of cereals decreased from the level of 500 grams to 400 grams during this period; whereas the consumption of soybeans increased 3 times, meats 2 times, eggs 2 times, milk 3 times, and fish 2 times. Table 10 compares the amounts of supplied nutrients, estimated from the national food balance sheet, and the intake nutrients, measured by the national food consumption survey. As in the previous period, the supplied amounts were higher than the intake amounts; a 20 to 30 percent difference between energy supply and consumption was observed. This difference is an indication that food

Nutrients	Supplied Nutrients		Intake Nutrients	
	1980	1986	1980	1986
Total Energy (kcal)	2485.00	2786.00	2052.00	1930.00
Plant Origin (kcal)	2257.00	2446.00	-	-
Protein (g)	73.60	89.50	67.20	74.20
Animal Origin (g)	20.10	30.40	-	-
Lipid (g)	36.60	53.90	21.80	28.10
Ca (mg)	511.00	466.00	598.00	593.00
Fe (mg)	12.60	27.20	13.50	17.00
Vitamin A (IU)	3037.00	3550.00	1688.00	2226.00
B1 (mg)	1.92	1.29	1.13	1.24
B2 (mg)	1.03	1.75	1.08	1.19
Niacin (mg)	23.4	19.30	19.10	27.20
C (mg)	125.00	112.00	87.90	84.30

Table 10. Comparison of the Amounts of Supplied and Intake Nutrients during the Late Development Period.

waste due to excessive supply was occurring in the now-affluent society.

The sudden increase in animal food consumption, the excessive food supply, and the tendency toward food waste caused new problems for the national health and the environment. As shown in Table 11, the total number of clinical treatments under the nationwide medical insurance program increased 1.8 times during the seven years from 1980 to 1986. The number of cases of diabetes increased 5.3 times and hyperpiesia 2.6 times, which clearly shows a rapid growth of food-related degenerative diseases. People began to suffer from the health problems caused by overeating and obesity, and the imbalanced nutritional status became an important issue.

Reflecting the nutritional problems of Korea in the late 1980s, the fourth amendment of the recommended daily intake for Koreans that was prepared in 1985 called for a substantial reduction in food intake, suggesting 2,500 calories of energy and 75 grams of protein for an adult male per day. However, the health problems and the economic loss caused by the trends toward Western-style food habits and the desire for more animal food cannot be alleviated until the nutritional education that has emphasized the superiority of the Western food habits is corrected.

Trends and Characteristics of the Changes in the Food Habits of Koreans

Korea experienced foreign occupation, war, and Western culture shock during the century that stretched from the end of the Choson Kingdom to the present. These political and social changes brought about changes in Korean food habits. Until the end of the Choson

	1980	1982	1984	1986
Total Patients	100	133.5	163.8	184.5
Cancer	100	130.9	161.0	227.5
Diabetes	100	176.1	311.8	532.8
Hyperpiesia	100	151.1	195.2	259.0
Heart Disease	100	157.7	232.5	334.4
Cerebral Bloodvessel Disease	100	118.0	181.9	271.7
Liver Disease	100	127.5	163.8	220.3

Table 11. Changes in the Number of Degenerative Disease Patients in Hospitals Covered by Medical Insurance.

Kingdom, a substantial portion of the food of the large number of poor families in the country was obtained from famine foods, such as wild plants and animals. However, the society had a certain nutritional goal under the Asian rules of health, which was achieved by eating standard meals known as Ch'op-bansang. These Korean standard meals provided a well- balanced diet in relation to the Western-style nutritional concepts that are prevalent in Korea today.

Korean dietary habits started to deteriorate during the Japanese Occupation, because of the extortion of rice and soybeans for shipment to Japan. The per capita supply of cereals and soybeans declined drastically during the Japanese Occupation, and was reduced further still during the Korean War, reaching its minimum during this century. Furthermore, the amount of per capita energy supply in the 1950s was only two-thirds that found in the standard meals of the Choson Kingdom. Therefore, it is not surprising to find malnutrition symptoms in the nutritional surveys that were conducted at that time. This fact was supported by the finding that the average body weight of a 15- year-old Korean boy, as surveyed between 1940 and 1960, was 6 Kg, or 12 percent less than that measured in early 1900.

The malnutrition symptoms that were shown in the nutrition surveys conducted in the 1950s and 1960s were to be expected, since the people suffered from serious food shortages and extreme poverty, and thus could not follow their traditional food pattern. However, the nutritionists at that time concluded that the poor nutrition of the people was caused by the inadequate food habit of Korea, and advocated that Western food habits and nutritional concepts be followed. Such a misunderstanding drove the nutritional education of Korea toward the Western model and accelerated the Westernization of the Korean food habit.

During the Korean War, Koreans were dependent mainly upon food aid from the United States, and wheat flour and nonfat dry milk were the only food materials that were available in bulk. Therefore, even non-milk-eating people were forced to eat milk products under

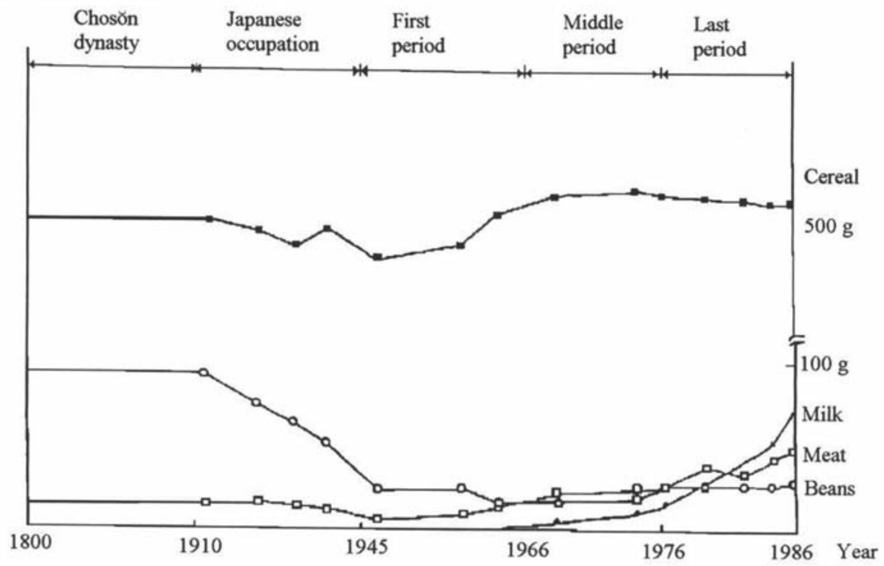


Figure 1. Changes in per capita food supply of Korea during the last century.

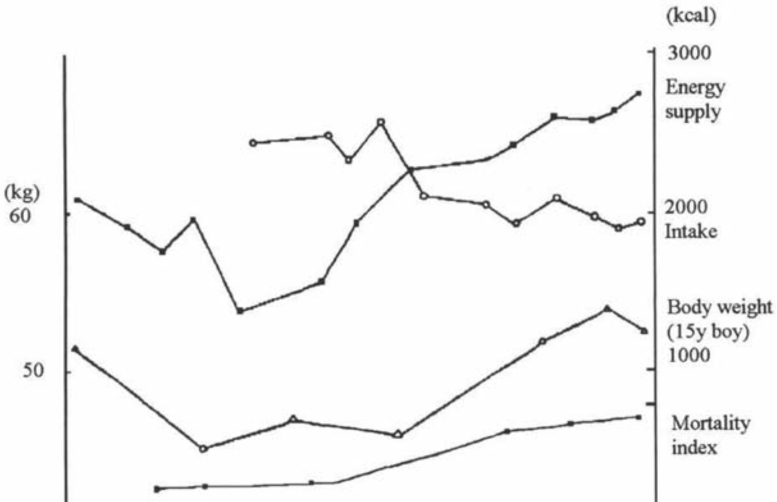


Figure 2. Changes in supplied energy, intake energy, average body weight, and relative mortality index of Korea during the last century.

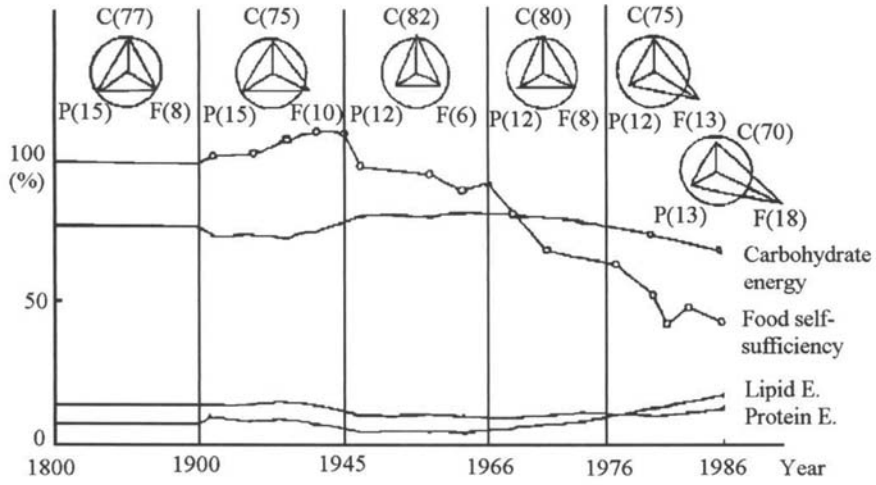


Figure 3. Changes in the composition of energy supplied and food self-sufficiency of Korea during the last century.

the starvation conditions of war. Such a historical consideration helps us to understand the explosive consumption of milk during the economic growth of the late 1970s and the rapid Westernization of Korean food habits afterward. The people demanded more and more animal foods and refined sugar, which resulted in the rapid drop of food self-sufficiency in the 1980s.

The present study indicates that under food shortage conditions, the amount of nutrients supplied to the people, as estimated from the national food balance sheet, is less than the amount of intake as measured by the national food consumption survey; while under food surplus conditions, the ratio reverses itself. As a result, the period of the late 1980s in Korea is characterized as representing a condition of food surplus and food waste.

The traditional standard meal of the Choson Kingdom supplied 77 percent of its energy from carbohydrates, 15 percent from proteins, and 8 percent from lipids, so that the CPL (Carbohydrate-Protein-Lipid) ratio was 7:16:8. During the last century, the Korean CPL ratio dropped to 82:12:6 (during World War II and the Korean War), but rose to that of the late Choson Kingdom by the end of the 1970s. However, the energy composition in this period was different from that of the Choson Kingdom, because it contained more energy from lipids, so that the CPL ratio was 75:12:13. The tendency toward high fat consumption continued and even strengthened thereafter. The CPL ratio in 1986 was 69:13:18. These dietary changes are considered to have a close relationship with the wide propagation of degenerative diseases among the people. From this point of view, it appears that adequate dietary goals and guidelines for of the traditional standard meals of the Choson Kingdom.

Glossary

- p.32 — *Imwŏn Simyukji* 林園十六志
- p.32 — Sŏ Yu-ku 徐有榘
- p.32 — *Chongjo Chi* 鼎俎志
- p.33 — *Sikkam Chwalyo* 食鑑撮要
- p.33 — *Siui Chŏnsŏ* 是議全書
- p.34 — *Myŏngchiok* 明治屋

References:

Chae, B.S. and Shin, Y.M. "Changes in the Food Consumption Patterns of Koreans between 1960 and 1970." In *Korean Journal of Nutrition*, 5(4): 161.

Chae, Y.S. "Report on the Food and Nutrient Intake of Koreans in Seoul." In *Korean National Institute of Chemistry Report*, 1:65.

Chosen Sotokufu, *Statistical Yearbook 1912-1940*, Seoul.

Chu, J.S. "Nutritional Status of Koreans." In *Korean Journal of Nutrition*, 1(1):1.

Economic Planning Board, Republic of Korea. *Annual Report of Industrial Production*. Seoul: 1982, 1985.

Food and Agricultural Organization, Korea. *Recommended Daily Allowance of Koreans*. Seoul: 1962.

Hong, S.P. *Choson Yorihak*. Seoul: Chokwangsa, 1940.

Kim, H.J. *Choson Singmul kaeron*. Seoul: Saenghwal kwahaksa, 1944.

Kim, S.H. "Socioeconomic Considerations on the Famine and Famine Food Development in the Late Choson Kingdom." In *Korean Journal of Dietary Culture*, 2(1).

Korea Health Insurance Administration. *Statistical Yearbook*. Seoul: 1987.

Korea Rural Economic Institute. *National Food Balance Sheet*. Seoul: 1986.

Lee, C.H. and Ryu, S.S. "Nutritional Evaluation of the Korean Traditional Diet." In *Korean Journal of Dietary Culture*, 3(3): 275-280.

Lee, K.Y. and Lee, Y.J. "Studies on the Recommended Balanced Meal of Koreans."In *Korean Journal of Nutrition*, 10(2): 59.

Lee, K.Y., Song, C.S., Yang, J.M., Kim, M.H., Soh, C.T., and Thomson, J.C. "Dietary Survey of Korean Farmers." In *Journal of Home Economics*, 54(3).

Lee, S.W. *Hangook Sigyung taejon*. Seoul: Hyangmunsa, 1981.

Pang, S.Y. *Urinara umsik mandununbub [Korean Cookbook]*. Seoul: Changchon toso, 1957.

Park, S.Y., Park, Y.W., and Koo, S.S. "Studies on the Changes in the Physique of Koreans." In *KyungHee University Thesis Collection*, 11(1):303.

Sunman Silop chosago. *Choson Singryo p'um Paltalji*. Seoul: 1922.

Yoo, J.Y. and Chae, Y.S. "Report of Food Consumption Survey (Report 2)." National Institute of Chemistry: 1962, 10:82.

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Impact of Trade Liberalization on Food Security Situation in Korea

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I. Introduction

Since the effect of WTO from 1st January 1995, Korean food trade and agricultural production have diversified significantly. Before and during Uruguay Talk, among 1,420 food and agricultural items for trade liberalization negotiation, 1,178 items have been liberalized, and further 166 items in 1995, 15 items in 1996 and 37 items in 1997, pulling up the trade liberalization rate to 98.3%. By the year 2001, additional 8 items including live cattle and beef will be liberalized (Ahn, 1997).

Although the number of items liberalized after 1995 is not large, these items have greater impact in the Korean agriculture and food industry, as they are major raw materials utilized in Korean diet. Some of the products liberalized in 1995 were barley, corn, soybean, potato, sweet potato, apple, grape juice, cheese, red pepper, garlic, sesame, chestnut and pine nut, those liberalized in 1996 include grape, apple juice, butter, condensed milk, peanut products, and artificial honey, and in 1997 pork, poultry, honey, orange, mandarine, orange juice and silk. Nevertheless, Korea is strongly against the tariff-based liberalization of rice, which is the staple food for the Koreans. Regardless, it is scheduled to open the market by minimum approach, starting from 1% import of the total amount of domestic consumption in 1995, increasing to 0.25% per year up to 1999, and ultimately expanding to 4% importation by year 2004. Such actions indicate that all of agricultural and food trade in Korea are practically opened to the world market after the start of WTO system.

The high influx of imported agricultural products into Korea is threatening to Korean agricultural business and farmers, where production of traditional field crops such as barley, soybean, corn and sweet potato are seriously deteriorating leading to infrastructure damage and bankruptsy of the primary industry. The Korean farmers are presently striving to survive by changing their crop cultivation to horticulture and floriculture. Some abandon their farms and the area of idle land is increasing. Consequently. Korea is faced with destruction of farming infrastructure which is difficult to restore in short period of time.

This paper reviews the changing pattern of Korean agriculture and food supply system during last three decades and the impact of recent WTO system on Korean food market and trade measures such as tariff, quarantine and sanitary control. The economic cosequences and food security concerns are also discussed, and the provisions to overcome this situation are considered.

II. The changing pattern of Korean food supply system

Historically Korea was an agricultural country,

Table 1. Changes in per capita GNP, Engel indices, farm population and food self-sufficiency in Korea during 1965-1996

Year	GNP per	(%) Farm	Food selfsufficiency (%)
1965	109	55.2	93.9
1970	252	45.0	80.5
1975	590	38.2	76.3
1980	1,589	28.9	54.3
1985	2,047	21.1	48.4
1990	5,883	15.5	39.8
1991	6,757	14.0	35.7
1992	7,007	13.1	33.5
1993	7,484	12.3	30.8
1994	8,467	11.6	30.4
1995	10,037	10.9	28.4
1996	10,543	10.3	

composing over 60% of her population living in farm until early 1960's. People had to survive with their agricultural products, which meant forced self-sufficiency of food without having any purchasing power for food from outside. Due to economic growth by industrialization in the 1970's, insufficient supply of food were imported, mainly cereals for staple food, and this was the beginning of Korean food trade. At that time the food self-sufficiency of Korea remained at the range of 70-75% as shown in Table 1. Major factory producing food were refined carbohydrate foods, such as flours, fine sugar, starch, glucose and instant noodle. Following this trend seasoning industries, such as soy sauce and monosodium glutamate industries, expanded rapidly (Lee, 1995).

As the industrialization progressed and the economic growth accelerated in the 1980's, the labor force in the farm area moved to urban industry, resulting in the reduction of farm population from 55% in 1965 to 21% in 1985, and the demands for meat and dairy products increased rapidly. The imported crops instead was used for feed stuff, and the food self-sufficiency dropped rapidly to below 50% in this period. Food industries achieved rapid growth both in quantity and quality by using mainly imported raw materials, and variety of processed foods became more available. The production of high-calorie and high-protein animal food, such as milk products, meat products, and fat and oil products, and of nonnutritious beverages, such as coffee and soft drinks, increased remarkably. The power of increase in per capita supply of processed food during the period of 1977 to 1986 were as follows: sausage 8 times, powdered milk 2 times, ice cream 1.5 times, city milk 6 times, fermented milk beverages 18 times, canned marine products 3.5 times, soybean oil 21 times, instant noodle 1.5 times, starch 3 times, coffee 8 times, carbonated drinks 2 times, cola drinks 4 times, fruit juice 1.5 times, and beer 3 times(Lee, 1995). The consumption of fruit and vegetables doubled during this decade.

Table 2 shows the chages in agricultural area and the amount of agricultural products between 1970-1995. The cultivation area for food grains in 1970 was reduced to 45% in 1995, while the areas for vegetables and fruits increased 1.6 times and 2.9 times, respectively. The area of vinyl-house vegetable cultivation icreased over 20 times for the same period. During this period the production amount of food grains decreased about 16%. Compared to the reduc-

Table 2. The cultivation area and amounts of agricultural products in Korea (Units: 1000ha, 1000 M/T)

Year	Food grains		Vegetables		House vegetables		Fruits	
	Area	Amounts	Area	Amounts	Area	Amounts	Area	Amounts
1970	2,950	6,524	258	2,653	4	140	60	423
1980	1,982	5,324	377	7,676	18	412	99	833
1985	1,669	6,990	366	7,763	29	680	109	1,464
1990	1.346	5,476	317	8,677	40	1,017	133	1,766
1995	1.346	5,476	408	10,586	82	2,423	174	2,300
'95/'70	0.45	0.84	1.58	3.99	20.5	17.3	2.90	5.44

Table 3. Annual food self-sufficiency rate in Korea (1970-1995) (Unit : %)

Food group	1970	1975	1980	1985	1990	1995	'95 Import amount (1000M/T)
Cereals	78.2	74.1	53.3	49.2	43.8	30.1	12,779.0
Rice	93.1	100.5	95.1	103.4	108.3	91.1	–
Barley	106.3	100.8	57.6	63.5	96.1	67.0	172.0
Wheat	15.4	5.5	4.8	0.3	0.1	0.3	2,777.0
Maize	36.1('65)	5.7	5.9	4.1	1.9	1.1	8,879.0
Starch Roots	100.0	100.0	100.0	109.0	100.0	98.8	9.7
Pulses	87.5	85.2	40.1	24.8	24.5	11.7	1,485.7
Soybean	86.1	83.3	35.1	22.5	20.1	9.9	1,435.0
Oil Crops	96.4	101.0	77.8	105.5	86.3	44.7	55.4
Vegetables	100.2	100.6	100.2	98.0	98.9	99.2	165.0
Fruits	100.2	101.4	98.6	93.6	102.5	93.0	183.5
Meats	100.0	100.6	97.4	99.6	92.9	89.2	188.2
Bovine meat	98.0	100.0	93.0	97.5	53.6	51.4	148.2
Pig meat	100.0	108.8	97.5	100.0	100.3	96.6	34.4
Poultry meat	100.0	100.0	100.0	100.0	100.0	98.1	5.8
Eggs	99.2	100.0	100.0	100.0	100.0	99.9	–
Milk	–	–	109.7	100.6	92.8	93.3	203.5
Fishs & Shellfishs	115.1	136.0	132.7	129.6	121.7	100.6	921.9
Seaweeds	108.9	168.0	177.1	158.5	172.8	123.0	16.1
Fat and oils	–	–	19.0	15.5	8.0	4.8	611.9

tion of cultivation land the reduction of production amount was not so much, which was mainly attributed by the increase in production yield per unit land. The production of vegetables increased 4 times and that of fruits over 5 times.

The self-sufficiency of food based on cereals and pulses further decreased from 50% level of the early 1980s to below 30% by 1995, and farm population decreased to 10% level (Table 1). The trade deficit of Korea in 1996 was USD 20.6 billion, of which 42% was from agricultural, forestry and fishery products import. Table 3 presents the annual food self-sufficiency rate between 1970-1995. As like the rate of cereals and pulses, the imports of oil crops, bovine meat and fat and oils began to decrease rapidly in the early 1990s. This indicates the effect of market liberalization during UR talk and WTO agreement. Korea imported 2.7 million M/T of wheat, 8.8 million M/T of maize, 1,4 million M/T of soybean in 1995. The 15% and 36% of self-sufficiences of wheat and maize recorded in 1975 has vanished completely today, and furthermore 86% self-sufficiency of soybean in 1975 has reduced to present 10%.

The food habit of Koreans has also changed during past three decades. Table 4 shows constant decrease per capita supply of cereals from 194.9 kg/person/year in 1970 to 171.4 kg/person/year in 1995. The decrease was mainly caused by reduction of barley consumption in the 1970s, and by the reduction of rice consumption in the 1980s and '90s. The amount of root crop sharply decreased from 56.0 kg/person/year in 1970 to 11.8 kg/person/year in 1985, and remained at the same level for last 10 years. All other food categories, especially sugars, fruits and vegetables, meats, milk, fish and shellfishs, and fat and oils, increased in supply during the period. The per capita supply of sugars increased 2.9 times, meat 3.8 times, milk 21 times and fat and oils 9.4 times during past three decades.

The change in food habit due to sufficient supply of imported foods caused two detrimental problems to the society, namely the deterioration of health con-

Table 4. Yearly per capita food supply in Korea (1970-1995) (Unit:

Food group	1970	1975	1980	1985	1990	1995	95/70
Cereals	194.9	193.0	185.0	185.4	175.4	171.4	0.88
Rice	130.4	119.8	132.9	128.0	124.6	11.0.0	0.84
Wheat flour	25.1	30.1	29.4	32.0	29.7	33.9	1.35
Barley	36.8	39.7	14.1	8.4	2.4	1.9	0.05
Others	2.6	3.4	8.7	16.6	22.5	25.6	9.85
Root crops	56.0	35.0	21.5	11.8	11.0	12.3	0.22
Sugars	6.2	5.2	10.3	11.7	15.3	17.8	2.87
Beans	7.4	8.3	9.7	10.7	10.3	10.8	1.46
Nuts	0.1	0.2	0.4	0.8	0.5	1.0	10.00
Seeds	0.1	1.3	0.4	0.5	0.7	2.0	20.00
Vegetables	59.9	62.5	120.6	98.6	132.6	140.7 (1994)	2.35
Fruits	10.0	14.0	16.2	26.6	29.0	40.9	4.09
Meats	8.3	9.3	13.9	16.5	23.6	31.5	3.80
Eggs	3.2	4.0	5.9	6.2	7.9	8.5	2.66
Milk	1.8	4.4	10.8	23.1	31.8	37.6	20.89
Fishs & Shellfishs	14.7	24.6	22.5	30.7	30.5	34.4	2.34
Seaweeds	2.6	5.3	4.5	6.5	5.7	11.6	4.46
Fat and oils	1.5	2.7	5.0	9.2	14.3	14.1	9.40

Table 5. Changes in the index number of degenerative disease patient in the hospital covered by medical insurance in Korea

	1980	1982	1984	1986
Total patient	100	133.5	163.8	184.5
Cancer	100	130.9	161.0	227.5
Diabetes	100	176.1	311.8	532.8
Hyperpiesia	100	151.1	195.2	259.0
Heart disease	100	157.7	232.5	334.4
Cerebral bl.vessel disease	100	118.0	181.9	271.7
Liver disease	100	127.5	163.8	220.3

dition of the people by the prevalence of degenerative disease and the pollution of the environment by the waste food materials from food industries, restaurants and households. The total number of clinical treatments under nationwide medical insurance program increased 1.8 times during the seven years from 1980 to 1986, while the number of cases of diabetes increased 5.3 times and hyperpiesia 2.6 times, which clearly shows a rapid growth of food-related degenerative disease (Table 5). Fig. 1 demonstrate that under food shortage condition in the 1960s, the amount of energy supplied to the people, as estimated from national food balance sheet was

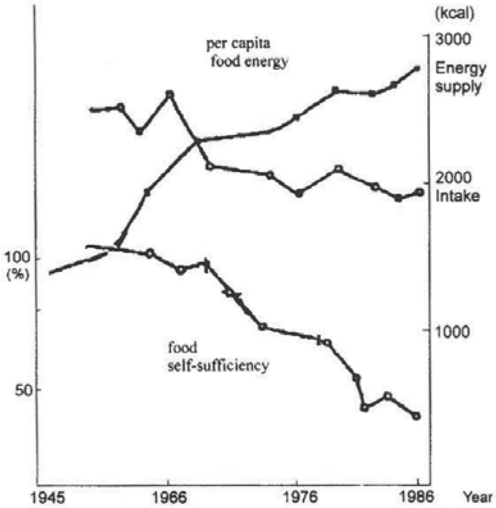

Fig. 1. Changes in the per capita supplied energy estimated from the National Food Balance Sheet and the intake energy estimated from National Food Consumption Survey, and the changes in the food self-sufficiency of Korea.

lower than the amount of intake as measured by national food consumption survey. On the other hand, in the 1980s the supplied energy exceeded far more than intake energy estimated from the consumption

Table 6. Food import before and after WTO in Korea (unit : million US$)

Food items	1994	1995	1996	95/94 (%)	96/94 (%)
Cereals	1,513.3	1,898.5	2,597.2	25.5	71.6
Maize	696.8	1,267.6	1,576.0	81.9	126.2
Wheat	783.5	467.2	725.0	-40.4	-7.5
Rice	-	-	50.6	-	-
Pulses	385.8	423.9	501.6	9.9	30.0
Soybean	351.6	401.9	473.4	14.3	34.6
Red bean	18.2	8.3	10.3	-54.4	-43.5
Root crops	38.3	58.4	144.4	52.5	277.0
Tapioca	14.6	27.6	98.6	89.0	575.3
Potato	23.1	29.7	45.5	28.6	97.0
Oil seeds	96.7	84.2	110.8	-13.0	14.6
Sesami	61.3	44.0	66.9	-28.3	9.1
Peanuts	12.7	10.3	17.2	-18.9	35.4
Fruits	250.1	315.4	323.2	26.1	29.2
Orange	78.5	101.4	89.6	29.2	14.1
Banana	49.3	49.5	56.4	0.4	14.4
Pineapple	22.3	24.0	24.4	7.6	9.4
Grape	5.7	20.6	23.6	261.4	314.0
Vegetables	152.3	140.2	175.9	-8.0	15.5
Red pepper	0.6	12.9	19.8	2050.0	3200.0
Garlic	30.5	10.6	8.8	-65.3	-71.1
Onion	26.4	6.0	21.6	-77.3	-18.2
Oilseed cake	293.8	429.0	614.4	46.0	109.1
Soybean meal	139.0	209.8	294.0	50.9	111.5
Animal foods	932.4	1,224.4	1,240.3	31.3	33.0
Beef	433.1	543.0	503.3	25.4	16.2
Pork	92.4	133.0	160.2	43.9	73.4
Milk powder	31.9	59.8	79.0	87.5	147.6
Cheese	8.6	33.9	50.5	294.2	487.2
Other foods					
Coffee	171.3	240.4	158.8	40.3	7.3
Cacao	80.2	84.4	105.1	5.2	31.0
Tobacco	245.2	376.5	424.0	53.5	72.9

survey, indicating a large food loss or waste of the country (Lee, 1998).

III. Food trade after WTO system in Korea

Table 6 compares the value of food import before and after WTO agreement in Korea. A remarkable increase in import value of cereals, pulses and root crops occured after WTO. In two years of WTO, cereal import increased 71.1%, pulses 30.0% and root crops 277%. The sudden increase in import value was partly contributed by the elevation of grain price in the world market Although the import amount of the individual items of oil seeds, fruits and vegetables are fluctuating sensitively with the domestic harvest conditions, the total import amount of these categoriese all increased in the ranges of 15-30% in two years of WTO. The import value of defatted oil seed meals, which were used for animal feed, increased sharply to 109.1% after WTO. Similar increase was also occurred in animal foods: 16.2% in

Table 7. The amount of import and export value of primary industry products in Korea (Unit: million US$)

Products	Import			Export		
	1994	1995	1996	1994	1995	1996
Agriculture	4,493.3	5,674.6	6,911.7	835.7	1.086.6	1.164.1
Animal husbandry	932.4	1,224.4	1,240.3	116.1	155.6	260.0
Forestry	2,562.8	2,778.1	2,788.0	511.1	504.6	405.2
Fishery	727.2	843.3	1,080.5	1,585.8	1,721.8	1,635.1
Total	8,175.7	10,520.4	12,020.5	3,048.7	3,468.6	3,464.4

Table 8. The amounts of export value of processed foods of Korea (Unit:millionUS$)

Food products	1993	1994	1995	1996	96/94
Milk products	3.4	4.5	9.1	14.7	3.26
Meat products	82.2	80.6	106.7	211.1	2.62
Marine products	1,147.1	1,214.8	1,352.2	1,323.9	1.09
Fruit/vegetable products	88.5	98.0	109.2	82.3	0.84
Fat and oil	4.5	6.5	17.5	17.6	2.71
Cereal products	1.7	1.9	3.8	6.3	3.32
Noodle/bakery products	174.6	248.0	325.5	372.6	1.50
Spices and food additives	18.8	23.8	42.6	60.1	2.53
Other food products	222.9	245.8	288.8	304.3	1.24
Alcoholic beverages	31.5	44.0	59.5	82.8	1.88
Non-alcoholic beverages	33.3	51.3	44.0	62.8	1.22
Total	1,808.6	2,019.4	2,359.1	2,538.7	1.26

beef, 73.4% in pork. 147.6% in milk powder and 487. 2% in cheese.

As shown in Table 7, the total import value of primary industry products in Korea icreased 47% from USD 8.1 billion in 1994 to USD 12.0 billion in 1996, while the export values from 1994 to 1996 were only USD 3.0 billion and USD 3.4 billion. In food category, agricultural products and animal foods were major import items, while fishery products were major export items in Korea. The national total trade deficit in 1995 was USD 10 billion, of which 70% was from agriculture, forestry and fishery products.

The total export value of processed food in Korea increased from USD 2.02 billion in 1994 to USD 2.54 billion in 1996, resulting in 26% expansion in two years of WTO, as presented in Table 8 (Chang, 1997). The export value of milk products increased 3.2 times, meat products 2.6 times, fat and oil 2.7 times, cereal products 3.3 times, spices and food additives 2.5 times, and alcoholic beverages 1.9 times during the same period. Although the total amount of processed food value for export is small, which is only 1/5 of the total import value of plant and animal food raw materials, the overall rate of increase is significantly high after WTO. This is good trend for Korean food industry, where she is turning to a country in importing agricultural products and in return exporting processed foods to the world market.

The major export items are changing recently from simple and cheap processed food, such as canned and dried foods, to more sophisticated processed foods such as Kimchi (Korean fermented vegetables), Kochujang (fermented soybean hot-paste), Ramen (deep-fried instant noodle) and confectionary products. The export of Kimchi has been increasing steadily for last 10 years, and has reached to USD 50 million in 1995. The export of fermented soybean products increased rapidly after WTO, and the export value in 1996 was USD 60 million resulting in 41% increase compared to the previous year. Kochujang is exported to over 37 countries, and the major importing country is USA taking over 50% of the total export. USA buys 1/3 of soy sauce exported from Korea. The export of Korean alcoholic beverages is also rapidly growing, increasing from USD 17.4 million in I991 to 82.8 million in 1996, producing an average annual growth rate of 37%. The export of pasteurized Tetra-pak Takju, asceptically packaged traditional Korean rice beer, is a good example of recent development of Korean food industries to be in part of the WTO.

The trade liberalization of agricultural products will continue to benefit food industries in purchasing variety of cheaper raw materials. However, there are still many technological and regulatory obstacles for food industries in Korea to counteract.

IV. Structure of Korean food industry

According to the Korea Statistics Agency, the total number of food industry employing over 5 people was 5,858 in 1994. The total employment in food industry is over 200,000 workers, producing USD 20 billion value of products. Most of the food manufacturers are small scale; 87% of them have less than 50 employees, as shown in Table 9. Large scale companies of over 100 employees and consisting 7.5% of the total number of food manufaturers has production power of 67.9% of the total food industry. As the size of company grew, the productivity becomes bigger and the maximum productivity of USD 160,000/person/year was achieved by the companies employing 200-299 workers. The average number of workers per company was 34, and the average annual value of food production per company was USD 3.35 million, which was higher than the national average value of all industries (Song 1998).

Table 9. The size distribution and productivity of Korean food industries

Number of emplyees	% of total number	% of total value produced	Per caput productivity (USD/year)
5-9	39.5	3.6	55.2
10-19	26.9	4.7	51.9
20-49	20.4	10.5	66.9
50-99	6.7	13.3	114.1
100-199	3.7	19.6	157.0
200-299	1.4	15.8	292.2
300-399	0.8	15.0	185.2
Over 500	0.6	17.5	129.3

V. Regulatory constrains on food industry

In accordance with the UR/SPS (Sanitary and Phytosanitary Measures) treaty, the quarantine control procedures in Korea has been widely adjusted in order to harmonize with the international standards. Before SPS all pest, whether it existed in the country or not, if s observed in customs inspection was destroyed or disinfected. In the new regulation only Quarantine Pests are controlled, which are presently 39 prohibited pests and 1,340 control pests. The mitigation of quarantine control procedure will result in more incidence of pest infection of imported agricultural products and insect damage of food ingredients. More detrimental consequence would be the importation of new pest which may affect phytoecho system of the country (Hong, 1997).

The biggest limitation of Korean food industry in competing with the world market is the constraint of regulation by customs policy. Due to the protection policy for agriculture and consumers, the protective tariff rates of 20-40% are applied to agricultural products, while a minimum tariff rate of 8% is applied to importing consumer goods, including food products. Since Korea imports most of food raw materials, the food companies are sufferring from price competition with imported products in the domestic market. Table 10 shows an example of the reversed tariff rates of food industry. Korean food industries have to use expensive raw materials charged with 30-40% tariff, and then compete with cheap imported products paying only 8% tariff. The tariff rates for

Table 10. Comparision of the tariff rates for raw materials and processed foods in Korea

Food raw materials		Processed foods	
Items	Tariff rate (%)	Items	Tariff rate (%)
Milk powder/dairy products	40	Cakes, confectionary products	8
Almond, Cashew nuts	30	Ice cream	8
Peanut oil, sunflower oil	30	Magarine. shortening	8
Lactose	20	Chocolate	8

Table 11. Comparision of tariff rates for processed foods in Korea and G-7/OECD countries

Items	Gum	Candy	Biscuit	Chocolate	Ice cream	Average
Korea	8.0	8.0	8.0	8.0	8.0	8.0
G-7 countries (average)	16.2	19.6	21.1	20.7	21.6	19.9
OECD countries (average)	27.9	30.8	30.7	31.9	34.9	31.8

processed foods are much lower than those of G-7 or OECD countries. As shown in Table 11, the average tariff rate for processed foods in G-7 and OECD countries are in the range of 16-35%, while Korea applies the minimum tariff rate of 8%.

Another prospective trade barrier in food and agricultural products is restriction on irradiated foods. With the increase in stricter hygiene and phytosanitary standards required in international food trade and prohibition and restriction of chemical preservatives and fumigants in and on food, irradiation is likely to play a more prominent role in food trade in the near future. As shown in Table 12, currently Korea has authorized up to 13 food groups to use Co-60 Gamma irradiation for sprout inhibition, insecticide, radurization and sterilization, and to comply with CODEX recommendation on irradiated foods (Lee, 1998a). However, the standard on food ir-

Table 12. List of authorized applications of food irradiation for human consumption in Korea (Unit: max. kGy)

Product	Type of clearance	Dose permitted	Date of approval	Note
Potato, onion, garlic	unconditional	0.15	16 Oct. 1987	
Chestnut	unconditional	0.25	16 Oct. 1987	
Fresh mushrooms	unconditional	1.00	16 Oct. 1987	
Dried mushrooms	unconditional	1.00	16 Oct. 1987	
Dried meats, powdered fish and shellfish	unconditional	7.00	14 Dec. 1991	Only for the processing food
Soybean paste powder, hot pepper powder, soybean sauce powder	unconditional	7.00	14 Dec. 1991	
Starch	unconditional	5.00	14 Dec. 1991	Only for the processing food
Dried spices and their preparations	unconditional	10.00	19 May 1995	
Dried vegetables	unconditional	7.00	19 May 1995	Only for the processing food
Yeast and enzyme foods	unconditional	7.00	19 May 1995	
Powdered aloe	unconditional	7.00	19 May 1995	
Ginseng products including red ginseng	unconditional	7.00	19 May 1995	
Second sterile meals for patient	unconditional	10.00	19 May 1995	

Table 13. Overview of research on genetically modified crops

Product/Food	Action/Application
Apples	Insect resistance(bacterially-derived)
Bananas	Intergrated pest management of viruses, fungi and nematodes
Broccoli	Slow ripening for longer freshness
Celery/Carrots	Crispness retention
Chicory	Increased availability of fructans
Coffee	Better flavour, higher yields and lower caffeine
Cole Crops	Resistance against insect predators
Corn	Insect resistance
Cucurbita	Viral,fungal and bacterial resistance
"Euromelon"	Ripens on demand
Grapes	New seedless varieties
Lettuce	Smaller size and insect resistance
Potato	Several disease resistances
Rapeseed	Production of hard fats in the plant High temperature frying oil, low in unsaturated fats
Raspberries	Slower ripening through ethylene
Soybean	Herbicide resistance Soy oil with lower palmitic acid
Strawberries	Frost resistance
Sunflower	Lower saturated fatty acid content
Tomatoes	Improve colour and flavour, slow down softening Resistance to viral diseases
Wheat	Herbicide resistance

radiation varies between countries, and subsequently would create difficulty in food trade. The FAO/IAEA/ICGFI Regional (RCA) Workshop on Harmonized Procedures and regulations on Irradiated Food was held in 27-29 April, 1998 in Seoul. Delegates from 15 countries in Asia-Pacific region working in the fields of food hygienic control and food irradiation technology participated to the workshop and the food regulations related to irradiation procedures, safety control rules, labelling requirements, quarantine procedures and marketing regulations of each country were reviewed. The Center for Advanced Food Science and Technology (CAFST) of Korea University organized a national seminar on "The Acceptance and Trading on Irradiated Foods" in conjunction with the RCA Workshop in Seoul. The people from food industry and consumer groups, journalists, food scientists and other interested people gathered to this seminar and discussed about the wholesomeness and regulatory aspects of irradiated foods for trade. Food industries are optimistic in the use of this technology, but consumers are in general not ready to accept it.

Genetically modified organisms is becoming another concerned issue in Korea. Consumer groups request scientific evidence of safety on using genetically modified soybeans and other food ingredients. It is estimated that 1/3 of soybeans imported from USA are the products of herbicide resistant Roundup Ready Soybeans developed by Monsanto Co. However, the use of genetically modified organisms for food will benefit food industries by supplying cheaper and more abundant raw materials with higher quality. CAFST of Korea University organized an international symposium on "Application of Genetic Engineering in Food Technology" in 20 June, 1996, in Seoul, and discussed how the scientists today could convince the consumers the safety of these products and their benefits. Table 13 presents some example of genetically modified crops developed in recent years (BINAS, 1995). Some are already produced for consumption such as herbicide resistant soybeans and improved tomatoes, and many other foods are prepared to be applied in the field. Efforts to guarantee the safety and educate consumers the benefit of these crops by scientific evidences and regulatory standards are urgently needed.

VI. Conclusion

WTO requests all the member countries to remove non-tariff trade barriers beween countries, to reduce tariff rate and to cease the governmental subsidies interrupting free market trade in order to liberalized the world trade of agricultural and food products. The influence of this new market order varies with different production sectors. In case of Korea, the traditional agriculture, especially crop cultivation, is seriously damaged by the new rule, and many of traditional farms are vanishing, and new horticultural and vinyl house farms are emerging. The farm size is growing and more modern machines and technologies are apied in order to meet the world competition. The customs system, quarantine procedures and food hygienic regulations are adjusting to the internationally harmonized models, for example CODEX and HACCP. In order to survive and to keep individual countries identity in the present situation, it is needed to adjust oneself properly and timely. Some aspects of systemic and technological adjustments of Korea to maintain her food security in WTO system are recommended as follows:

(1) The adjustment of cultivation land from traditional crop to horticultural products is inevitable, but it is necessary to maintain the infrastructure of staple food production.

(2) The trade deficit caused by the importation of agricultural products should be compensated by the export of processed foods, especially traditional Korean foods.

(3) Reduction of the tariff rate for importing food industry raw materials and elevation of tariff rate for importing processed food are necessary.

(4) Industrialization of traditional food processing and its quality improvement are needed. More efforts should be focused on the production scale-up technology and preservation technology to extend the shelf-life of products.

(5) Amendment of food regulations and hygienic standards, especially for indigenous food products, are needed in order to make them more competitive in the quality.

(6) Education of consumers on the safety and benefit of newly emerging technologies, such as food irradiation and genetically modified food materials, with sound scientific knowleges and evidences is needed.

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References

1. Ahn, K.O.: The status of trade liberalization of agricultural and food products in Korea after WTO system, Food Science and Industry, 30(4), 37-55 (1997)
2. BINAS.: Biotechnology in food and drinks, BINAS News, 1(4) 2-6 (1995)
3. Chang, J.K.: The prospect of food export under WTO system, Food Science and Industry, 30(4), 15-22 (1997)
4. Lee, C.H.: Changes in the dietary patterns, health and nutritional status of Koreans during the last century, Korean and Korean American Studies Bulletin, 6(1), 32-47 (1995)
5. Lee, C.H.: Development and constraints of food industries in Korea, The 5th JIRCAS International Symposiumon Sustainable Agricultural Development Compatible with Environmental Conservation in Asia, 9-10 September, Tsukuba, Japan, p. 191-199 (1998)
6. Lee, C.H.: Acceptance and Trading on Irradiated Foods, Korea University Press, Seoul, Korea, p. 191 (1998a)
7. Song, S.W.: Food industry and custom policy, Food Science and Industry, 31(1), 28-33 (1998)
8. Hong, I.S.: The present status and procedures of quarantine control of imported agricultural products under WTO system, Food Science and Industry, 30(4) 23-30, (1997)

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Review

Harmonization of Eastern and Western Health Knowledge; Nutrigenetics and *Sasang* Typology

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The completion of human genome project and the powerful tools of molecular biology together with bioinformatics technology give possibility to open the dialog between modern medicine and traditional remedies including Eastern medicine. Many of functional foods are originated from the traditional herbal medicine, and the scientific substantiation of the effectiveness of these products is required for the regulatory standards as well as for consumer protection. Needs for the reliable and efficient methods of scientific substantiation are increasing, and nutrigenomics may provide a short-cut way to scientific evaluation of many functional food ingredients and herbal medicine which have been used in the traditional societies for thousand years. Studies to apply nutrigenomic methodologies to the objective classification of Sasang body constitution types of Korean are reviewed. It is suggested that the empirical health food knowledge accumulated in the Eastern medicine may be explained scientifically by using the nutrigenomic methods, and it will contribute to open the custom-made nutrigenetic food age in the near future.

Keywords: Functional food, nutrigenomics, Sasang body constitution typology

Introduction

Human perception on food has changed through history, from the survival food of the 19th century and before to the convenience food of the 20th century. We all realize that functional food and personally prescribed nutraceuticals will be the food for the 21st century consumer of the affluent societies (Lee, 2006). Nutrigenomics will play key role in prescribing the personalized health food for individuals. The degenerative diseases, cardiovascular disease, cancer, diabetes and obesity coming from imbalanced nutrition mainly by overeating and reduced physical activity, became the major causes of death today (Lee *et al.*, 2005), and people want to correct their imbalanced nutrition by taking functional food and dietary supplements which are made for special target group.

One of the difficulties in the evaluation of the effectiveness of a functional food or functional component is that it is true for some people but not for others. The personal specificity in the response to chemical components is often encountered in nutritional and pharmaceutical researches. Recent progress in human genome research and the powerful tools of molecular biology make us enable to explain the personal specificity by genetic basis. Although the knowledge of nutrigenetics is in the stage of impetus, it will open the age of nutrigenetic food, which supplies tailor-made personal food fulfilling individual requirement for best fitness.

The traditional societies in Asia as well as in Europe have used natural remedies and herbal medicine, and they are now considered as complementary and alternative medicine (CAM) supporting the Western scientific medicine. The Eastern medicine, generally known as traditional Chinese medicine (TCM), has long history of practical use, although the scientific substantiations of the effectiveness are not fully established. It emphasizes the organic harmony of whole body based on the Chinese old philosophy Yin/Yang and Five-phases theory (Maoshing, 1995). Korean Eastern medicine emphasizes the type of body constitution in diagnosis and treatment of diseases, which is represented by Sasang body constitution typology.

Recent scientific developments make us to start to raise the curtain between Eastern and Western health knowledge. The way to nutrigenetic food age will be shorten by combining the analytical approach of Western science to the holistic approach of Eastern traditional medicine.

Scientific Substantiation of Effectiveness

The most important issue of functional food market today is the substantiation of the effectiveness that producers claim. In the Western society, food and medicine are strictly divided by regulation, and food can not claim any medicinal effect. In case of functional food, health benefit claims are permitted only when the sufficient scientific substantiation is provided (Ashwell, 2002; Hasler, 2002). For the scientific substantiation, we should know the chemical composition of a food and identify the effective components to determine the effectiveness by *in vitro* and *in vivo*, and then ultimately by human trial (Kim, 2004). However, the present scientific approach has important drawbacks.

Firstly, many of health and medicinal effects of natural

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products come from not a single component but the integrated action of multiple components. Not a single component can provide absolute benefit to the body, which is made of various organs and tissues having different functions and chemical reactivity. This fact is recently evidenced by the nutrigenomic researches (Ordovas and Mooser, 2004; Weggenmans *et al.*, 2001). The present nutritional science simplifies the matter too much. Emphasizing only a known beneficial effect by concentrating the responsible component in the diet may possibly create numerous unknown adverse effects. The emphasis of useful nutrients in the Western nutrition science last century resulted in the consumption of highly refined and concentrated foods by removing fiber and filthy substances, and we all know that it is the main cause of obesity, constipation, some cancers and heart diseases (Lee *et al.*, 2002).

Secondly, the response to the intake of nutrient and chemical components in food varies with people. The statistical method to overcome this problem is apt to select and generalize a response which is most probable in the cost of variable individual responses. In many cases, the large variation in test results makes the researcher impossible to draw any conclusion on the health effectiveness of a food. We should have in mind that the health benefit of a food or food component is personalized response that is hard to generalize, same as food allergy. It is closely related to the individual genetic trait and the environmental factors.

Application of Nutrigenomics

Recently, the molecular biologists start to recognize that the variation in genetic make-up of individuals may cause the variation in response to nutrient intake (Milner, 2004). It is often observed that, with similar food consumption pattern in a family, one suffers from obesity but the other is normal. Food allergy and celiac disease, for example, are another evidence of genetic variation on food components (Murray, 2005).

Genetic components responsible for differences in dietary response have been proposed for many years by the molecular biologists, and the researches to examine these nutrient-gene interactions has begun recently (Ordovas and Mooser, 2004; Kaput, 2004). The individual genetic variation is possibly explained by single nucleotide polymorphism (SNP). The total number of SNP expected to be found in human races of the world is 3×10^6, which are less than 1% of human genome length (3.2×10^9 bp) and are mostly localized in the non-coding region of human genome.

Many polymorphisms influence an individual's risk of diseases as well as the response to foods and their components (Kim, 2006). Increased knowledge about the interdependence of a response to food components on an individual's genetic background (nutrigenetic effects), the cumulative effects of food components on genetic expression profiles (nutritional transcriptomics and nutritional epigenomics effects), the occurrence and activity of proteins (nutritional proteomic effects), and/or the dose and temporal changes in cellular small molecular weight compounds (metabolomics effects) will assist in identifying those who respond and do not respond to dietary intervention.

Methods for the detection of SNP by scanning and screening are now established, and the genetically regulated heterogeneity in food and drug responses of individuals is under investigation in many research groups. Many efficient high-throughput SNP genotyping technologies have developed, and as many as 500,000 SNPs can be detected at a time (Lee, 2006).

The effect of a dietary component on a specific phenotype (e.g. plasma lipid concentration, obesity, or glycemia) can be explained by one or more genetic polymorphism (Ordovas and Mooser, 2004). The most rapid development of gene-diet interaction researches has been achieved in the area of cardiovascular disease risk, which can be easily quantified (i.e. plasma cholesterol concentration). However, the preliminary results regarding gene-diet interactions in cardiovascular diseases are for the most part inconclusive because of the limitations of current experimental design (Weggenmans *et al.*, 2001). In addition, most cases of obesity, cardiovascular disease, diabetes, cancer and other chronic diseases are resulted by the complex interactions between several genes and environmental factors (Kaput and Rodriguez, 2004). The integrated research of various disciplines designed to work on large population studies is required in order to relate the genotype to the resulting phenotype through systems biology.

Traditional Approaches

The traditional societies like China and Korea have long history of using food as medicine (Kim *et al.*, 1995; Lee *et al.*, 1998). Traditional Chinese medicine, for example in Shennong's Materia Medica, divides medicines into three classes as follows (Lee and Kwon, 2003).

120 upper medicines, which is non-toxic used for long term as food.

120 middle medicines, which have low level of toxicity used for chronic diseases

125 lower medicines, which have high level of toxicity used for acute illness

Food is considered the most important medicine to be used for the maintenance of health and prevention of illness and also at the first stage of treatment of an illness. The middle or lower class medicines are used only when the medicinal food (upper medicine) cannot cure the disease. The lists of medicines are found in many traditional Chinese literatures (Dang *et al.*, 1999). They have been developed by thousand years of experience, mainly acquired by human trials, and explained the effectiveness on the basis of yin/yang and Five Phases theories (Lee, 2004).

Considering food to be medicine, practitioners of traditional medicine studied each food ingredient for its yin/yang property, and its applicability in diet therapy. Their knowledge has been compiled in numerous classical medicinal books in both China and Korea for thousands of years, and has been practiced in everyday life at the household level as a dietary custom (Lee *et al.,* 1995; Cowmeadow, 1993; Hur, 2002).

Healthy food in traditional Chinese medicine implies balancing and harmonizing yin and yang and Five Phases in a diet. A healthy diet must contain food materials having cold/cool (yin) and warm/hot (yang) properties and five tastes evenly (Lee, 1998; Kim, 1995). Therapeutic food means enforcing certain Chi (or energy) for the imbalanced condition (illness) of a body, and enriching certain taste to enhance or suppress an organ function. The effectiveness of functional food has been explained systematically by this principle in the traditional Chinese medicine.

The disease susceptibility and medicine response of individuals are also explained by the differences in Chi and properties of personality trait. The body constitution consideration in the Traditional Chinese Medicine is focused on the medicinal practice based on yin/yang and Five Phases theories. On the other hand, Korean Sasang constitution typology is based on the combination of Neo-Confucianism and the medical tradition of Korea, and describes nature as quaternary (Chae *et al.,* 2003). Traditional Chinese medicine places importance on the harmony between humanity and nature, whereas Sasang typology emphasizes the harmony in social life and developing one's character.

Sasang Constitution Typology

The personal variable responses to food and medicinal treatment have long been recognized in Eastern traditional medicine and explained by the body constitution typology. At the end of the 19th century a Korean traditional Eastern Medicine practitioner, Je-Ma Lee, proposed Sasang Medicine in his book, Dongeuisusebowon (Lee and Choi, 1996). Sasang is a unique theory of categorizing people into four body types, TaeYang, TaeEum. SoYang, SoEum. According to their temperaments, body shapes and other general character features. Figure 1 shows a schematic diagram of Sasang types from a biopsycologic perspective (Chae *et al.,* 2003). The Yang types (TaeYang and SoYang) are extroverted and the Eum (yin) types (TaeEum and SoEum) are introverted. TaeYang type is very rare in Korea. The body shape of TaeEum type is larger than that of SoEum and SoYang types. The personality trait and physical characteristics are symbolically expressed by the organ size; TaeYang - large lung and small liver, SoYang - large spleen and small kidney, TaeEum - large liver and small lung, SoEum - large kidney and small spleen (Lee and Choi, 1996). Sasang typology emphasize the importance of individual body type in the diagnosis and treatment of diseases, and suggest prescribing different medicinal treatments and food intake for different body constitution types.

Many attempts to establish a reproducible and objective method of assessing Sasang constitution types have been reported after Je-Ma Lee (Song, 1998; Choi *et al.,* 2000; Park *et al.,* 2000).

A questionnaire developed by KyungHee University (QSCC II) was most widely studied for the assessment of Sasang types, and distinctive personality traits associated with Sasang types could be demonstrated by using psychometric and anthropometric instruments (Chae *et al.,* 2003). Numerous food therapy schemes suggesting beneficial and harmful food items for different Sasang types have been reported and used by TCM doctors and dietitians in Korea (Kim *et al.,* 1995; Lee *et al.,* 1998; Hur, 2002). Table 1 shows an example of Sasang food list beneficial for different body constitution types.

Although the assessment of constitution type of individuals is not conclusive, many people in Korea follow Sasang theory in selection of their food and herbal treatment, especially when their health condition is not satisfactory. A recent survey conducted in my laboratory revealed that 90% of the respondents (total 839 Korean men (55%) and women (45%) of 20 to 60 years old) knew about Sasang typology and 88.4% believed that man should consume the desirable diet for his/her body type

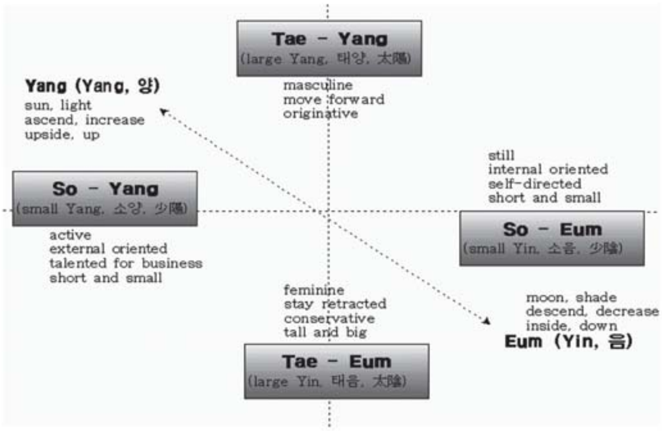

Fig. 1. A schematic diagram of Sasang types from a biopsycologic perspective (Chae *et al.,* 2003).

Table 1. An example of Sasang food list (Kim *et al.*, 1995).

	Tae Yang	So Yang	Tae Eum	So Eum
Cereals	Buckwheat	Barley, red beans, mung beans, barnyard millet, sesame	Soybeans, Job's tears, sugar, wheat, wheat-flour, great millet, perilla, sweet potato, common millet, peanut	Sticky rice, hulled millet, glutinous millet, potato
Fruits	Kiwifruit, grape, persimmon, cherry Chinese quince	Water melon, oriental melon, strawberry, banana, pine apple	Chestnut, pear, walnut, gingko nut, pine-nut, apricot, mum, plum	Apple, mandarine orange, peach, jujube
Vegetables	Water shield, pine needles	Cucumber, Chinese cabbage pumkin, lettuce, eggplant, sowthistle, edible burdock bamboo shoot, , asian plantain	Raddish, bellflower root, Indian lotus, taro, hemp, bracken, lanceolate root shiitake mushroom, ear mushroom, mastutakemushroom, *Umbilicariaesculenta*	Water dropwart welsh onion, garlic, black pepper, ginger, spinach, carrot, red pepper, crown daisy, onion, mustard
Fishes	Oyster, abalone. conch, shrimp, crucian carp, crab, sea slug, mussel	Flatfish, puffer, turtle, crawfish, carp, snapping, snakehead fish	Freshwater-snail, codfish, yellow corvina, small octopus brown croaker, herring, squid, , brown seaweed, laver, kelp	Alaska Pollack, loach, eel, snake, catfish
Meats		Pork, eggs, duck	Beef, milk	Chicken, lamb dog meat, pheasant, goat, sparrow meat

for the prevention and cure of diseases. 45.5% of the people believed that they knew their own body type, which were mainly determined by Eastern medicine physicians (23%) and by the questionnaire (12%).

Dr. Bong-Su Hur, a therapeutic food doctor in Korea, applies yin/yang theory in selection of food for his patients. He believes that yin (Eum) type people should have food of yang property, and vice versa, in order to harmonize yin and yang in the body. Combining this principle to the Sasang constitution, he listed food items desirable for the four body constitution types (Hur, 2005). He also suggested that celiac disease, the gluten intolerance, is an evidence of body constitution and food relationship in Sasang theory; celiac disease occurs mainly in yin type people.

Nutrigenetics and Sasang Constitution Typology

The health effects of food components are related to specific interactions on a molecular level SNP in gene regulation, translational control of RNA, enzyme regulation (proteomics) and metabolite modulation (metabolomics), which occur as genotype (Ommen, 2004). On the other hand, in the traditional Eastern medicine numerous phenotypic data on diet response to health have been accumulated, and systematically classified by the Sasang body constitution theory. Body constitution is a genomic trait of individuals, which is mainly determined by the SNPs. Therefore, it is possible to relate the molecular level genomic studies to the body constitution typology.

An attempt was made to develop marker genes for the classification of Sasang body constitutions (Park, 2006). 34 TCM school students in Korea, who were classified identically by QSCC and by three TCM doctors, were selected and their blood samples were assayed with microarray analysis, and the Sasang-specific genes were identified. About 145 genes were differentially expressed

Table 2. Genes expressed differentially in microarray with Sasang constitution types (Park, 2006).

Category	Locus ID	Mean of Tae-eum	Mean of So-eum	Mean of So-yang	F-value	P-value
Anti-oxidation	SOD2	0.532	0.44	0.526	5.387	0.029
ATP synthesis	ATP5D	0.396	0.58	0.388	4.006	0.057
	ATP5H	0.479	0.529	0.441	3.602	0.071
Cell cycle, Growth and Differentiation, Apoptosis	DAPK1	0.535	0.443	0.477	53.999	0
	S100A9	0.431	0.546	0.448	33.52	0
	BCL2A1	0.529	0.458	0.468	7.938	0.01
DNA or RNA binding protein	HNRPA2B1	0.541	0.433	0.459	49.855	0
	CHD3	0.516	0.44	0.482	21.464	0
Immune response	FCGR3A	0.538	0.437	0.494	204.969	0
	GZMA	0.493	0.477	0.542	30.029	0
	IGHG3	0.485	0.48	0.537	18.592	0.001
	GZMB	0.547	0.444	0.459	8.712	0.008
	PF4	0.54	0.433	0.494	68.165	0
Metabolism	B4GALT6	0.483	0.458	0.515	21.643	0
Transport	ABCB1	0.56	0.39	0.51	14.43	0
Protein degradation	PSMC4	0.476	0.46	0.518	23.459	0
	PSMC5	0.565	0.437	0.404	8.438	0.009
	UBC	0.557	0.473	0.378	4.359	0.048
Signal transduction	TM4SF4	0.521	0.459	0.473	7.332	0.013
	GNAI3	0.452	0.533	0.487	56.048	0

in microarray, and they were clustered into three groups, respectively, Tae-Eum, So-Yang and So-Eum. Genes expressed differentially depending on the Sasang constitution types were related to signal transduction, transport and immune response in their function (Table 2). Among them Cytochrome p450 2D6, 2C9, 1A2, SOD2 genes were related to Sasang types. SOD2 showed higher expression in Tae-Eum type than in So-Yang and So-Eum types. Three SNPs, -455C/A, -257T/C and -247A/G were found in 5′-UTR of SOD2 gene. The SNP distribution pattern of So-Eum type was different from those of other two types. A total of 6 haplotypes were obtained with the three SNPs. The distribution pattern of each haplotype varied with Sasang constitution types. Statistically SOD2 expression was significant ($P<0.05$), depending on the haplotypes. However, the SNP analysis of single SOD2 genes was not sufficient enough to determine the Sasang constitution type, since diverse genes were involved in the phenotypic expression of the constitution. Although this study is not conclusive in classification of the constitution types, it provides the possibility of using microarray analysis and SNP analysis of specific genes for the objective determination of the body constitution types.

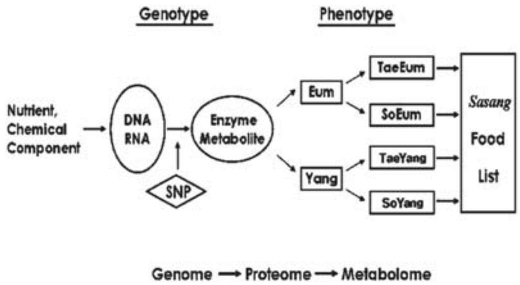

Fig. 2. The relationship between nutrigenetic studies and Sasang body constitution studies.

A Novel Integrated Approach

As body constitution is a genomic trait of individuals, it will be possible to determine Sasang body constitution types with the molecular level genomic studies, when sufficient data are accumulated. It is important to know the genes or SNPs responsible to the phenotypic body constitution types, specifically TaeYang, TaeEum, SoYang and SoEum. Once they are found, we will be able to classify Sasang constitution types objectively and reliably, and ready to utilize the old wisdom of diet therapy which has been developed for thousand years by human trial, as illustrated in Fig. 2. The metabolomics studies, which depict the phenotypic consequences of genetic coding, will also assist to relate the genotypic make-up to Sasang constitution types.

Figure 3 illustrates the relationship between nutrigenetic studies and Sasang typology, which have developed toward opposite directions in the East and the West. If we are able to find a channel to relate the Western analytical approach to the Eastern holistic approach, we will

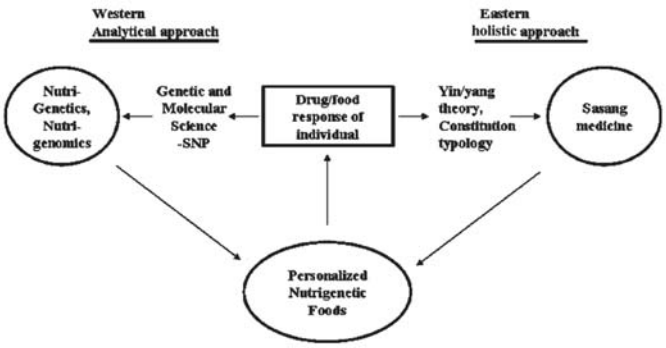

Fig. 3. Collaboration of Western analytical approach and Eastern integral approach in the field of functional food.

achieve a great advancement in the human nutrition and biomedical researches. It will allow us to utilize all the data accumulated in the Eastern medicine for predicting health effectiveness of foods. If we are able to identify the SNPs that are responsible to Sasang Typology, we can select food materials useful for a person having specific SNP from the Sasang food list. It will make possible Western analytical researchers to communicate with the Eastern medical doctors, and discuss the scientific substantiation of traditional functional foods in the East (Lee, 2003).

It will open the new era of nutrigenomics, and we will be able to substantiate scientifically the health benefit of functional foods more easily. It will reduce the variation in the experimental results, minimize the cost for scientific evidence of functional foods, and consequently prevent the adverse effect of functional food, which occurs often in some segments of population. The personalized or custom-made functional food which is effective for a specific group of body constitution will enhance the vitality of consumers and will treat their health problems. The new era of personalized nutrigenetic food will lend great opportunity to future food industries, and it will also contribute greatly to the betterment of the quality of human life.

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References

Ashwell, M. (2002). Concepts of Functional Foods. *In ILSI Europe Concise Monograph Series,* ILSI Press, Washington, D.C.

Chae, H,, Lyoo, I.K., Lee, S.J., Cho, S., Bae, H., Hong, M. and Shin, M. (2003). An alternative way to individualized medicine: Psychological and physical traits of Sasang Typology. *Journal of Alternative and Complimentary Medicine,* **9,** 519-528.

Choi. S., Chi, S., Jung, B., Ahn, K., Koh, B. and Sung, H. (2000). The study on the relationship between Sasang constitutions and Myers-Briggs type indicator. *Korean TCM Research Institute Journal,* **6,** 47-57.

Cowmeadow, O. (1993). Introduction to microbiotics. *Thorsons Publishing Group,* pp. 20-50.

Dang, Y., Peng, Y. and Li, W. (1999). Chinese Functional Food. New World Press, Beijing, China.

Hasler, C.M. (2002). Functional foods: Benefits, concerns and Challenges - A position paper for the American Council on Science and Health. *Journal of Nutrition,* **132,** 3772-3781.

Hur, B.S. (2002). Chegilsupsaenghak (Nutrition on body constitution). *Shinki Publishing Co.,* Seoul, Korea. pp. 155-162.

Hur, B.S. (2005). A study on the clinical effects of body constitution diet by applying the response to foods that contain gluten in patients with hypertension, diabetes or obesity. Ph.D. thesis, *KyungHee University,* Seoul, Korea.

Kaput, J. (2004). Diet-disease gene interactions. *Nutrition,* **20,** 26-31.

Kaput, J. and Rodriguez, R.L. (2004). Nutritional genomics: the next frontier in the post genomic era, *Physiological Genomics,* **16,** 166-177.

Kim, D.B. (2004). Status of functional foods in Korea-Report of the ILSI South East Asia Region, *In FAO/WHO Workshop on Functional Foods,* 6 September, Jeju, Korea.

Kim, J.Y., Kim, C.W., Koh, B.H. and Song, I.B. (1995). Justification and usage of food classification according to body constitution. *Journal of Constitutional Medicine,* **7,** 263-279.

Kim, M.H. (1995). Nature, Man and Traditional Korean Medicine, *Yoksa Bipyungsa,* Seoul, pp. 187.

Kim Y.S. (2006). Genomics in the science of nutrition, Proceedings on KCIST-2006 Nutrigenomics; New Perspectives and Applications, July 20-22, Muju, Korea, 19.

Lee, C.H. (1998). Health concept in traditional Korean diet, in Therapeutic use of foods in East Asia. *Korean and Korean American Studies Bulletin,* **9,** 8-18.

Lee, C.H. (2003). Paradigm shift: Harmonization of Eastern and Western food system. In *Bioprocess and Biotechnology for Functional Foods and Nutraceuticals* (pp. 415-425), New York: Marcel Dekker.

Lee, C.H. (2004). Functional food of interest to ASEAN, from traditional experience to modern production and trading. *Food Science and Biotechnology,* **13,** 390-395.

Lee, C.H. and Kwon, T.W. (2003). Introduction to Korean Food Science, Korea University Press, Seoul, Korea. pp. 18.

Lee, C.Y., Lee, C.H. and Kwon, T.W. (2002). Future of food: Harmonization of Eastern and Western food systems, The World of Food Science, 3(3), www.worldfoodscience.org

Lee, E.J., Koh, B.H. and Song, I.B. (1995). A discussion on food. *Journal of Constitutional Medicine,* **7,** 143-168.

Lee, E.J., Lee, S.K., Kim, E.J., Cho, R.W., Koh, B.H. and Song, I.B. (1998). The study of constitutional dietary therapy. J Constitution Medicine, 10, 305–349.

Lee, J.E. (2006). High-throughput SNP Genotyping Technologies, Proceedings on KCIST-2006 Nutrigenomics; New Perspectives and Applications, July 20–22, Muju, Korea, 60.

Lee, J.M. and Choi, S.H. (1996). Longevity and Life Preservation in Eastern Medicine. *KyungHee University Press,* Seoul, Korea.

Maoshing, N. (1995). The Yellow Emperor's Classic of Medicine. Shambhala, Boston, MA, USA.

Milner, J.A. (2004). Molecular targets for bioactive food components. *Journal of Nutrition,* **9,** 134.

Murray, J. (2005). Celiac disease: A model of genetically determined food intolerance. *In ILSI Annual Meeting,* Wyndham, New Orleans, USA, 14–19 January 2005.

Ommen, B.V. (2004). Nutrigenomics: Exploiting systems biology in the nutrition and health arena, *Nutrition,* **20,** 4–8.

Ordovas, J.M. and Mooser, V. (2004). Nutrigenomics, nutrigenetics. *Current Opinion in Lipidology,* **15,** 101–108.

Park, K.A., Kim, H.J., Hu, K.S., Ahn, S.K., Lee, S.H., Lee, J.E. and Lee, W.T. (2000). *Korean Journal of Physical Anthropology,* **13,** 389–396.

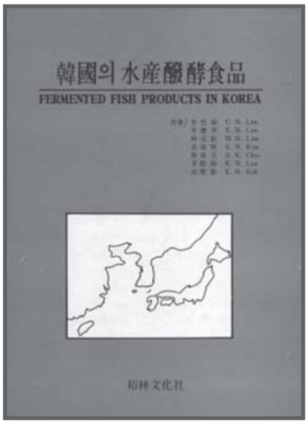
Park, S.S. (2004). Fundamentals of genomics. *In Founding Symposium of the Korean society of Clinical Genomic Medicine,* 5 December, Korea University, Seoul, Korea.

Park, S.S. (2006). Scientific rationale for Sasang constitution; Development of marker genes for the classification of the constitution, Proceedings on KCIST-2006 Nutrigenomics; New Perspectives and Applications, July 20–22, Muju, Korea, 19.

Song, I.B. (1998). The future prospect of the studies on the objectification of Sasang constitution. *Journal of Constitution Medicine,* **10,** 1–11.

Weggenmans, R.M., Zock, P.L., Ordovas, J.M., Ramos-Galluzzi, J. and Katan, M.B. (2001). Genetic polymorphisms and lipid response to dietary changes in human. *European Journal of Clinical Investigation,* **31,** 950–957.

Books Authored/ co-authored



FERMENTED FISH PRODUCTS IN KOREA

C. H. Lee, E. H. Lee, M. H. Lim, S. H. Kim, S. K. Chai, K. W. Lee and K. H. Koh

Yulim Moonhwasa, Seoul, 1989

2 Chapters, 186 pages (in Korean and English)

▪ Preface ▪

Korea has Inherited various fermented foods from the ancestors. Chang (fermented soybean sauce and pastes), Kimchi (fermented vegetable products) and Jeot-kal (fermented fish products) are the three major salt-fermented and preserved foods in Korea. Chang and Jeot-kal have been important protein and fat sources and Kimchi the vitamins and mineral source for the rice-eating Korean people. In spite of the importance of the salt-fermented foods to Korean diet, little efforts have been paid for the systematic classification of the products and scientific evaluation and theoretical explanation of the processing techniques.

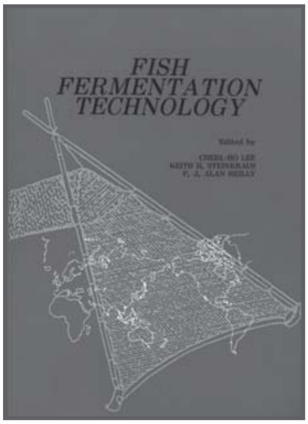
The research need for the traditional fish fermentation technology has been recommended at the UN University Workshop on Traditional Food Technologies, held at Mysore, India in July 18-26, 1983. The international cooperative network on fish fermentation technology has been established in the United Nations University and Korea University became the cooperating unit for this project. According to this project, a national survey on fermented fish products was conducted from July 1 to October 15. 1985 by six regional universities in Korea, they were Korea University, National Fishery University in Busan, Tae-Gu University, National University of Jeju, Seoul Health Junior College and Kunsan National Fisheries Junior College. From this survey, 33 kinds of fermented fish products were Identified and their processing methods, chemical composition, storage method, utilization and pictures were collected. The survey materials were classified and supplemented with the literature review on the microbiology, biochemical changes and recent research trends of each item at the Food Research Center of Korea University. It was then translated into English.

The fermented fish products in Korea are largely classified into four groups. Jeot-kal, Sikhae, Gulbi and Jaban. Jeot-kal is subdivided into high- salt and low-salt fermentations. High-salt fermented Jeot-kal is further grouped by the raw materials. whole fish, viscera, shell fish and crustacean. The micro-organisms and biochemical changes of fermented products are mostly unknown, except for a few items, and need to be studied in the future.

This book attempted to classify the existing fermented fish products in Korea, to provide data for establishing theoretical foundation of the fish fermentation technology and to stimulate researches in this field. Therefore, this book is far from perfection and open for further comment sand corrections provided by the readers concerned. It is also expected to provide proper information on Korean fermented fish products to the other countries and to make a momentum for exchanging related knowledges through this book.

The authors would like to take this opportunity to express their sincere gratitude to the financial support of the United Nations University for the survey work, and to the publisher, YuLim MoonHwaSa, Mr.Mr. Yu-Won Kim and his colleagues.

Cherl- Ho Lee, Ph. D



FISH FERMENTATION TECHNOLOGY

Edited by Cherl-Ho Lee, Keith H. Steinkraus and P. J. Alan Reilly
United Nations University Press, Tokyo, 1993
20 Chapters, 321 pages (in English)

This book is the result of the united Nations university's ongoing interest in promoting the study of traditional food technologies that was initiated in 1983 with a workshop organized at the Central Food Technological Research Institute (GFTRI) in Mysore, India. Subsequently, a network of researchers with active interest in fermented marine products was established with the support of the UNU under the co-ordination of Professor Cherl-Ho Lee of Korea University. Through a UNU project that began in 1985, detailed information on processing technologies used in the preparation of fermented fish products, the patterns of consumption and the nutritional composition of products was collected from a number of countries in Asia. The results of the project, together with invited papers on related topics, were presented at a UNU workshop that took place in Seoul, Korea in 1987. This book is primarily based on the workshop presentations.

▪ Preface ▪

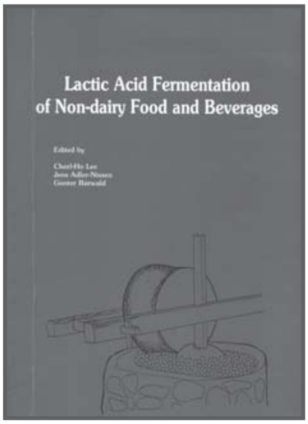
The need for research on traditional fish fermentation technology was recognized at the United Nations University (UNU) Workshop on Traditional Food Technologies, held at Mysore, India, on 18-26, July1983. During the workshop the delegates from Burma (Dr. M. T. Tyn), Japan (Dr. M. Kozaki), Korea (Dr. C. H. Lee), and Thailand(Dr. N. Boon-Long) decided to form a research network in this field. This idea was adopted by the UNU Food and Nutrition Program managed by Dr. N. S. Scrimshaw, Dr H. A. p. Parpia and Dr. R. Kokke. A UNU-sponsored survey on fermented fish products was conducted in 1985-1987 in different regions of the world, including Korea, Sri Lanka, and Thailand. On the basis of these studies, the UNU Workshop on Fish Fermentation Technology was held at Korea University, Seoul, in June1987.

This book is made up of the papers presented at the UNU Workshop in Seoul. Some important aspects of fish fermentation, such as cultural background, resource availability, and missing country papers, were included at the later stages of editing. The book is an attempt to elucidate the cultural aspects of fish fermentation, the present status of production and technology in different regions of the world, and the microbiological and biochemical aspects of fish fermentation.

Considering the importance of fermented fish products to the people of the world, particularly in the lesser developed countries, very little study has been conducted on fish fermentation compared to other fermentation technologies such as those involving milk and soybeans. The aim of this book is to collect what little knowledge there is from different regions and to stimulate the interest of the researchers concerned. Comparing the products of different regions, identical but differently named products can be found, and this could be the starting point for scientific communication on fish fermentation technology world wide.

The editors are grateful for the sincere cooperation of the authors contributing to this book. We also acknowledge the great efforts made to wards the publication of the book s contre aBesrat and Mntre ae aerboleda of UNU, MntrYu-Won Kim and his colleagues of the Yu-Rim Publishing Company, Seoul and Mns. Sook Jonghehee, who under took the painstaking proofreading and indexing.

Cherl-Ho Lee
Keith H. Steinkraus
P. J. Alan Reilly
January 1993



LACTIC ACID FERMENTATION OF NON-DAIRY FOOD AND BEVERAGES

Edited by Cherl-Ho Lee, Jens Adler-Nissen, and Günter Bärwald,
Harnlimwon, Seoul, 1994
20 Chapters, 274 pages (in English)

▪ Preface ▪

Lactic acid fermentation is probably one of the first biological processes from which human being has discovered the benefits of fermentation. The sour ferments of flour dough, milk cereals and vegetables have been used for the enhancement of keeping quality and palatability of food from the prehistoric era of human civilization.

Lactic acid fermentation of milk products, such as yogurt, is well developed in Western countries and extensively studied all over the world. On the other hand, in Asia and Africa lactic acid fermentation has been widely and routinely used to process their staple cereals, vegetables and fish, but little scientific studies on these products have been conducted yet. Consequently, the level of industrialization of these products is very low.

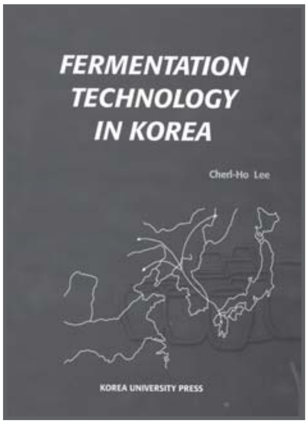
The changes in food consumption patterns of the world are characterized by an increase in animal food. reduction of cereal consumption and increase in unhealthy less-nutritious beverages like coffee and carbonated beverages. One of practical way of helping to solve this problem is to develop nutritious and tasty beverages from under-utilized food materials, including cereals, legumes and tubers. Many of indigenous lactic acid fermentation techniques are found to convert these plant materials into palatable food and beverages.

A UNIDO-sponsored joint research project to develop high protein content lactic beverages from vegetables has been carried out since January 1987 at Korea University in Seoul and MIT in Cambridge, MA., USA. The project was expanded in 1990 as a second phase UNIDO project in the title of “Industrialization of lactic acid fermentation technology of cereals and its dissemination to the developing countries” It comprised three major activities; a continued joint research program between Korea University, Korea Food Research Institute and the Technical University of Denmark an international training course for food fermentation technology and an international workshop on this field.

This book is made up of the papers presented at the UNIDO workshop on “Lactic acid fermentation of non-dairy food and beverages”, held in Seoul in June 22-25, 1992. The aim of this book is to exchange the idea and collect available knowledges of lactic acid fermentation especially of under-utilized plant food materials and industrialization of these traditional methods. Many of the papers on this book are the outcomes of the UNIDO project above mentioned.

The editors express sincere thanks to the sponsoring organizations of the project, United Nations Industrial Development Organization, United Nations Development Program in Seoul, Korea Science and Engineering Foundation, Korea University and Korea Food Research Institute. The editors are grateful for the sincere cooperation of the authors contributing to this book. We also acknowledge the great efforts made towards the publication of this book by Mr. Yong Woo Kim and his colleagues of Harn Lim Won, Seoul, and Mrs. Sook Jong Rhee, who under took the proofreading and indexing work.

Cherl-Ho Lee
Jens Adler-Nissen
Günter Bärwald
January 1994



FERMENTATION TECHNOLOGY IN KOREA
Cherl-Ho Lee
Korea University Press, 2001
9 chapters and Appendix, 330 pages (in English)

▪ Preface ▪

Twenty years ago when I returned home from 10 years of study abroad, there was one thing that most impressed me. It was Dr.

Tai-Wan Kwon's work on collection of research paper abstracts in English on fermented foods in Korea. It was needed to introduce to the world the fermentation technology of Korea, which had been a hermit land for the last 19th century and once shadowed by Japanese invasion. During the period of misfortune, which coincided with the time of introducing the East to the West, Korea lost her thousand years of history being falsely treated as part of Chinese or Japanese.

It is generally recognized that Korea has long history of fermentation technology and the people use extraordinarily abundant amounts and varieties of fermented foods. The evidence of food fermentation goes back to 6000 B.C., the Primitive Pottery Age of Northeast Asia. The technology was transferred to Japanese archipelago during the 3rd to 7th centuries A.D. Koreans eat 100g of kimchi and 40g of fermented soybean products every day. Hundreds of fermented fish products are prepared at household and numerous rice and cereal wines and beers are produced in industry scale. Indeed, food fermentation is the most important and unique technology that Koreans take pride of.

This book was prepared for the 11th IUFoST World Congress of Food Science and Technology to be held in Seoul in April 22-27, 2001. It was the author's intention to distribute this book to the overseas participants of the congress in order to introduce them the fermentation technology of Korea. The related articles written by the author during last 20 years were collected and some of them published in Korean were translated into English. The research papers on Korean fermented foods published in Korean journals since 1960 were surveyed, and 426 abstracts in English were collected for publication in this book.

The author is grateful for the Korean Society of Food Science and Technology, Korean Society of Food Science and Nutrition, Korean Society of Applied Microbiology, Korean Society of Agricultural Chemistry and Korean Society of Fishery for their generous permission for the publication of English abstracts in their journals. Dr. Bun-Sam Lim, former President of Daesang Food Co., suggested me to use his article on present status of Korea fermentation industry, and it enriched greatly the content of this book. My deepest appreciation goes to my graduate students led by Mrs. Sook-Jong Rhee who surveyed the abstracts and performed the secretarial work faithfully, and Dr. Chung-Young Lee who made English corrections and editorial work. Lastly, the author wishes to acknowledge Prof. Seung-Ha Shin, Director of Korea University Press and his staff, whose cooperation and assistance were invaluable in completing this book.

Cherl-Ho Lee
January 2001

QUALITY CONTROL FOR THE FOOD INDUSTRY

Cherl-Ho Lee, Soo Kyu Chae, Jin-Keun Lee, and Bong-Sang Park
Yulim Moonhwasa, Seoul, 1982
10 chapters, 324 pages (in Korean)

Contents: Quality attributes in foods, Appearance, Texture, Flavor, Sensory evaluation, Statistics, Control chart.

FOOD ENGINEERING

Edited by Korean Society of Food Science and Technology
Chapter 2, Flow property of fluid food,
Chapter 12, Mechanical separation Processes by Cherl-Ho Lee
Hyung-Sul Publishing Co., Seoul, 1984
14 chapters, 475 pages (in Korean)

BIOPRODUCTION

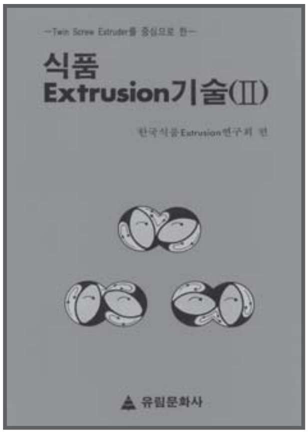
Byung-Hwa Kang, Ki-Hyun Paik, Kuen-Woo Park, Su-Gil Lim, Yong-Seok Son, and Cherl-Ho Lee,
Korea University Press, Seoul, 1986
6 chapters, 352 pages (in Korean)

Contents: Crop production, Forestry production, Plant production environment, Soil and plant production, Animal Husbandry, Biomaterials production and utilization

FOOD EXTRUSION TECHNOLOGY

Cherl-Ho Lee, Dong Chul Kim, Je-Hyen Chon, Chul Jin Kim, Jong-Bae Kim, Jae-Deuk Kim and Jung-Chon Son
Yulim Moonhwasa, Seoul, 1987
11 chapters, 248 pages (in Korean)

Contents: Extrufer types and structure, Dough rheology, Extrusion model analysis, Experimental variables and product quality, Structure and operation of food extrusion cooker, Low-cost extrusion cooker, Protein texturization, Starch industry application, Snack industry application, Feed industry application



FOOD EXTRUSION TECHNOLOGY II

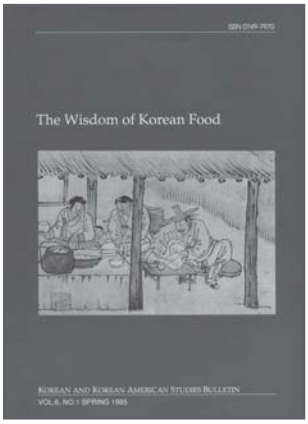
Korea Food Extrusion Research Group (Cherl-Ho Lee)
Yulim Moonhwasa, Seoul, 1988
14 chapters, 309 pages (in Korean)

Contents: Extruder types and function, Single screw extruder structure and operation, Tween screw extruder(TSE) principles and utilization, Protein texturization, Proyein texturization and starch modification by TSE, Enzyme inactivation and sterilization by TSE, TSE energy analysis, Food TSE, Die structure and design, Food rheology under high temperature and high pressure, Alph rice starch production, Extrusion noodle production, Soybean texturization and rice cake production, Application in fermentation industry.

FOOD ORCHESTRA

Cherl-Ho Lee
Yulim Moonhwasa, Seoul, 1994,
4 chapters, 248 pages (in Korean)

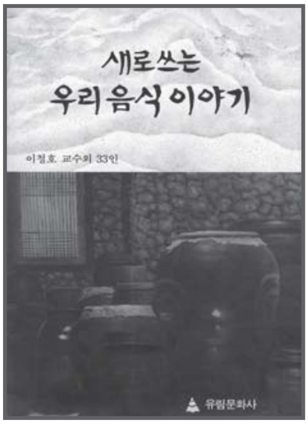
An essay collection on food thought and culture



THE WISDOM OF KOREAN FOOD

Guest editors: Cherl-Ho Lee and Steven Soon Young Kwon
Korean and Korean Americans Studies Bulletin
Vol.6, No.1, Spring 1995
East Rock Press, New Haven, Connecticut, USA
6 chapters, 54 pages (in English)

Contents: Introduction to Korean food culture, Role of soybeans, Kimchi, and Changes in dietary pattern and nutritional status of Koreans



RIVISED TALES ON KOREAN FOODS

Cherl-Ho Lee and 33 authors
Yulim Moonhwasa, Seoul, 1995
34 chapter, 239 pages (in Korean)

Contents: Korean natural environment, Brief history of 5000-year Korean food, Ritual foods, Description on 31 kinds of Korean food

WHITE-BOOK ON FOOD HYGIENE INCIDENCES

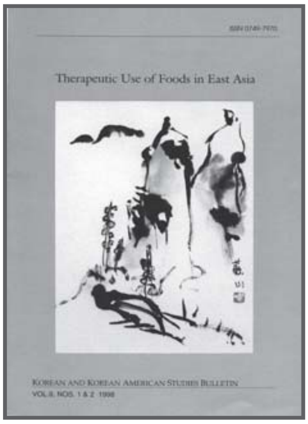
Cherl-Ho Lee and Young-Sun Maeng
Korea University Press, Seoul, 1997
21 chapters, 235 pages (in Korean)

Contents: Drinking water story, Pesticide contaminated soybean sprout and imported foods, Ramen tallow incidence, Acid hydrolyzed soy-sauce, MCPD in soysauce, MSG debate, Saccharin debate, Steviocide in Soju, Coloring stuff in seaweed, milk pasteurization debate, pus milk, Antimicrobial substance in milk, lead contaminated canned foods, Toluene contamination, Plastic packing film debate, Vegetable juice presser incidence, Bamboo- salt story.

ACCEPTANCE AND TRADING ON IRRADIATED FOODS

Edited by Cherl-Ho Lee
Korea University Press, Seoul, 1998
6 chapters, 214 pages (in Korean and English)

Contents: Utilization of atomic energy in non-power generating area, International developments of food irradiation and consumer acceptance, Current status in Korea, Prospects for trade in irradiated foods within and from Asian countries.



THERAPEUTIC USE OF FOODS IN EAST ASIA

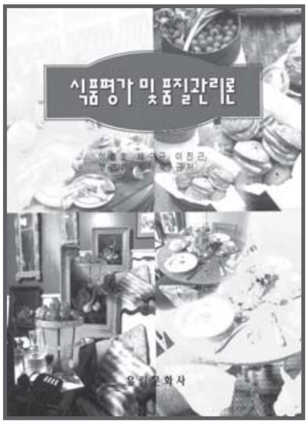
Guest editor: Cherl-Ho Lee
Korean and Korean Americans Studies Bulletin Vol.9, No.1-2, 1998
East Rock Press, New Haven, Connecticut, USA
4 chapters, 60 pages (in English)

Contents: Health concept in the traditional Korean diet, Therapeutic foods in China, Korea and Japan

FERMENTED CEREALS-A GLOBAL PERSPECTIVE

Norman F. Haard, S.A. Odunfa, Cherl-Ho Lee, R. Quintero-Ramirez
FAO Agricultural Service Bulletin 138, FAO, 1999
4 chapters, pages (in English)

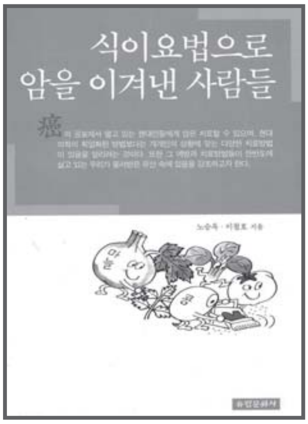
Contents: Cereals; rationale for fermentation, Cereal fermentations in African countries, Asia-Pacific region and Latin American countries.



FOOD EVALUATION AND QUALITY CONTROL

Cherl-Ho Lee, Soo Kyu Chae, Jin-Keun Lee, Kyung-Hee Koh, Hhe-Sook Son
Yulim Moonhwasa, Seoul, 1999
10 chapters, 462 pages (in Korean)

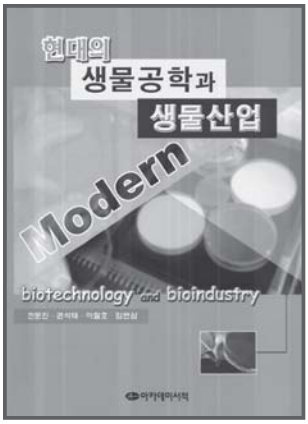
Contents: Quality attributes in foods, Appearance, Texture, Flavor, Sensory evaluation, Statistics, Control chart.



PEOPLE OVERCOME CANCER BY DIET THERAPY

Seung-Ok Ro and Cherl-Ho Lee
Yulim Moonhwasa, Seoul, 2002
5 chapers, 150 pages (in Korean)

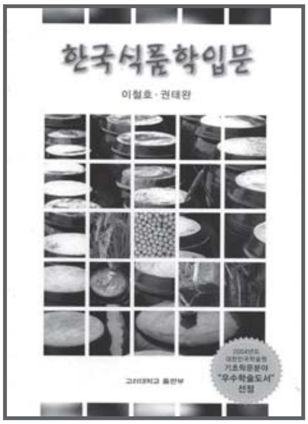
Contents: Environment and disease, Diet therapy of Korean, Dialog with the patients who recovered from liver cancer, Complimentary and alternative foods for cancer patients, The wisdom of food for healthy life.



MODERN BIOTECHNOLOGY AND BIOINDUSTRY

Mun-Jin Chun, Suk Tae Kwon, Cherl-Ho Lee, Bun Sam Lim,
Academy Book, Seoul, 2003
10 chapters, 444 pages (in Korean)

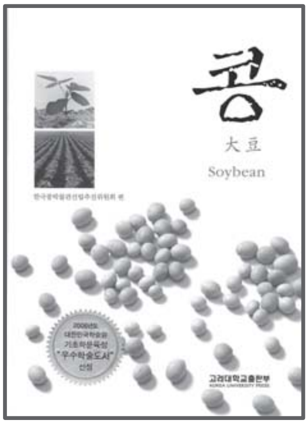
Contents: Bioindustry and principal technology, Biotechnology in Microbial, Plant, Animal, Enzyme, Food and Medicine. Future biotechnology, metabolic engineering, and Patent application.



INTRODUCTION TO KOREAN FOOD SCIENCE

Cherl-Ho Lee and Tai-Wan Kwon
Korea University Press, Seoul, 2003
7 chapters, 600 pages (in Korean)

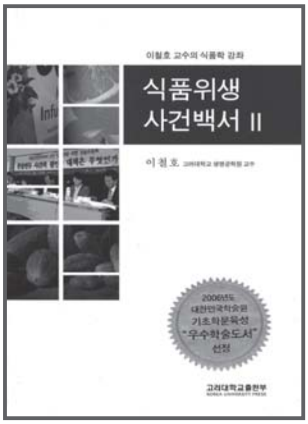
Contents: Human evolution and food culture, Origin of Korean dietary culture, Rice and rice foods, Soybean and soybean foods, Kimchi and Joetkal, Alcoholic beverages, Present and future Korean foods



SOYBEAN

Soy-world Museum Construction Committee
Korea University Press, Seoul, 2005
13 chapters, 794 pages (in Korean)

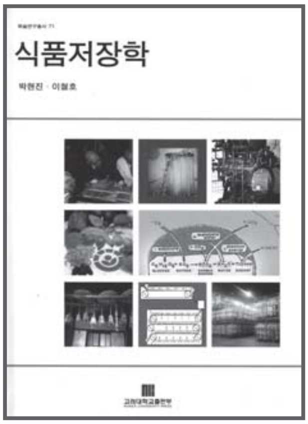
Chapter 1, Cherl-Ho Lee and Taiwan Kwon, History of soybean Utilization, page 3-44



WHITE-BOOK ON FOOD HYGIENE INCIDENCES II

Cherl-Ho Lee
Korea University Press, Seoul, 2007
16 chapers, 349 pages (in Korean)

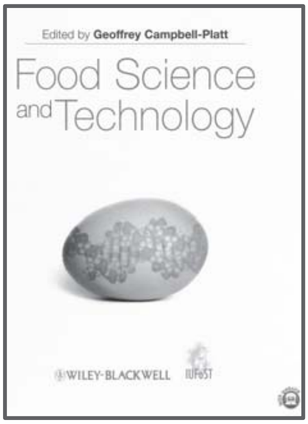
Contents: School lunch food poisoning, Chlostridium contaminated milk power, *Bacillus cereus* in RTE raw cereal powder, *E. coli* 0157 in imported beef, Demonstration against BSE, FI incidence, Nitrite in processed meats, Formalin in canned sea food, Acrylamide in deep fried foods, Endocrine disrupting substances in foods, Viagra-like substance added foods, Minicup-jelly accidents, Irradiated export ramen, GM bean-curd issue, Poor quality dumpling incidence, Provisions on food safety risk management. AD2015-Odesity tax hearing.



FOOD PRESERVATION

Hyun-Jin Park and Cherl-Ho Lee
Korea University Press, Seoul, 2008
13 chapters, 530 pages (in Korean)

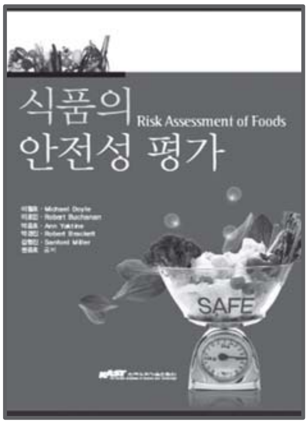
Contents: History of food preservation, Food spoilage and hazard, Shelf-life of foods, Fresh food storage, Fermentation, Chemical storage, Freezing, Thermal processing, Concentration, Drying, Irradiation, Emerging technologies, Food packaging.



FOOD SCIENCE and TECHNOLOGY

Edited by Geoffrey Campbell-Platt
Blackewell Publishing Ltd. 2009
21 chapters, 508 pages (in English)

Chapter 5. Food Biotechnology by Cherl-Ho Lee, page 85-114



RISK ASSESSNENT OF FOODS

Cherl-Ho Lee, Hyo Min Lee, Yong Ho Park, Gyung-Jin Bahk, Hyung-Chin Kim, Joong Ho Kwon, Michael P. Doyle, Robert L. Buchanan, Ann L. Yaktine, Robert E. Brackett, Sanford A. Miller
KAST Press, Sung-Nam, Korea, 2010
12 chapters, 260 pages (in Korean)

This book is the result of The 2nd KAST-US NA Bilateral Symposium on The Science of Food Safety Risk Assessment held on August 24-25, 2009 in Seoul, Korea. The symposium was organized to expand our knowledge on risk assessment practices applied to the national food safety assurance and disseminate the science-based rationals to the public. The first day symposium contained public lectures on food safety risk assessment principles of chemical and microbial hazards, and risk assessment of GM foods and irradiated foods. The second day meeting was Expert Workshop on Translating Risk Assessment into Policy with the invited speakers and panels from the academia and industry/government risk managers. All the English lectures given by US National Academies' speakers were tape recorded, typed and then translated into Korean by the Korean speakers. A great coordinating effort was made by Dr. Linda Meyers of US NA to publish the Korean book from the English spoken materials.

Contents: Food safety risk assessment and management, Risk assessment- Perspectives from the US, Risk assessment of chemicals in food, Risk assessment of antimicrobial resistance in food and feed, Quantitative microbial risk assessment, Application of quantitative microbial risk assessment, Safety assessment of GM foods, Safety of GM food, Safety assessment of irradiated foods, Irradiation as part of the food safety toolkit, Risk assessment and communication, Science and regulation.

Research Project Reports

- English reports
- Korean reports
- Korean Dietary Culture Film, Part I-VI
- International Course for Food Fermentation Technology
- Center for Advanced Food Science and Technology(CAFST)

English reports

- **Development of low-cost food dehydration system using solar-energy and coal for the village level food preservation in Korea**, submitted to International Foundation for Science, Stockholm, Sweden (March 1981- June 1984)
  First Year Progress Report by Cherl-Ho Lee and Jae Gak Lim, December 1981, 39 pages
  Final Research Report by Cherl-Ho Lee, Jae Gak Lim and Dae Hwan Kim, June 1984, 25 pages

- **Utilization of Australian lupinseed in Korea food system**, submitted to The Grain Pool of West Australia, Perth, W.A. 6000, Australia.(June 1982-July 1986)
  First Half-Yearly Progess Report by Cherl-Ho Lee, Chan-Shick Kim and Sung-Hoon Oh, November 1982, 87 pages
  Second Half-Yearly Progess Report by Cherl-Ho Lee, Chan-Shick Kim and Sung-Hoon Oh, July 1983, 50 pages
  Third Half-Yearly Progess Report by Cherl-Ho Lee, Chan-Shick Kim and Sung-Hoon Oh, November 1983, 44 pages
  Fourth Half-Yearly Progess Report by Cherl-Ho Lee, Chan-Shick Kim and Sung-Hoon Oh, June 1984, 65 pages
  Fifth Half-Yearly Progess Report by Cherl-Ho Lee, Ouck-Han, Hyun-Duck Lee and Jeong-Kyo Kim, July 1985, 56 pages
  Sixth Half-Yearly Progess Report by Cherl-Ho Lee, Young-Wook Kim and Hee-Don Choi, July 1986, 51 pages

海外

레이건•베긴 6월會談

★베긴 유엔訪問후 워싱턴서

메나헴 베긴 이스라엘 수상은 오는6월 레이건 美대통령과 회담할 것이라고 이스라엘 국영방송이 12일보도。이 방송은 회담이 아마도 베긴수상의 유엔방문에 맞추어 워싱턴에서 이루어질 것이라고 덧붙였다。그런데 베긴수상은 軍縮에관한 유엔특별총회에 참석,연설할 예정이다。

베시合參議長 인준

★존즈議長후임으로 7月부임

차기 美합참 의장으로

人物廣場

動靜

申秉鉉 貿協회장

淸州師大서 경제特講

申秉鉉貿協회장은 13일하오 淸州에서 현지수출업체대표 60여명과 만나 수출타개방안을 논의하는 ... 한편 淸州師大에서 「국제무 ... 여환경의 변화와 우리무역의 당면과제」란는 주제로 특별강연。

李哲鎬 高大교수

濠洲서 研究基金받아

高大식품공학과 李哲鎬교수는 13일 濠洲의 西濠洲곡물공사로부터 루핀콩의식품이용연구기금 2만5천달러를 기증 받았다。李교수는 앞으로 2년동안 濠洲産루핀콩을 대두 대용품으로 사용하여 식물성단백제품등에 이용하는 방법에 대해 연구할 계획。

李源京 체육장관

強訓중인代表선수 격려

李源京체육부장관은 13일 취임후 처음으로 泰陵선수촌을 방문,강화훈련중인국가대표선수들을 격려했다。曺相鎬대한체육회장의 안내로 선수촌을 방문한 李장관은 훈련중인 국가대표선수및 임원들에게 『86년아시안게임과 88년 올림픽의 ...

(A newspaper(Gyunghyang, 1982 / 5 / 14) announced the Australian Lupinseed Project of Prof. Lee's Lab.)

- Utilization of Australian wheat for Korean noodle making, submitted to The Australian Wheat Board, Melbourne, Austalia.(July 1985-June 1987)
  First Half-Yearly Progress Report by Cherl-Ho Lee, Hyun-Duck Lee, Byoung-Seung Yoo and Sung-Hie Hong, December 1985, 77 pages
  Second Half-Yearly Progress Report by Cherl-Ho Lee, Hyun-Duck Lee, Byoung-Seung Yoo and Sung-Hie Hong, July 1986, 54 pages
  Third Half-Yearly Progress Report by Cherl-Ho Lee and Sung-Hie Hong, June 1987, 64 pages

- The product quality and storage stability of Korean fermented fish products, by Cherl-Ho Lee, Young Bae Kim, Young Taik Kim, Chang Soo Kim and Moussa Souane, submitted to The United Nations University, Tokyo, Japan, March 1987, 63 pages (May 1985-February 1987)

- Flavor control in lactic acid fermentation of high protein vegetable beverages, by Cherl-Ho Lee, Sook-Jong Lee, Moussa Souane, Kyung-Hee Koh, Gi Myung Kim, Chang Hyun Kim, Do Youn Lee, Mi Ryung Kim and Kyung Chan Min, submitted to UNIDO Project No. DP/ROK/89/002, February 1992, 136 pages (July 1990- December 1991)

- Industrialization of lactic acid fermentation of cereals and its dissemination to developing countries, by Cherl-Ho Lee, submitted to UNIDO Project No. ROK/89/002/C/01/37, February 1993, 155 pages (July 1990-December 1992)

- Large scale production of lactic acid in batch and continuous culture, by Cherl-Ho Lee, Mohamed A. Abdel-Naby, Yun-Kyung Cho and Do Youn Yi, submitted to Sun Hill Glucose Co. Ltd., January 1993, 51 pages (August-December 1992)

- Microbiological study and isolation of Staphylococci from Korean fermented fish products, submitted to The Nestec Ltd., Switzerland (August 1994-February 1996)
  First Half-yearly Progess Report, by Cherl-Ho Lee, Young Bae Kim, Mi-Na Um, Mi-Ryung Kim and Chi-Yon Hong, February 1995, 26 pages
  Second Half-Yearly Progress Report, by Cherl-Ho Lee, Young Bae kim, Chi-Yon Hong, Mi-Ryung Kim and Sun-Young Park, September 1995, 32 pages
  Final Research Project Report, by Cherl-Ho Lee, Young Bae Kim, Mi-Na Um, Mi-Ryung Kim, Chi-Yon Hong and Sun-Young Park, February 1996, 47 pages

- Soya as a main ingredient for drinks, submitted to NESTEC Ltd., Vevey, Switzerland. (October 1966-September 1998)
  First Year Progress Report, by Cherl-Ho Lee and Hyun-Duck Lee, August 1997, 29 pages
  Final Research Report, by Cherl-Ho Lee, Hyun-Duck Lee, Young-Shick Hong, Jien-Yeol Lee and sung-Jun Cho, October 1988, 53 pages

- Development of functional peptide drinks by using soybean protein hydrolysate, submitted to Nestle Research Center, Lausanne, Switzerland. (July 1999-August 2001)
  First Year Progress Report by Cherl-Ho Lee, Hyun-Duck Lee, Chung-Young Lee, Mi-Ryung Kim and Bum-Jin Lee, November 2000, 19 pages
  Second Year Progress Report by Cherl-Ho Lee, Chung-Young Lee, Mi-Ryung Kim, So-Jeong Han, Jeong-Haing Hur and Byung-Hee Ryu, September 2001, 18 pages

Korean reports

- Studies on the effect of protein hydrophobicity on the functional properties of food proteins, submitted to The Korea Science and Engineering Foundation. (December 1982-Noember 1986)
  First Report by Cherl-Ho Lee, Sung-Ku Kim, Sam-Pin Lee and Joo-Soon Lee, June 1984, 68 pages
  Second Report by Cherl-Ho Lee, Sam-Pin Lee and Bu-Yong Lee, January 1987, 92 pages

- Historical and scientific studies on the Korean traditional cookies for their film production, by Cherl-Ho Lee, Chi-Hyun Chang, Il-Shick Hong, Young-Sun Maeng and Hyun-Sook Ahn, submitted to Asan Social Welfare Foundation, Decmber 1986, 99 pages (1 year project)

- Application of extruder for the improvement of Takju making process, by Cherl-Ho Lee, Gi-Hyung Ryu, Chi-Young Kim and Dong-Hoon Shin, submitted to Dae-Sun Flour Milling Co. Ltd., First Report June 1988, 48 pages, Second Report December 1988, 50 pages (December 1987-December 1988)

- Changes in texture of Korean cabbage during Kimchi processing and storage, by Cherl-Ho Lee and In-Ju Hwang, submitted to Food Research Institute, Korean Food Manufacturers Association, August 1987, 69 pages (January 1987-August 1987)

- Studies on the utilization of broken rice obtained as a by-product of rice-bran oil production, by Cherl-Ho Lee, Young-Bae Kim, Hyung-Woo Park and Won-Nam Han, submitted to Sam-Yang Oil Co., February 1984, 33 pages (September 1983-February 1984)

- Starch production by using broken rice from rice-bran oil by-products, by Cherl-Ho Lee, Chan-Shick Kim and Il-Jun Kang, submitted to Shin-Yang Oil Co., August 1984, 29 pages (September 1983-August 1984)

- Sensory evaluation of ginger extracts, by Cherl-Ho Lee and Hye-Kyung Hong, submitted to Food Research Institute, Korean Food Manufacturers Association, January 1988, 33 pages (December 1987-January 1988)

▸ Studies on the instant traditional tea processing by spray drying, by Cherl-Ho Lee, Bu-Yong Lee, Chang-Ho Lee and Sung-Young Park, submitted to Pulmuone Co. Ltd., September 1988, 29 pages (July-September 1988)

▸ Studies on the development of food estrusion technology, by Cherl-Ho Lee, Yong-Jin Choi, Kyu-Man Chee, Dong-Hoon Shin, Gi Myung Kim and Hun Kim, submitted to Korea Science and Engineering foundation, August 1990, 59 pages (September 1988-August 1990)

▸ Wheat germ and wheat bran processing with extruder, by Cherl-Ho Lee, Chi-Young Kim, Hun Kim and Yong-Bum Kim, submitted to The U.S. Wheat Association and Dae-Sun Flour Milling Co. Ltd., December 1990, 67 pages (June 1990-December 1990)

▸ Studies on the thermal processing of Takju for Tetra Pak aseptic packaging, by Cherl-Ho Lee, Won-Taik Tai, Hyun-Duck Lee, Gi Myung Kim and Moussa Souane, submitted to Korea Tetra Pak Co., Wonjin Sanup Co., Seoul Takju Manufacturers Association, January 1990, 44 pages (December 1988-January 1990)


【6】 (1993. 2. 24 제3종 우편물(가급)인가) 식품유통신문

탁주유통기한 연장방법 개발

인천탁주 고대식품공학과 이철호교수팀에 의뢰 성공

해외 수출도 가능…상온 6개월까지 저장

우리나라 전통술인 탁주의 유통기한을 연장시킬 수 있는 방법은 없는가?

현재 식품공전상에는 탁주의 권장유통기한을 「10°C이하에서 5일」로 규정하고 있다.

탁주는 발효식품으로 4~5일이 지나면 변질될 가능성이 높다. 이러한 점때문에 탁주의 전국 유통이 불가능했고 수출은 더더욱 기대하기 어려웠다.

있다.

이러한 문제를 해결하기 위하여 고려대학교 식품재료공학 연구실에서는 한국테드라팩과 서울탁주제조협회의 도움을 받아 「테트라팩 살균포장을 위한 탁주의 열처리에 관한 연구」를 수행했다.

연구결과 80°C에서 20초내외간 살균하는 것이 가장 바람직하는 사실이 밝혀졌다.

그러나 서울탁주측이 실제생

(A newspaper reported packed maggolli(Takju) process developed by Prof. Lee's Lab.)

▸ Studies on the sensory recognition mechanism and expression of the taste of monosodium glutamate, by Cherl-Ho Lee, Hye-Kyung Hong and Hyun-Duck Lee, submitted to Miwon Culture Foundation, First Report, August 1989, 32 pages, Second Report, December 1990, 65 pages (September 1988-December 1990)

- Development and dissemination of twin-screw extruder for Korea food industry - Survey on the present status of food extrusion technology in Korea, by Tai-Wan Kwon, Cherl-Ho Lee, Chul-jin Kim, Hyun-Yu Lee, Dong-Chul Kim, Ouk Han, Young-Ho Kim, Sang-Hyo Lee and Gi-Hyung Ryu, submitted to Korea Food Research Institute, June 1989, 111 pages

- Studies on pasteurization and pakaging of Yi-Dong Maggoli, by Cherl-Ho Lee, Do Youn Yi and Gi Myung Kim, submitted to Hanil Takju Manufacturer, October 1994, 36 pages (February-October 1994)

- Functional properties of sugar derivatives, Fructo-oligo sugar, High maltose syrup and Maltitol, by Cherl-Ho Lee, Jae-Gak Lim and Hyun-Duck Lee, Moussa Souane, Bok-Jin Han, Eue-Jung Yoon, Na-Young Kim and Sun-Young Kim, submitted to Sun Hill Glucose Co. Ltd., June 1990, 77 pages (April 1989-June 1990)

- Application of extrusion-cooking process for the pretreatment of biomass for alcohol fermentation, by Cherl-Ho Lee, Jae-Gak Lim, Moussa Souane, Dong-Hoon Shin, Gi Myung Kim and Hun Kim, submitted to The Ministry of Energy Resources, Republic of Korea, February 1991, 57 pages (January 1989-December 1990)

- Studies on the shelf-life of rice-beer Nongju in aseptic packaging, by Cherl-Ho Lee, Hyun-Duck Lee, Chi-Yong Kim and Gi Myung Kim, submitted to Incheon Takju Manufactureres Association, February 1993, 30 pages (October 1992-February 1993)

- Partition of contaminated Thiophanate-methyl to the milling fractions of wheat, by Cherl-Ho Lee, Do-Yeon Yi and Young-Sun Kim, submitted to Korea Flour Millers Association, July 1993, 52 pages (December 1992-July 1993)

- Studies on the shelf-life of rice-wine Myung-ga in aseptic packaging, by Cherl-Ho Lee and Gi Myung Kim, submitted to Incheon Takju Manufactureres Association, December 1994, 27 pages (July 1993-Decmber 1994)

- Texturization of surumi by extrusion cooking, by Cherl-Ho Lee, Won-Seok Choi and Jin-Ho Choi, submitted to Dong-Won Foundation, January 1995, 35 pages (November 1993-December 1994)

- Studies on the instrumental measurement of the eating quality of Korean rice and its quality ranking, by Cherl-Ho Lee, Kyung-Hee Koh, He-Sook Shon, Chang-Ho Lee, Ho-Young Kim and Eun-Joo Lee, submitted to Korea Science and Engineering foundation, May 1994, 92 pages (September 1994-August 1997)

- Studies on the production and processing of dextran, by Cherl-Ho Lee, submitted to Su-Dang Foundation, May 1994, 60 pages (1993-1994)

- Studies on the shelf-life of rice cake Garaeddok, by Cherl-Ho Lee, Bo-Sun Ahn and Sung-Jun Cho, submitted to HanwooMul Food Co., November 1997, 17 pages (August - November 1997)

- Changes in chemical composition and keeping quality of rice wine by thermal treatment, submitted to Yi-Dong Rice-Wine Co., G-7 Research Project, Ministry of Science and Technology, ROK, (August 1995-July 1998)
  First Year Progress Report, by Cherl-Ho Lee, Kyung-Hee Koh, Gi Myung Kim, Do-Yeon Yi and Sung-Won Yoon, October 1996, 35 pages
  Second Year Progree Report, by Cherl-Ho Lee, Gi Myung Kim, Do-Yeon Yi and Sung-Won Yoon, October 1997, 56 pages
  Final Report, by Cherl-Ho Lee, Gi Myung Kim, Do-Yeon Yi and Sung-Won Yoon, October 1998, 213 pages

- Product development study for home-made soybean fermentation kit, by Cherl-Ho Lee, Seung-Ok Ro, Byung-Kuk Choi and Bum-Jin Lee, submitted to Korea Industrial Technology Evaluation Agency, ROK, June 2000, 36 pages (May 1999-April 2000)

- Studies on the production of food protein hydrolysate and the quality improvement by using biotechnological approach, by Cerl-Ho Lee, Soang-Yoon Choi and Mu-Hyun Lim, October 1999, 177 pages (April 1996-September 1999)

- Studies on the safety and consumer acceptance on irradiated foods, by Cherl-Ho Lee, Hyun-Duck Lee and Eun-Joo Lee, submitted to Korea Food and Drug Administration, December 1998, 165 pages (April 1998- December 1998)

- Improving the public understanding of food irradiation, by Hak-Su Kim, Cherl-Ho Lee, Hyun-Duck Lee, Eun-Joo Lee and Man-Ho Lee, submitted to Korea Atomic Energy Research Institute, March 2000, 84 pages (1998-2000)

- Development of ESR detection method of irradiated food, by Cherl-Ho Lee, Eun-Joo Lee and Vitaly I. Volkov, December 2001, 35 pages (January -December 2001)

- Accelerated aging process of soybean paste by using enzyme systems and Gamma-irradiation, by Cherl-Ho Lee, Eun-Joo Lee, Suk-Jong Lee, Bo-Sun Ahn, Yu-Shin Lee, Young-Won Park, Hong-Wook Park, Hie-Ju Choi, Young-Taik Kim, submitted to Ministry of Agriculture and Forestry and Hai-Ma Food Co., January 2002, (November 1999-November 2001)

- Studies on the contents of pseudo-oestrogenic compounds in fermented soybean products and its effects on human body, by Cherl-Ho Lee, Kyung-Hee Ko, Chungyoung J. Lee, Sung won Yoon, Hyunmin Jin and Nak-Hee Chung, submitted to Korea Food And Drug Administration, February 2003, 32 pages (March 2000-February 2003)

- Survey of medicinal foods in Korea and their property right protection methods and industrialization, by Jong Hwan Hwang, Cherl-Ho Lee, Sook-Jong Lee, Ji-Eun Kwak and Sung-Won Yoon, submitted to Ministry of Agriculture and Forestry, ROK, October 2003, 229 pages (2001-2003)

- Analysis of functional components and quality evaluation of *Lycium chinense*(Bulro) fruit extracts, submitted to Ministry of Agriculture and Forestry, ROK, (October 2002-October 2005)
  First Year Progress Report by Ju-Chan Lee, Kyung-Hee Ko, Cherl-Ho Lee, Bum-Jun Kim, Chung-Young Lee, Kyung-Il Kang and Yu-Mi Park, October 2003, 51 pages
  Second Year Progress Report by Kyung-Hee Ko, Cherl-Ho Lee, Jin-Young Chung and Yu Park, October 2004, 97 pages
  Third year progress report by Kyung-Hee Koh, Ju-Chan Lee, Cherl-Ho Lee, Jin-Young Chung and Yu Park, October 2005, 102 pages
  Final Report, November 2005, 348 pages

- Hemorheological studies on the blood cholesterol lowering effects of some foods, by Cherl-Ho Lee, Chung-Yung J. Lee, Ki-Chan Kim, Se-Moon Park, submitted to Ministry of Health and Welfare, ROK, May 2005,29 pages (May 2003-April 2005)

- Measurement of water movement and image analysis of food and biological systems by using Pulsed Field Gradient NMR and Magnetic Resonance Imaging, submitted to Korea Science and Engineering Foundation, (September 2003-August 2006)
  First year progress report by by Cherl-Ho Lee, Young-Shik Hong, Chung-Yung J. Lee, Gwan-Soo Hong, Eun-Soo Lee, Se-Mun Park, December 2004, 46 pages
  Third year progress report by Cherl-Ho Lee, Young-Shik Hong, Gwan-Soo Hong, Eun-Soo Lee, Jung-Hun Jo, Nari kim, August 2006, 22 pages

- Development of antioxidative food packaging materials by using herbal extracts, by Gi Myung Kim, Cherl-Ho Lee, Chang-Yong Lee, submitted to Rural Development Agency, ROK, November 2008, 21 pages (March 2008-December 2009)

- Development of carbohydrate/peptide functional ingredients, by Kwan-Hwa ParK Cherl-Ho Lee, Sung-Won Yoon, Woo-Jin Park, Bong-Kuk Ko, Hong-Suk Son, submitted to Korea University Center for Functional Food Materials, Ministry of Health and Welfare, Midterm progress report, March 2006, 65 pages (May 2005-March 2011)

Korean Dietary Culture Film, Part I-VI

Produced by Traditional Dietary Culture Visual Image Preservation Project of Korea University (1985-1998).

Professor Cherl-Ho Lee organized the Planning Committee for Traditional Dietary Culture Visual Image Preservation Project when he became the Director of Food Research Institute of Korea University in 1985. The purpose of the project was to produce films on Korean dietary culture which were rapidly vanishing from the society. In the second committee Meeting held in September 1985, the items and order of production was decided; 1. Korean cookies, 2. Rice cakes, 3. Non-alcoholic beverages, 4. Alcoholic beverages, 5. Kimchi, 6. Fermented soybean products, 7. Fermented fish products, 8. Soybean curd and soy milk, 9. Culinary dishes. This project was transferred to the Institute of Korean Culture, Korea University on September 5, 1991. Up to present days, first 6 items were made into film (ca. 20min. length each) in Korean and in English. The original 16 mm films and video tapes are kept in Korea University Central Library, and the copies of video tapes and DVDs are distributed by the Institute of Korean Culture, Korea University (Tel. 82-2-3290-1610).

Planning Committee Memders :

Prof. Tai-Jong Yu (Korea Univ., Chair)
Prof. Sang-Soon Kim (Sukmyung Woman's U.)
Prof. Chi-Hyun Chang (Sungsim College for Women)
Prof. IL-Sik Hong (Korea Univ.)
Prof. Hae-Sung Hwang (Sungkyunkwan U.)
Prof. In-Hee Kang (Myungji Univ.)
Prof. Hyo-Sun Shin (Dongkook Univ.)
Prof. Woo-Hyun Won (Korea Univ.)
Prof. Jae-Ho Chung (Korea Univ.)
Prof. Heung-Kyu Kim (Korea Univ.)
Prof. Gui-Ju Lee (Korea Univ.)
Dr. Bun-Sam Lim (Miwon Re. Inst. of Korea Food & Dietary Culture)
Prof. Cherl-Ho Lee (Korea Univ.)

Korean Dietary Culture

Part I. Korean Cookies (Hankwa) (20 min.) - Sponsored by Miwon Co.
Literature review by Cherl-Ho Lee and Young-Sun Maeng(1985-1986)
Produced by Cinetel Seoul, Directed by Hyun-Woo Shim,
First preview at Science Library Auditorium, January 18, 1988.

Part II. Rice Cakes (20 min.) - Sponsored by Miwon Co.
Literature review by Cherl-Ho Lee and Young-Sun Maeng(1987. 5.-10.)
Produced by Seoul Film Co., Directed by Soon-Shick Kim
Forst preview at Science Library Auditorium, October 19, 1989.

Part III, Non-alcoholic Beverages (20 min.) - Sponsored by Miwon Co.
Literature review by Cherl-Ho Lee and Sun-Young Kim(1990. 1.-6.)
Produced by Seoul Film Co., Directed by Soon-Shick Kim
First Preview at Inchon Memorial Hall, June 23, 1992.

Part IV. Alcoholic Beverages (20 min) - Sponsored by Baekwha Co.
Literature review by Chjerl-Ho Lee and Gi-Myung Kim(1992.10.-1993.4.)
Produced by Seoul Film Co., Directed by Soon-Shick Kim
First Preview at Inchon Memorial Hall, June 22, 1994.

Part V. Kimchi (20 min) - Sponsored by Doosan Farmland Products Co.
Literature review by Cherl-Ho Lee and Bo-Sun Ahn(1994.9.-1995.1.)
Produced by Seoul Film Co., Directed by Soon-Shick Kim
First Preview at Inchon Memorial Hall, June 26, 1996.

Part VI. Fermented Soybean Products(Jang) - Sponsored by Sam Pyo Food Co.
Literature review by Cherl-Ho Lee and Jun-Chul Kim(1996.8.-12.)
Produced by EBS Production, Directed by Woo-Chul Kim
First preview at Business School New Auditorium, September 5, 1998.

Professor Cherl-Ho Lee donated 1000 copies of DVD CD which contains the six films in Korean and in English each to the Institute of Korean Culture, Korea University. The CDs can be purchased from the institute (Tel. 82-2-3290-1610, Fax. 82-2-926-8385, jroh@korea.ac.kr).

Prof. Cherl-Ho Lee donated DVD to the Institute of Korean Culture(Director, Prof. HeungKyu Kim)

동 아 일 보 1987年9月1日 火曜日

"사라져가는 맛 되살리자"

전통음식 映像으로 기록

高大 식품가공실험실·김치박물관서 작업

재료 제조법등 비디오 촬영

사라져가는 전통食文化를 영상에 담아 보존하는 작업이 활기를 띠고 있다. 高大농대 식품가공실험실에서는 韓菓 전통음료 酒類 장류 젓갈류등 우리 대표적인 전통음식 9가지를 골라 고증을 거쳐 영화로 만드는 작업에 착수, 현재 그 첫작품 「韓菓」의 촬영이 진행중이며 김치박물관에서도 전국의 대표적인 김치 10가지를 담은 비디오의 완성단계에 있다.

·신혼 첫날밤 황촉 아래 족두리쓴 신부와 마주 앉은 사모관대의 신랑이 방안에 차려진 주안상에서 술을 따라마시며 쌀튀김을 묻힌 산자를 나눠 먹는다.

이어서 전통요리연구가 姜仁姬씨(전明知大교수)가 단단하게 말린 조그만 찹쌀반죽이 기

사라져가는 우리 전통음식을 영상으로 기록해두려는 식문화 영상화 작업이 활기를 띠고 있다.

A newspaper announced Korean Dietary Culture Film Production Project of Korea University(1/9/1987)

International Course for Food Fermentation Technology
KU-UNIDO International Training Program(October 1991-July 1992)

A 10-month training course on Food Fermentation Technology was conducted at Korea University from October 1, 1991, by inviting 8 food scientists from the developing countries in Asia and Africa. The impetus of the project goes back to the UNIDO Workshop on Importance of lactic acid fermentation in food industries held in Mexico City in November 1984. Professor Cherl-Ho Lee was invited to the workshop as an invited speaker, and decided to conduct a collaborative research with Professor Anthony J. Sinskey at MIT, USA, who was also attending to the workshop.

A MIT-Korea University Cooperative R&D to develop high protein content lactic beverages from vegetable was carried out for two years from January 1987 under the sponsorship of UNIDO. During the research period, starter cultures for cereal lactic acid fermentation were screened and isolated from traditional Korean fermented foods, and the possibility of developing high protein lactic beverages from vegetables were shown. The research results were highly evaluated by UNIDO, and a second phase research project was suggested to conduct.

The 2nd phase UNIDO research project 'Industrialization of lactic acid fermentation technology of cereals and its dissemination to the developing countries' was started in July 1990. The project comprised a collaborative research of three institutes, Institute of Food Resources of KU, Korea Food Research Institute and Department of Biotechnology, Technical University of Demark(DTH), and a 10-month post-graduate level training course, and an international workshop on the lactic acid fermentation of non-dairy food and beverages at the end of the project.

The training course was planned to invite 10 food scientist from the developing countries, and 18 applicants from 11 countries were collected. 10 scientists were selected, but two applicants from China and Ethiopia could not get permission from their countries. Final 8 scientists from Nigeria, Sudan, Philippines, Sri Lanka, Thailand, Vietnam, India and Egypt arrived in Seoul at the end of September 1991, and stayed at Korean University Dormitory for 10 months. The training course was supported by UNIDO($360,000 through UNDP), Ministry of Science and Technology, Republic of Korea($100,000), and Korea University(dormitories, teaching facilities, etc.), and in total a million dollar project.

The course staffs, time schedule, the instructors, curriculum and participants of the training course are as follows.

1. Course staffs

Project director: Dr. Cherl-Ho Lee

Project Manager : Mr. Gi Myung Kim, Ph.D. candidate at KU

Laboratory Teaching Assistants : Hyun Duk Lee, Jung Won Hong, Yong Bum Kim,
Kang Kwon Lee, Chung Young Lee

2. Time Schedule

1991	Oct. 1 ~ Oct. 5	Arrival Orientation
	Oct. 7 ~ Dec. 21	First Semester
1992	Jan. 5 ~ Feb. 28	Pilot Plant practice (KFRI)
	Mar. 2 ~ Jun. 30	2nd Semester
	Jun. 26 ~ Jun. 28	International Workshop
	Jul. 20 ~ Jul. 30	Return to home country

3. Textbooks

- Cereal Lactic Acid Fermentation Technology, by Cherl-Ho Lee, Ho Lee and Chul-Kyun Mok, 203 pages
- Traditional Food Fermentation Technology, by Cherl-Ho Lee, Ki-Young Lee and Tai-Wan Kwon, 372 pages
- Koean Dietary Culture, by Jin-Soon Ju, Myung-Bok Lee, Cherl-Ho Lee ad Chul Rhee, 248 pages
- Extrusion Cooking Technology, by Cherl-Ho Lee and Kyu Man Chee, 336 pages
- Starter Culture Technology, by Won Mok Park and Wang Jin Kim, 242 pages
- Enzyme Process Technology, by Youg-Jin Choi and Hyo-Ihl Chang, 300 pages
- Biotechnology and Genetid Engineering, by Se young Lee and Young In Park, 228+85 pages
- Laboratory Manual for Traditional Fermentation Technology, Compiled by Cherl-Ho Lee, 79 pages
- Laboratory Manual for Molecular Biology, Compiled by Se Young Lee, 118 pages

Textbooks for the UNIDO International Training Program

4. Curriculum

	Subject	Lecture time
101	Traditional fermentation Technology	42 hrs
102	Cereal Lactic Fermentation	24 hrs
103	Biotechnology and Genetic Engineering	42 hrs
104	Korean Language	26 hrs
201	Extrusion Cooking Technology	42 hrs
202	Starter Culture Technology	24 hrs
203	Enzymic process Technology	24 hrs
204	Koearn Dietary Culture	24 hrs
301	Pilot-Plant Practice	2 months

Korea Shares Its Food Technology

Korean researchers have been finding new applications for traditional food fermentation techniques. Christopher McIntosh describes how other developing countries are benefiting

Anyone who has visited Korea is likely to have tasted the fermented cabbage known as *kimchee* that is one of the country's staple foods. *Kimchee* is made by a process known as lactic fermentation, caused by the action of benign bacteria similar to those that turn milk into yoghurt. In many parts of the world, lactic fermentation has been used for centuries to preserve food, enhance its taste and keep it free of harmful organisms that can cause food poisoning. The technique can be used with a wide variety of foods including flour dough, milk, meat, fish, cereals and vegetables.

Until recently lactic fermentation had not been subjected to much scientific research. Consequently, industrial production of such foods is still relatively limited. However, scientists at the Univer-

drinks. One of the ways to help solve this problem is to make nutritious and tasty beverages from food materials such as cereals, legumes and tubers. This can be done using some of our traditional lactic fermentation techniques."

Another problem, explains Professor Lee, arises from the increased consumption of dairy products such as yoghurt. "As Korea has very little grazing land, these products have to be imported, with the result that Korea's food self-sufficiency has markedly declined. To help the situation, we have developed a yoghurt substitute made from rice and soya protein using lactic fermentation."

The findings of Professor Lee's department are now being shared with other developing countries, many of which share similar problems. This autumn the university began a training programme in food technology. The course lasts for 10 months and is open to developing country applicants with a BA in food science and a minimum of three years experience in the food industry or with a research institute. The United Nations Industrial Development Organization (UNIDO) assisted in the development of the course and helped to find suitable candidates.

Two of the participants in the international course on food fermentation recently inaugurated by Korea University: Hanan Elsoufi from the Sudan (*above*) and Balaraman Manohar from India.

5. List of participants and their advisors

Country	Name	Age	Degree	Affiliation	Advisor
Nigeria	Mr. Tajudeen O. Nashiru	31	Ms. Biochem.	Fed. Inst. of Industrial Res	Dr. Se Young lee Professor of Molecular Biology
Sudan	Miss Hanan Elsoufi	28	B. Sc. Family Sci	Food Res. Center, Agri. Res, Coorp.	Dr. Young Jin Choi Professor of Microbial Genetics
Philippines	Miss Lilia S. Collado	35	Ms. Food Sci.	Inst. Food Sci. Technol., of Philippines	Dr. Won Mok Park Professor of Plant Pathology
Sri Lanka	Mr. Mohamed F. Moheedin	31	Ms. Microbiol	Nat. Aquatic Resource Agency	Dr. Kyu Man Chee Professor of Animal Nutrition
Thailand	Miss Kanchanich Vachanavinchi	40	Ms. Phamacy	Inst. Food Res. and Product Devel., Kaset Sart Univ.	Dr. Yong In Park Professor of Molecular Biology
Vietnam	Mr. Nguen Van Viet	40	B. Cs. Chemistry	Food Industry Research Inst.	Dr. Hyo Ill Chnag Professor of Biochemistry
India	Mr. Manohar Balaraman	30	Ms. Chem. Eng.	Central Food Technological Res. Inst., Mysore	Dr. Chul Rhee Professor of Food Engineering
Egypt	Mr. Mohamed A. Abdel-Naby	36	Ph. D. Biochem.	National Research Center	Dr. Cherl Ho Lee Professor of Food Engineering

Center for Advanced Food Science and Technology(CAFST), Korea University

CAFST was established in 1995 under the leadership of Prof. Cherl-Ho Lee. It was a Science/ Engineering Research Center of Encouragement sponsored by the Korea Science and Engineering Foundation(100million Won per year for three years). The objectives of the center were:

(1) Research and development of new technologies for the preservation of food and agricultural products.
(2) Research and development of advanced food processing systems.
(3) Improvement and industrialization of traditional foods.
(4) International cooperative researches on food processing technologies.
(5) Industrial cooperation through collaborative researches and education programs.

The center was organized with five laboratories, Food Preservation Lab., Advance Food Processing System Lab., Traditional Food Lab., Food Biotechnology Lab., Special Project Lab., and a Supporting Lab.

The Center started with 25 faculty members from 8 universities and 6 scientists from three research institutes, as listed below.

Director: Cherl-Ho Lee(Korea University)
Managing Director: Seung-Taik Lim(Korea University)

Korea University Participants: Sang-Yoon Choi(Dept. of Food Technology), Yong-Jin Choi(Dept. of Genetic Engineering), Ha-Jin Sung(Dept. of Genetic engineering), Hyo-Il Chang(Dept. of Genetic Engineering), Chan-Hwa Kim(Dept. Of Genetic Engineering), Se-Young Lee(Dept. of Agricultural Chemistry), Kyu-Man Chee(Dept. of Animal Husbandry), Moon-Il Ryu(Dept. of Agrobiology), Kwon-Woo Park(Dept. of Horticulture), Jeong-Sup Shin(Dept. of Food Resources), Seung-Gil Hong(Physiology Lab, School of Medicine), Seok-In Hong(Dept. of Chemical Engineering), Ji-Yun Yu(Dept. of Electric Engineering), Hun Hur(Dept. of Control and Instrumentation).

Participants from other universities: Jae Kun Chun(Dept. of Food Technology, seoul National University), Dong-Hwa Shin(Dept. of food Technology, Chonbuk Natioanl University), Jeung Uk Choi(Dept. of Food and Biotechnology, Kyungbuk National University), Ki Young Lee(Dept. of Food and Biotechnology, Hoseo University), Seung Ju Lee(Dept. of food Technology, Dongkuk University), Hyun-Jin Park(Dept. of food Technology, Mokpo University), Bu-Dol Choi(Dept. of Food Technology, Singu College).

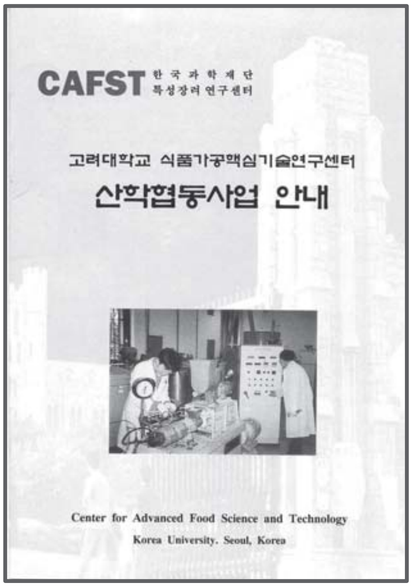
Participants from Research Institutes: Suk Hoo Yoon(Korea Food Research Institute), Ouk Han(Korea Food Research Institute), Nak-Kyung Kim(Miwon Central Research Laboratory), Jin-Young Yu(Korea Fiid Research Institute), Chong-Sei Park(KIST Doping Control Center), Jae-Ku Pan(KIST Genetic Engineering Laboratory).

The first year research projects supported by the center were as follows:

(1) Ecology of stored product pests (Prof. Moon-Il Ryu)
(2) Mass transfer of biopolymer membranes and their application (Prof. Chan-Hwa Kim)
(3) Effects of plant genetical and physiological regulation on storage of agricultural products (Prof. Jeong-Sup Shin)
(4) Granulation of cereal powders with wet compression and their physical properties (Prof. Seung Ju Lee)
(5) Studies on the developments of mechanical structure of food extruder and its applications (Prof. Seung-Taik Lim)
(6) Enzymic hydrolysis of food proteins and the taste (Prof. Sang-Yoon Choi)

The center supported overseas visit and research paper presentation of the participating professors, and the first year recipients were Prof. Seung Taik Lim (AACC Starch Round Table in USA), Prof. Sang-Yoon Choi (International Conference on Food Factors in Japan), Prof. Hyo-IL Chang (University of Washington, Seattle, USA) and Prof. Cherl-Ho Lee (UNIDO Headquarter, Vienna, Austria). Dr. Virginia Campbell of UNIDO visited the center in November 1995 to discuss about the establishment of International Food Fermentation Network.

The center activated the industry membership program. By paying certain amount of membership fee(1 million won per year), the member companies could received technical advise from and conduct collaborative research with the professors of the center. The companies involved were Haema Food Company, Crown Confectionary Co., Edong Maggolli Co., Miwon Co., Taekyung Nongsan Co. and Oyang Fishery Co. The picture shows the front page of a guide book introducing CAFST Industry Membership Program.



In the 2nd year the center generated several research projects which were supported by national and industry research funds.

(1) Insect control technology in dried foods(30 million Won from the Ministry of Health and Welfare)
(2) Benefit assessment and hazardous component analysis of health foods and their ingredients(30 million Won from the Ministry of Agriculture, Forestry and Fisheries)
(3) Noodle processing technology by using food extruder(3.5 million Won from U.S. Wheat Association)
(4) Novel food processing technologies using high pressure and ohmic heating(15 million Won from the Ministry of Health and Welfare)
(5) Controlled release system of food and physiologically active substances(20 million Won from Boryung Pharmaceutical Co.)
(6) Improving the keeping quality of traditional alcoholic beverages(22.4 million Won from G-7 Project of Korea Science and Engineering Foundation)
(7) A biotechnological study for the production and quality improvement of food protein hydrolysate(44million Won from Korea Science and Engineering Foundation)
(8) Chemical factors influencing the quality of Korean wheat(30 million Won from Korea Science and Engineering Foundation)

The center organized invited lectures, seminars and workshops related to the research projects performed.

(1) International workshop on Novel food processing technology using biotechnology, June 20, 1996, sponsored by UNIDO, Vienna, Invited lecturer - Dr. George Tzotzos, UNIDO.
(2) Special course on Therapeutic foods of Traditional Chinese Medicine, September - October, 1996, Invited lecturer - Prof. Dang Yi, Beijing TCM University, China.
(3) Third CAFST International Symposium on Granular and Molecular Structure of Starch, March 26-27, 1997, sponsored by Aveve/Handuk Ltd and US Feed Grain Council.
(4) International Workshop on Food and Biotechnology Transfer, April 9-28, 2001, sponsored by Korea International Cooperation Agency(KOICA)

The center was approved to a research institute of Korea University in 1999. The second Director was Prof. Seung Taik Lim and the third Prof. Hyun-Jin Park, who changed the center name to Research Center for Health and Functional Foods in 2003.

Research Societies

- Korea Food Extrusion Research Society
- Research Society for Korean Traditional Food Industrialization
- Korea Food Security Research Foundation

Korea Food Extrusion Research Society

Professor Cherl-Ho Lee founded Korea Food Extrusion Research Society in 1985. The purpose of the society was to enhance information exchange the knowledge and training food industry people on food extrusion technology and to activate the research network among universities and research institutes within the country and also of overseas. The society organized a study trip to Japan in 1987 and visited National Food Research Institute of Japan in Tsukuba and other industry research groups in Japan by the help of Dr. Akinori Nokuchi. Since then close cooperative research and training works were undertaken with Japanese research group headed by Dr. Akinori Noguchi.

The society established a Food Extrusion Technology Library at Prof. Lee's laboratory in Korea University which was open to industry people, and published a Newsletter periodically. In the founding address on the first issue of the Newsletter Prof. Lee stressed the urgent need of information on food extruders in order to select suitable extruder for Korean food manufacturers and education of the industry people the fundamental theory of extruder operation including food materials rheology and flow behavior in the machine.

The society opened one-week training course at Korea University in June 1986. Prof. Cherl-Ho Lee's laboratory constructed a pilot-plant scale single screw extruder(d=8cm, sectioned heating barrel, screw speed adjustable, feed speed adjustable, screw type changeable) by the endeavor of Dr. Jae-Gak Lim, a graduate student at that time, and used the machine at the course for practical learning of extruder operation. The summer course continued for 6 years, and then changed to Society Annual Meeting Symposium/Workshop until 1999. The last Newsletter number 46 was published in December 1999 when the 2nd term President Kwan-Hei Park, President of Daesun Flour Milling Co., turned over the leadership to Dr. Chul-Jin Kim of National Food Research Institute.

Two books were published for the summer course and several proceedings were prepared for the workshops and symposia taken placed during the 15 years of the society activity.

A photo taken at the study trip to Japan in July 19-26, 1987.

◐ List of books and proceedings published

- Food Extrusion Technology, Authored by Cherl-Ho Lee, Dong Chul Kim, Je-Hyen Chon, Chul Jin Kim, Jong-Bae Kim, Jae-Deuk Kim and Jung-Chon Son, Yulim Moonhwasa, Seoul, 1987, 11 chapters, 248 pages (in Korean)
- Food Extrusion Technology II, Authored by Korea Food Extrusion Research Society (Cherl-Ho Lee), Yulim Moonhwasa, Seoul, 1988, 14 chapters, 309 pages (in Korean)
- Proceedings of Seoul International Food Extrusion Workshop '90, Korea Exhibition Center, April 23-25, 1990 (President Cherl-Ho Lee)
- Proceedings of The First Korea-Japan Food Extrusion Research Symposium, Olympic Center, Seoul, October 15, 1990. (President Cherl-Ho Lee)
- Textbook for '91 Summer Course for Food Extrusion Technology, Science Library, July 2-5, 1991. (President Kwan-Hei Park)
- Proceedings of Korea Food Extrusion Research Society Workshop on The Problems and Provisions of Korean Food Extrusion Technology, Korea University, November 23, 1991. (President Kwan-Hei Park)
- Proceedings of '92 Korea Food Extrusion Research Society Workshop on Studies of Wheat Food Extrusion and Flour Quality, Science Library, Korea University, October 27, 1992. (President Kwan-Hei Park)
- Proceedings of '93 Food Extrusion Technology Workshop on Food Rheology and Extrusion Cooking Technology, June 6-11, 1993. (President Kwan-Hei Park)
- Proceedings of '95 Food Extrusion Technology Workshop, Inchon Memorial Hall, Korea University, June 121-24, 1995, (President Kwan-Hei Park)
- Abstract Book for the 11th Annual Meeting and Symposium of The Korea Food Extrusion Research Society, College of Natural Resources, Korea University, November 29, 1995. (President Kwan-Hei Park)
- Proceedings of '96 Korea Food Extrusion Research Society Workshop on Extrusion Technology for Noodle Processing, Inchon Memorial Hall, Korea University, August 21-22, 1996, (President Kwan-Hei Park)
- Proceedings of '97 Korea Food Extrusion Research Society Workshop on Extrusion Technology for Biscuit Manufacturing, Engineering School Auditorium, August 29, 1997. (President Kwan-Hei Park)

◐ Proceedings of Seoul International Food Extrusion Workshop '90

- Preface

Extrusion-cooking technology has been developed significantly during the last two decades. The artisanal single-screw extruder operations are largely replaced by the automatically controlled twin-screw extrusion cooker and more applications are under exploration ranging from novel food processing to bioreactor. The technology is considered to be playing the key role in the future food industries.

The history of the use of food extruder in Korea is not so old, but we have experienced a considerable trial and errors. Some of our food companies once thought that extruder was a trouble maker causing serious economical loss to the company. The food companies blamed the extruder manufacturers as unreliable and irresponsible.

The Korea Society of Food Extrusion Research was established in 1985 in order to correct these misunderstandings and to educate Korean food technologists more fundamental aspects of extrusion-cooking technology. The society conducted biannual summer course on food extrusion technology and published two books on this subject in Korean. The Society also arranged study tour to Japan visiting several extruder manufacturers in that country. The Society has published a quarterly news-letter to share the newest informations and research results in this field. Through these activities the Society has attempted to strengthen the fundamental knowledge of the members and the ability to select proper machines and operational conditions for their respective purposes.

This workshop is held as a branch of the activities of the Society to expand the knowledge of our members by exposing ourselves to the most up-to-date technological developments in this field. I would like to use this opportunity to express my sincere thanks to all the distinguished lecturers, Professor Jozef Kokini, Professor Pekka Linko, Dr. Akinori Noguchi, Dr. Shi-Sup Chung, Dr. Chul-Jin Kim, Dr. Jae-kag Lim and all the representatives from the food extruder manufacturers for their cooperation and support to this workshop. I also express my sincere thanks to Prof. Si-Myung Byun, Prof. Kew Mahn Chee, Prof. Young-Chun Lee, Prof. Sun-Kon Kim and Mr. Kwan-Hei Park for their chairmanship and enthusiasm for the workshop. This workshop is sponsored by the participating extruder manufacturers and the leading food and feed companies in Korea, and I express sincere thanks for their financial support. The Korean Society of Food Science and Technology, Korean Society of Rheology and Korea Trade Promotion Corporation are the cooperating organizations for this workshop, and on behalf of the members of the Society, I express sincere thanks for their cooperation.

April 23, 1990
Professor Cherl-Ho Lee
President, Korea Society of Food Extrusion Research

◐ Proceedings of The First Korea-Japan Food Extrusion Research Symposium

‣ Preface

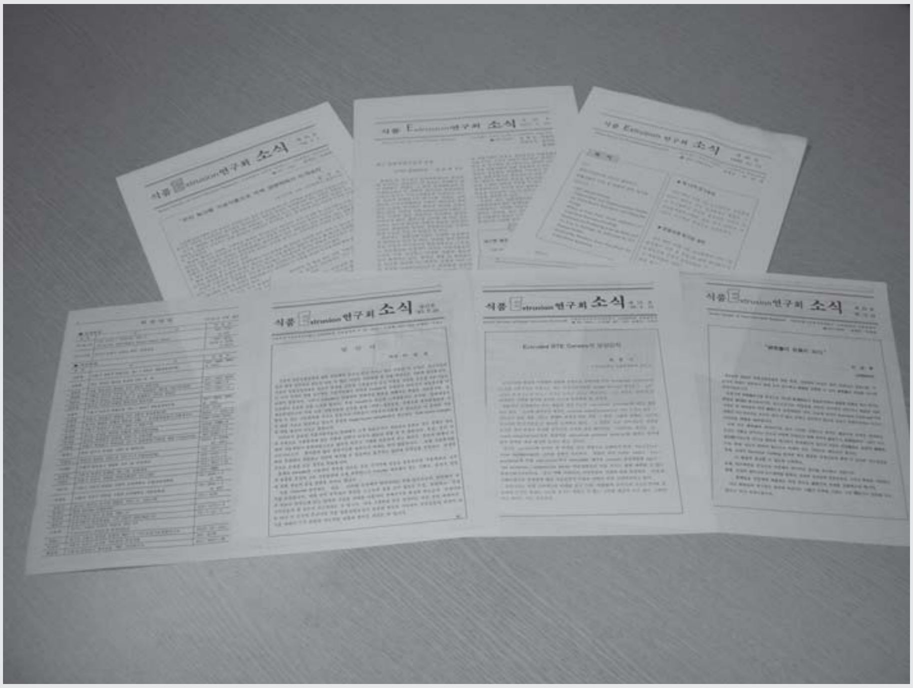
The cooperative relationship between the scientists of Korea and Japan in the field of food extrusion research has been continued for many years. In July 1987, a group of 14 people from the Korea Society of Food Extrusion Research took a study tour to Japan and visited five food extruder makers and the food extrusion research groups of Kyoto University and the National Food Research Institute of Japan. This tour was made possible by the arrangement of Dr. Akinori Noguch of NFRI, Japan. In November 1987, seven members of the Korea Society attended the Symposium of the Association of R&D on Extrusion-Cooking in Japan held in Tokyo. The Japanese scientists have also participated actively to the international workshops on extrusion technology held in Seoul in 1988 and 1990.

Today, we are very glad to have the members of the Japanese Association of R&D on Extrusion-Cooking here in Seoul. It will be a good opportunity for us to exchange the knowledge on this rapidly growing field of food technology and to get acquainted each other for the future cooperation. On behalf of the Korea Society of Food Extrusion Research, I welcome you all the participants from Japan, and hope to have nice experience and memory on your study tour in Korea.

I would like to express my sincere thanks to Dr. Akinori Noguchi for taking all the trouble in the arrangement of this symposium, and to the distinguished lecturers of this symposium for their cooperation. This symposium is sponsored by the Association of R&D on Extrusion-Cooking in Japan, the U.S. Wheat Association and Dae-Sun Flour Milling Co., Ltd., and I take this opportunity to express my sincere thanks for their support.

October 15, 1990
Cherl-Ho Lee
President, The Korea Society of Food Extrusion Research

Proceedings prepared for workshops and symposia organized by
Korea Food Extrusion Research Society



Newsletters(No.1 - No.46) published by the Korea Food Extrusion Research Society

Research Society for Korean Traditional Food Industrialization

Professor Cherl-Ho Lee founded Research Society for Korean Traditional Food Industrialization in September 1998. The objectives of the society were to stimulate the research activities in the universities and research institutes on traditional foods and to activate the collaborative works between academia and food industry people especially in traditional food manufacturing business. With the nation-wide interests and participation 260 members were assigned respectively into 13 research committees; Korean cooky, Rice cake, non-alcoholic beverage, Kimchi and pickle, soysauce and paste, soymilk and curd product, fermented fish product, Noodle, Rice and side-dish, seasonings and extracts, fat and oils, and health food. The first society symposium, Industrialization of Traditional Foods - What is the problem?, was held at Korea University Science Library in November 14, 1998. Traditional Food Industrialization Awards were given to Ms. Young-Hei Lee, President of Design House Co., and Mr. Young-Ho Bae, Director of Baesangmyon Traditional Wine Museum in November 1998. The research society Newsletter was published periodically, and industry site visits were made twice a year. The food hygiene and presevation technology winter courses were open for the small scale food manufacturers at Korea University two times in 1999 and 2000. The Newsletter was published up to number 8 in 2002, until the society leadership was turned over to Professor Dong-Hwa Shin of Chonbuk National University.

A site-visit to Sunchang Kochujang Village(December 12, 2000).

1998년 9월 14일 월요일 제97호 〈주간〉 식품음료신문

"전통식품 세계화 앞장"

'전통식품산업화연구회'발족 초대회장 이철호교수 선임

이철호 회장

전통식품 산업화기술의 발전을 위한 산학연관 협동체제의 「한국전통식품산업화연구회」가 지난 5일 공식 발족됐다.

고려대 생명공학원 식품가공핵심기술연구센터(CAFST)는 지난 5일 오후 고려대 인촌기념관 제1회의실에서 전통식품산업화연구회 창립총회를 열고 초대회장에 이철호 고려대 생명공학원 교수를 선임했다.

학계 업계는 물론 관련 연구기관 정부관계자등 50여명의 발기인이 참석한 가운데 열린 이날 총회에선 연구회의 향후활동방향, 회원의 자격등을 골자로한 회칙을 제정, 승인하는 한편 회원상호간 연구협력과 친목을 통해 우리 전통식품의 세계화에 매진할 것을 다짐했다.

초대회장으로 선출된 이철호교수는 인사말을 통해 『전국적으로 6만여개의 전통식품 제조, 가공업소가 있으나 수공업단계를 벗어나지 못하는 영세업체가 대부분을 차지하고 있다』며 『산업현장에서 필요로 하는 기술을 학계와 연구소가 적극 찾아 도와주는 조직으로서 체계적이고 전국적인 산학협동사업을 전개해나갈 방침』이라고 포부를 밝혔다.

이를위해 연구회는 가족단위의 영세 식품가공업체에 이르기까지 산업현장의 기술수준과 경험 및 문제점을 파악 데이터베이스를 구축하고 분야별 문제해결을 위한 연구와 자문을 병행해나갈 계획이라고 이회장은 덧붙였다.

A newspaper announced the establishment of the Research Society for Korean Traditional Food Industrialization

Nwesletters and teaching materials published by the Research Society for Korean Traditional Food Industrialization

Korea Food Security Research Foundation

Professor Cherl-Ho Lee established Korea Food Security Research Foundation in April, 2010. The purpose of the foundation was to announce to the people the severity of the low food self-sufficiency of the country and to find proper provisions and policies for achieving stable food supply system. The importance of food industry in food supply chain was emphasized and the foundation was formed mainly by the food industry support and registered as a juridical foundation under the Ministry of Food, Agriculture, Forestry and Fisheries. The promoters meeting elected Professor Cherl-Ho Lee to the Chairman of the Board of Trustees, and six members of BOT; Mr. Jin-Soo Kim, President of CJ Jeiljedang Co., Mr. Ryang Kim of Samyangsa, Mr. Kwan-Hwa Park, President of Daesun Flour Milling Co., Sung-Chil Park, President of Daesang Co., Mr. Snag-Yoon Lee, President of Nongshim Co., and Mr. Sun-Ho Lee, President of Samyang Food Co. Four advisors were eleclted; Dr. Tai-Wan Kwon, Emeritus professor of Inje university, Mr. Hak-Yong Kim, Member of Parliament, Dr. Hyun-Ku Rhee, Presidential Adviser for Science and Technology, and Mr. Jung-Yun Chun, Chairman of Samyang Food Company. Dr. Hun-Pal Moon and Prof. Han-Jun Hwang were elected to the auditors. The office is located in Korea University and managed by Prof. Young-Sik Park as the director of the foundation. The foundation supports the research activities of young scholars in the fields of agriculture and fisheries, food science and technology and food economy and policy. It will also stimulate and support the publication of books and research papers related to the food safety and food security.

Members participated to the Promotion Meeting in April 27, 2010

2010년 5월 3일 월요일, 식품음료신문

'식량안보연구재단' 출범

식품산업 식량안보 기능 강화·정책지원 방안 도출

초대 이사장에 이철호 교수

식량 공급의 주체로 부상하고 있는 식품 산업의 식량 안보적 기능을 강화하고 국민적 이해와 정책적 지원 방안을 도출하기 위한 '식량안보연구재단'이 출범했다.

한국식량안보연구재단은 지난달 27일 서울 밀레니엄 힐튼호텔 3층 토파즈룸에서 재단 창립 발기인 총회를 열고 초대 이사장에 고려대 이철호 교수를 선출했다고 밝혔다.

이철호 교수가 기부 출연한 사재 1억 원을 기본 자산으로 출발해 독지가들의 후원금으로 운영될 재단은 관련 학계와 식품 산업이 중심이 되는 민간 연구 단체, 식품 유통과 안전, 국민 영양 및 식생활 전체를 아우르는 종합적인 식량안보정책 수립을 위한 연구 활동을 벌일 예정이다.

재단은 출범 원년인 올해 △연구지원 사업 △저술 및 번역 지원 사업 △토론회 및 포럼 개최를 계획하고 있다. 특히 '우리나라 식량자급률 제고를 위한 방안과 정책개발 연구' '식품 산업의 식량 안보적 기능과 정체성 확립에 관한 연구' '기후 변화에 의한 세계 식량 사정의 변화 예측과 한국의 대응 전략 연구' 사업을 추진할 계획이다.

이 날 총회에서는 이사로 김진수 CJ제일제당 사장, 김 량 삼양사 사장, 박관회 대선제분 사장, 박성칠 대상 사장, 이상윤 농심 부회장, 이선호 삼양식품 사장이 선출됐으며 권태완 인제대 명예교수, 이현구 대통령과학기술특보, 전중윤 삼양식품 명예회장, 김학용 국회 농수산식품위원이 고문으로 추대됐다.

감사에는 문현팔 과학기술한림원 식량안보과학특별위원장과 황한준 고려대 교수가 피선됐다. 재단 사무국장은 박영식 고려대 연구교수가 맡게 된다.

한편 이날 총회에는 이현구 대통령과학기술특보, 박현출 농식품부 식품산업정책실장, 김학용 국회농수산위원, 전은숙 식약청 식품안전국장, 박관회 대선제분 사장, 이선호 삼양식품 사장, 이상윤 농심 부사장, 김 량 삼양사 사장, 김창민 CJ제일제당 상무, 김영민 대상 상무, 권태완 인제대 명예교수, 김석동 　 콩세계과학관건립추진위원장, 문현팔 한림원식량안보과학위원장, 정 승 농림수산식품기술기획평가원장, 경규항 ILSI Korea회장, 임재각 한국산업기술대학교수, 황한준 고려대 교수, 박현진 고려대 교수, 김영태 법무사, 홍현찬 서울셀렉션, 박영식 고려대 연구교수, 이철호 고려대 교수 등이 참석했다.

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A newspaper announced the launching of Korea Food Security Research Foundation

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Research Paper Abstracts

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- NMR Application in Food Science
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Fermentation Technology

Studies on the amino acid composition of Korean fermented soybean Meju products and the evaluation of the protein quality

Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 5, No. 4, 210-214. (1973)

This study analyses and compares the amino acid composition and available lysine content between Korean fermented soybean Meju and its products as well as home-made and commercially made products. The protein quality of the products was evaluated by the results, and the biological value of the proteins was estimated by using the regression equation for chemical score to biological value as calculated by B.O. Eggum. The amino-N content of soybean is found to be 85% of the total nitrogen content and is reduced to approximately 75% in the fermented products except home-made soysauce, where as the content of ammonia-N and other N-compounds is increased. The difference in protein quality between home-made and commercially made products is not found to be significant. The protein quality of soybean is not damaged greatly in the making of Meju but is seriously damaged during the long periods of ripening. After the ripening the chemical score of the product's protein is reduced to approximately one half of the original soybean protein and the available lysin content to 1/3 - 1/2.

The effect of Korean soysauce and soypaste making on soybean protein quality. Part I, Chemical changes during Meju making

Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 8, No. 1, 12-18. (1976)

Fermented soybean Mejus were prepared in the laboratory with varying lengths of fermentation and the changes in the chemical composition during the Meju making were determined. The moisture of cooked soybean was gradually evaporated during the Meju fermentation, and after 2 months of fermentation the water level reached to the level of the raw soybean. The concentration of crude fat, crude protein and ash of the dry matter of soybean did not change considerably during soaking, cooking and Meju fermentation of up to 3 months, whereas carbohydrates decreased significantly during soaking and Meju fermentation. The percentage retention of the nutrients were 58% for carbohydrates and 93% for crude fat and crude protein. The nitrogen solubility of soybean decreased drastically during cooking, from 79% to 21%, while Meju fermentation increased it to approximately 30% in the first week and this level remained constant for the duration of the fermentation. The concentration of free amino nitrogen in total nitrogen of soybean decreased during cooking, from 7% to 3% but fermentation of Meju liberated it to the level of raw soybean. The concentration of free amino-nitrogen in the total-N of soybean was increased by cooking and further increased during Meju fermentation. The amino acid pattern of soybean did not change significantly during soaking, cooking and the Meju fermentation.

The effect of Korean soysauce and soypaste making on soybean protein quality. Part II, Chemical changes during Meju-brine ripening

Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 8, No. 1, 19-32. (1976)

The laboratory Mejus as well as home-made Meju and improved Meju from Korea were ripened in the brine for up to 8 months and the changes in the chemical composition during the process were determined and the differences between the types of Meju were compared. On the basis of the amino acid pattern, the changes in the protein quality of soybean during the process was evaluated. No significant changes in the general chemical composition of Meju were noticed during the ripening for 8 months. However, the nitrogen solubility of Meju increased from 13-29% to 66-78% during 8 month ripening of the Meju-brine mixture. The concentration of free amino-N to the total-N increased from 4-7% in Meju to 5-14% in the 8 month ripened mixture and the changes varied with the type of Meju used. Remarkable changes in the amino acid pattern of soybean were occurred during the ripening of Meju.

The effect of Korean soysauce and soypaste making on soybean protein quality. Part III, Changes in the lysine availability

Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 8, No. 2, 63-69. (1976)

The changes in lysine availability during soybean fermentation were determined by the chemical analysis method as well as the biological methods with rat. The FDNB-reactive lysine determined by the difference (TLMI) method indicated that cooking and Meju fermentation reduced the lysine availability of soybean, but the subsequent ripening restored the availability to the same level of the raw soybean. On the other hand, the biological value, NPU, NER and the relative lysine availability of the rat experiments showed a general decrease in the lysine availability of soybean during the ripening process as well as Meju fermentation.

The Effect of Korean Soysauce and Soypaste Making on Soybean Protein Quality Part IV. Protein Supplementary Effect of Soybean Products to the Rice Diet

Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 8, No. 3, 121-128. (1976)

Cooked soybean, soybean curd, soymilk residue and fermented soybean Meju products were prepared in the laboratory and the protein supplementary effect of these food to the rice diet was determined by the rat feeding experiments. The soybean products providing 20% of the dietary protein were added to steamed rice and the protein digestibility (TD), Biological value (BV), NPU, PER, and Partial Carcass Nitrogen Value of the diets were measured. The protein supplementary effect of soybean products indicated that the non-fermented products generally improved the protein quality of the rice diet, whereas the fermented products did not but reduced it in some cases. There was observed a possible antinutritional effect for the diet supplemented with Home-made Meju. This growth retarding effect of Home-made Meju disappeared during the subsequent ripening in the brine for 6 months.

Changes in the Chemical Compostion and Flavor of Yeast Extracts during the Autolysis of Baker's Yeast

Cherl-Ho Lee, Chang-Real Park and Kyeoung-Sik Chung

Korean J. Food Sci. Technol., Vol. 13, No. 3, 181-187. (1981)

The changes in the chemical composition of yeast extracts during autolysis and their effect to the sensory quality were studied with baker's yeast, Saccharomyces cerevisiae. The amounts of extracted solids, proteins, amino-N, amino acids, especially glutamic acid, alanine and lysine, increased by the autolysis time up to 48 hrs. The results of sensory evaluation made by the multiple paired comparison test and Duncan's test indicated a significant difference in taste by the time of autolysis. In the profile test, the flavor character notes expressed by the panel were 17 different characters, 11 in aroma and 6 in taste. The character notes and the intensity of flavor changed with the time of autolysis. The sharp and beany flavor of the extracts which was autolyzed for 4 hours turned into meaty and worty flavor by 48 hours of autolysis. A proper arrangement of the flavor characters in the quantitative descriptive chart could provide a weighted value of the flavor grade. The aroma grade index and the taste grade index correlated to the amplitudes of the profile test.

Studies on the Nomenclature of Korean Fermented Food

Tae-Ick Mheen, Tai-Wan Kwon and Cherl-Ho Lee

Korean J. Appl. Microbiol. Bioeng., Vol. 9, No. 4, 237-240. (1981)

A nomenclature method for Korean fermented foods was developed in order to apply this to the international nomenclature system for fermented foods. It is made by a four digit number; the first digit indicates the major ingredient used, the second for fermentation method, the third for major type of microorganism, and the last digit for the type of consumption. Following the nomenclature number, a detailed description of product is given. Examples of application of the nomenclature system to Korean fermented foods are shown.

Traditional fermented food products in Korea

Tae-Ick Mheen, Tai-Wan Kwon and Cherl-Ho Lee

Korean J. Appl. Microbiol. Bioeng., Vol. 9, No. 4, 253-261. (1981)

Fermented foods available in Korea may be classified into four groups, fermented soybean products, fermented cereal products, fermented vegetable products, and fermented fishery products based on raw materials used. The representative fermented foods based on soybean are Kanjang(soysauce), Doenjang(fermented soybean pastes), and Kochujang(red pepper added fermented soybean paste). Such fermented products are made using Meju(functioning as a starter and prepared by fermentation of steamed soybean mash) as an essential ingredient, and used widely as a soup base and/or in seasoning side-dishes for everyday meals year around. Excepting Sikhae, all fermented products based on rice and other cereal grains are of alcoholic nature. Takju(Makgeolli) used to be made using rice as the major raw material. however, mainly due to the shortage of rice in recent years, other cereals, such as, barely, corn, and wheat flours are also used to replace rice today. Owing to such changes in the raw materials, the popularity of Takju has been somewhat reduced, yet it is still widely consumed in rural areas. Although Chungju is a popular rice wine with superior quality over Takju, the amount consumed is considerably limited. The highest quality rice wine, Bupju, in particular, is made by a low temperature fermentation using glutinous rice. Kimchi is an unique fermented vegetable product of long tradition in Korea. Although it was for consumption mainly in winter season serving as a source of vitamins, today it is widely used throughout the year. Except Kkakdugi and Dongchimi, all of the fermented vegetable products contain salted Korean cabbage as an essential item, while they abound in varieties depending on material composition and methods of processing, and also on seasons and localities. Next to Kimchi in this category is Kkakdugi made of raddish in popularity and quantity consumed.

Studies on the Fermentation of Lupinseed (Part I) Determination of the Growth Rate of *Aspergillus oryzae* on Beans

Cherl-Ho Lee, Sung-Hoon Oh and Chan-Shick Kim

Korean J. Appl. Microbiol. Bioeng., Vol. 10, No. 3, 227-232. (1982)

The methods determining the growth rate of mold on beans were investigated in order to compare the growth of *Aspergillus oryzae* on lupinseed to that on soybean. The growth of *A. oryzae* on cooked whole or paste form of bean substrates was evaluated by the measurements of colony diameter and hyphae length of the mold. The mold showed characteristic lag times to form the colony on different types of substrate. The growth of colony diameter was coincided with the increase in α-amino nitrogen content of the substrate when the moisture level of the substrates was similar each other. The colony diameter and the cultivation time after the lag period showed a straight line relationship, from which the growth rate was estimated. In general, lupinseed paste allowed faster growth of *A. oryzae* than soybean paste at the initial growth phase. The lag time to form the colony was 24.0 hrs on lupinseed paste and 44.4 hrs on soybean paste. The growth rate after colony formation was, however, 7.05 mm/day for lupinseed paste and 8.83 mm/day for soybean paste, which indicated that the growth rate after the lag period was faster on soybean compared to lupinseed. The sporulation time of the mold was related to the lag time for the colony formation. The measurement of hyphae length on whole beans could be used as a simple and rapid method of estimating the growth property of mold on different substrates. It showed that the growth of *A. oryzae* was partly hindered by the thick hull of the lupinseed.

Studies on the Sik-hae Fermentation Made by Flat-fish

Cherl-Ho Lee, Tae-Sook Cho, Moo-Hyun Lim, Ju-Whoi Kang and Han-Chul Yang.

Korean J. Appl. Microbiol. Bioeng., Vol. 11, No. 1, 53-58. (1983)

Sik-hae is a traditional Korean fermented fish product which is made from flat-fish, garlic, salt, red pepper and millet. The changes in chemical composition, pH, acidity and the contents of Amino-N, VBN, TMA and organic acids were investigated during the fermentation of Sik-hae. The changes in the microflora, enzyme activity and the sensory quality including textural characteristics were also evaluated. The changes in the content of crude protein, crude fat and moisture during Sik-hae fermentation were negligible. The pH of the product tended to decrease in the course of fermentation and it showed the minimum value of 4.5 after 7 days of fermentation. On the other hand the acidity continued to increase up to 2300mg% by 4 weeks of fermentation. Lactic acid was the major organic acid. The content of Amino-N in Sik-hae gradually increased up to 673.6mg% by 2 weeks of fermentation, while little changes in TMA content was observed. The number of proteolytic bacteria increased slightly for the first 2 weeks and then rapidly decreased. The number of yeast and acid forming bacteria increased rapidly from the 4th day to the 14th day fermentation and then decreased. Both lipase and protease activities showed the maximum at the 11th day of fermentation. The texture softening of the fish occurred after 1 week of fermentation and the adhesiveness appeared after 2 weeks of fermentation. Summarizing these results, the optimum fermentation time for Sik-hae from flat fish were 2 weeks at 20℃ and the quality of the product could be kept for up to 4 weeks in refrigerator.

Studies on the Fermentation of Lupin Seed (Part II) Preparation of traditional Korean fermented been sauce and paste

Sung-Hoon Oh and Cherl-Ho Lee

Korean J. Appl. Microbiol. Bioeng., Vol. 11, No. 3, 241-248. (1983)

Lupin seed was used to make Meju, the fermentaion starter for Korean soybean sauce and paste in substitution for soybean and the fermentation characteristics were compared with those of soybean. Mejus were prepared by inoculation of *Asp. oryzae* on the cooked whole beans. The dried Mejus were used for making fermented bean sauce and paste by mixing with brine and subsequent ripening for 4 weeks. In general the protease activity and amylase activity during ripening were higher in lupin seed Meju than those of soybean Meju. The increase in protease activity correlated to the increase in α-amino nitrogen content of the fermented paste and sauce. The development of dark-brown color of the sauce during ripening was faster with lupin seed Meju compared to soybean Meju. In sensory evaluation the flavor score of lupin seed sauce and paste was slightly lower than that of soybean products but the overall quality of fermented lupin seed sauce was acceptable.

Lactic Acid Fermentation of Lupinseed Milk

Ouk-Han, Won-Taik Tae, Young-Wook Kim, Joon-Kyoung Lee and Cherl-Ho Lee

Korean J. Appl. Microbiol. Bioeng., Vol. 13, No. 3, 191-198. (1985)

Seven different strains of lactic bacteria and 13 combinations of these microorganisms were tested for their acid forming capacity on a vegetable milk made from lupinseed protein concentrate (LPC). *L. acidophilus*, *L. casei*, *S. lactis*, *L. mesenteroides*, mixed culture of *L. acldophilus* and *S. thermophilus*, and mixed culture of *S. lactis* and *L. mesenteroides* were selected and further tested for their growth pattern and acid forming property on lupinseed milk both untreated and partly hydrolized one with carbohydrate decomposing enzymes. The enzyme hydrolized lupinseed milk had 1.5 folds of total free sugar; 8.2 folds of fructose, 3 folds glucose, 2.3 folds maltose, compared to the untreated lupinseed milk. For the untreated lupinseed milk, *L. mesenteroides* was appeared to be most suitable microorganism having the maximum cell concentration of 1.0 x 1.0^9/ml and the final pH 4.40 with the acidity 0.46%. For the enzyme treated lupinseed milk, mixed culture of *L. acidophilus* and *S. thermophilus* showed the best performance having 1.9×10^9/ml maximum cell number and the final pH and acidity were 3.69 and 1.13% respectively. Lactic acid fermentation altered the physical property of lupinseed milk, by fermentation the viscosity generally increased with untreated lupinseed

mlik, but decreased with enzyme hydrolized one. The viscosity change and sedimentation rate of fermented milk varied with the type of lactic bacteria. The results of sensory evaluation indicated that *S. lactis*, *L. casei*, mixed culture of *S. lactis* and *L. mesenteroides*, and mixed culture of *L. acidophilus* and *S. thermophilus*, grown on enzyme hydrolized lupinseed milk, could produce acceptable lactic acid beverage.

Characteristics of Korean Fish Fermentation Technology

Cherl-Ho Lee, Eung-Ho Lee, Moo-Hyun Lim, Soo-Hyun Kim, Soo-Kyu Chae, Keun-Woo Lee and Kyung-Hee Koh

Korean J. Dietary Culture, Vol. 1, No. 3, 267-378. (1986)

The evolution of Korean fish fermentation technology was reviewed from the old literatures and the on-going processes were surveyed. The principles involved in the traditional fermentation methods were explained by the recent scientific findings. The fish fermentation technology can be classified into two groups; jeot-kal process, where salt is the only material added to the fish for fermentation, and sik-hae process, where cooked cereals, garlic and red pepper powder are added to the salted fish. A total of 46 kinds of jeot-kal was identified in a survey, depending on the raw materials used. The characteristic feature of Korean jeot-kal process is to produce fermented products which still has original shape after 2-3 months of fermentation to be used for side-dishes of rice meal, as well as fish sauce by keeping these products for longer time (over 6 months) for enzymatic hydrolysis to be used for the sub-ingredient of Kimchi (Korean fermented vegetable food). The taste of jeot-kal was formed by the protein hydrolysates due to the action of salt-tolerant *Pediococcus*, *Bacillus*, *Halobacterium* etc. When the taste of jeot-kal deteriorates, yeasts appear to dominate. In ski-hae fermentation, the safety of preserved fish is kept by the rapid decrease in pH resulting from the acid fermentation of added cereals. The roles of acid forming bacteria and proteolytic bacteria are important. The fermentation is completed in 2 weeks and the excess production of acid during prolonged storage limits the taste acceptability. The fish fermentation technology in Korea stands at important position in Korean food science and technology, since the processes of jeot-kal and soy sauce have same root in the principle of microbial proteolysis and the processes of sik-hae and Kimchi in the microbial acid production principles.

Kimchi; Korean Fermented Vegetable Foods

Cherl-Ho Lee

Korean J. Dietary Culture, Vol. 1, No. 3, 395-492. (1986)

The history of Kimchi fermentation technology in Korea was reviewed from the literatures and the changes in Kimchi making method during the last 200 years were investigated. The factors affecting the quality of Kimchi, especially, taste, nutrition, safety and storage stability were reevaluated from the recent scientific findings on Kimchi fermentation.

Microbial Characterization of Gajami Sik-hae Fermentation

Moussa Souane, Young-Bae Kim and Cherl-Ho Lee

Korean J. Appl. Microbiol. Bioeng. Vol. 15, No. 3, 150-157. (1987)

The microflora of the raw materials and fermented product of Gajami sik-hae and the influence of spices on the microbial growth were studied. *Lactobacillus* and *Leuconostoc* spp. were found to be the dominant microflora of the product fermented at 5℃ or 20℃ in spite of their rareness in the raw materials. The secondary flora were constituted mainly by *Bacillus* spp. Garlic juice were found to inhibit the growth of *Bacillus*, *Micrococcus*, *Pseudomonas* and *Aspergillus* species, while *Lactobacillus* and *Leuconostoc* spp. were not effected by it. The number of total acid producing and proteolytic bacteria decreased when garlic content in the Gajami sik-hae was increased from 2.5% to 5%. The other spices, red pepper and ginger showed no broad and significant antimicrobial activity.

Changes in the Chemical Composition and Textural Properties of Korean Cabbage during Salting

Hee-Seoup Rhee, Cherl-Ho Lee and Gui-Ju Lee

Korean J. Soc. Food Sci., Vol. 3, No. 1, 64-70. (1987)

The effects of salting on the compositional and textural changes of Korean cabbage were studied. The optimum brining conditions were established and the dietary fiber composition, mineral contents and moisture content of raw and salted Korean cabbage were determined. The cutting test of cabbage was made by Rheometer and the brittleness and chewiness were evaluated organoleptically. The optimum condition for brining was at 20% NaCl concentration for 6 hours. ln the compositional changes of Korean cabbage by salting at 20% NaCl solution for one month, the content of hot water soluble pectin (HW-P) increased from 43.6% to 55.9% and that of hexametaphosphate soluble pectin (HM-P) decreased from 35.9% to 29.5%. The contents of cellulose and hemicellulose increased, but that of lignin decreased slightly by salting, showing no significant differences in raw and salted cabbage. The content of Na increased significantly and those of Ca, Mg and K decreased by salting. And also moisture content decreased from 91% to 79%. In the textural changes of Korean cabbage by salting, the maximum cutting force and cutting work increased five times and two and half times respectively. And organoleptic test did show significant increase in chewiness and decrease in brittleness. The maximum cutting force by Rheometer was well correlated with the sensory parameters. The results taken together showed that the changes in textural properties during salting are relevant to the changes in pectic substances, moisture content and mineral contents, but relatively irrelevant to the changes in cellulose, hemicellulose and lignin. And it is considered that the maximum cutting force by cutting test is good means for the expression of texture of Korean cabbage.

Quality Evaluation of Different Types of Salt-fermented Shrimp Product

Young-Taik Kim and Cherl-Ho Lee

Thesis Collection of Agricultures and Forestry, Korea University, Vol. 27, 151-154. (1987)

The differences in chemical composition, physical properties and sensory quality of three different types of salt-fermented shrimp (Yuk-jeot; harvested and prepared in June, Chu-jeot; harvested and prepared in October and Doitaki-jeot) were measured. The contents of total nitrogen, amino-N and non-protein extractive-N (NPE-N) varied widely with the type of product. Glutamic acid, aspartic acid, lysine and proline were the major amino acids of the all types of product tested, Proline, lysine, glutamic acid and leucine were the major soluble amino acid. Yuk-jeot had higher content of soluble amino acids, especially proline, compared to the other two products. The sensory evaluation marked Yuk-jeot the highest values in taste, odor, appearance and overall preference, but gave the lowest scores to Doitaki-jeot. The sensory quality was related to the size of shrimp and hardness of shrimp texture. Higher quality was observed with higher content of total nitrogen and amino-N, and lower content of NPE-N.

Effects of K-Sorbate, Salt-Fermented Fish and $CaCl_2$ Addition on the Texture Changes of Chinese Cabbage During Kimchi Fermentation

In-Ju Hwang, Eu-Jeong Yoon, Seong-Yun Hwang and Cherl-Ho Lee

Korean J. Dietary Culture, Vol. 3, No. 3, 309-317. (1988)

The effects of $CaCl_2$, K-sorbate, and fermented fish sauces and blanching on the texture of Chinese cabbage of Kimchi were evaluated. The addition of salt-fermented shrimp or salt-fermented anchovy accelerated the pH reduction, acidity increase and reducing sugar consumption, but K-sorbate, Ca-chloride and blanching suppressed the ripening process of Kimchi. The latter retarded the softening rate of Chinese cabbage during Kimchi fermentation, as demonstrated by the cutting force, compression force, recovered height and work ratio. The sensory evaluation confirmed the results of instrumental texture measurements. The instrumental measurements, i.e. pH, acidity, cutting thickness, cutting force and compression test parameters, showed close correlation with sensory attributes, i.e. the preferences for taste, appearance and texture, and the level of crispiness, hardness, chewiness and fibrousness. The pH of Kimchi was appeared to be an important quality parameter, which had significant correlations with the taste, appearance, chewiness, hardness, fibrousness and crispiness.

Fish Fermentation Technology

Cherl-Ho Lee

Korean J. Appl. Microbiol. Bioeng., Vol. 17, No. 6, 645-654. (1989)

The historical background of fish fermentation in Asia and other regions of the world is reviewed. The classification of fermented fish products in different regions is attempted with respect to the technology involved. The fermented fish products are largely divided into three groups; (1) high- salt, (2) low-salt, and (3) non-salt fermented. High-salt fermented products contain over 20% of salt and are represented by fish sauce, cured fish and fish paste. Low-salt fermented products contain 6~18% salt and are subdivided into lactic fermented products with added carbohydrate and acid pickling associated with low temperature. Non-salt fermented products are represented by the solid state bonito fermentation and some alkaline fermentation of flat fishes. The local names of the products in different regions are compared and classified accordingly. The microbial and biochemical changes during fish fermentation are considered in relation to the quality of the products, and their wholesomeness is reviewed.

Sensory Quality Attributes of Takju and Their Changes During Pasteurization

Cherl-Ho Lee, Hyun-Duck Lee, Ji-Yong Kim and Ki-Myung Kim

Korean J. Dietary Culture, Vol. 4, No. 4, 405-410. (1989)

The sensory quality describing terms of Takju were surveyed by questionair and classified according to the sensory characteristics. The effects of thermal treatment for the pasteurization of Takju on the sensory quality were tested and statistically evaluated. The important sensory quality attributes of Takju were white, gray, and yellow for color, acidic and yeasty for smell, sour, astringent, bitter and sweet for taste and gritty, viscous and carbonated for mouthfeel. The organoleptic properties of grayness, yeasty and cooked smell, astringent and bitter taste and thickness increased, while sourness, sweetness, yellowness, grittiness and carbonated feel decreased by the pasteurization treatments, heating 82℃, 93℃ or 135℃ for 9 seconds. These changes coincided with the overall reductions in the preference scores of pasteurized Takju. The degree of sensory quality deterioration appeared to be affected to some extent by the heating temperature.

Selection of Microbial Strains for the Lactic Acid Fermentation of Cereals

Cherl-Ho Lee, Kyung-Chan Min, Moussa Souane and Myung-Jun Chung,

Thesis Collection of Agricultures and Forestry, Korea University, Vol. 30, 130-147 (1990)

The acid and flavor forming properties of *Lactobacillus antarum* and *Leuconostoc mesenteroides* isolated from Sikhae were examined and compared to those of conventional yogurt producing bacteria, *Lactobacillus casei* and *Lactococcus lactis* DRC3. Rice flour was prefermented in solid-state with *Bacillus laevolacticus* and *Saccharomyces cerevisiae* and subjected to extrusion cooking at 120℃. The extrudate was dispersed in water or soymilk and malt digested, and then fermented with lactic acid bacteria at 30℃ for 24hrs. Extrusion-cooking and prefermentation of rice increased the soluble solid and sugar contents before malt digestion. The amount of sugar consumption during lactic fermentation varied with the type of bacteria. *Leuc. mesenteroides* (Sikhae) and *L. plantarum* (Sikhae) grew well on rice or rice+soymilk substrate, but *Lc. lactis* grew poor on the same substrates. The final pH of the cereal lactic beverage was in the range of 3.4~4.1, *Leuc. mesenteroides* (Sikhae) had higher pH compared to other lactic acid bacteria. *Leuc. mesenteroides* (Sikhae) produced apple juice-like flavor, while *L. plantarum*, *L. casei* and *Lc. lactis* yielded objectional off-flavor. The HPLC analysis showed that the organic acid composition of the lactic ferment of *Leuc. mesenteroides* (Sikhae) was slightly different from those of the other lactic bacteria.

Studies on the Pasteurization Conditions of Takju

Cherl-Ho Lee, Won-Taek Tae, Gie-Myung Kim and Hyun-Duck Lee

Korean J. Food Sci. Technol., Vol 23, No. 1, 44-51. (1991)

The thermal resistance of the important microorganisms in takju, Korean traditional turbid alcoholic beverage, was measured and optimum heating time and temperature to achieve the commercial pasteurization of these microorganisms were examined. Most of the vegetative bacterial cells in takju were destroyed by heating at over 60℃, except for the spore forming organisms, which did not actively grow in takju after pasteurization. The important microorganisms for the quality deterioration of pasteurized takju were then appeared to be yeast and molds, and their thermal resistances were measured. The thermal resistances of these microorganisms changed greatly depending upon the heating method. The D values of yeast in takju were 3.5 min at 65℃ and 0.46 min at 80℃ in cap-tube, and 7.1 sec at 65℃ and 2.3 sec at 80℃ in a continuous coil heat exchanger. Those of molds were 2.7 min at 65℃ and 0.25 min at 80℃ in cap-tube, and 3 sec at 65℃ and < l sec at 80℃ in the coil heat exchanger. The acidity and pH did not change at 30℃ for two weeks after pasteurization by heating in the coil heat exchanger at 65℃ for 17 sec, but the viscosity increased slightly by the heat treatment. Significant differences in sensory quality, especially the formation of burnt smell and bitterness by heating takju for 12D of yeast at 70, 80 and 85℃, respectively, were observed and this resulted in the significant reduction in overall likeness of pasteurized takju. However, when the heating temperature was fixed to 80℃, the overall likeness of pasteurized takju did not affected significantly by the heating time ranging from 8D to 12D of yeast. It was concluded that the optimum pasteurization condition of takju in a continuous heat exchanger was heating at 80℃ for 23sec(l0D of yeast).

Microbial Characterization of Jangsu

Sun-Young Kim, Moussa Souane, Gie-Eun Kim and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol 23, No. 6, 680-694. (1991)

Jangsu, a Korean ancient non-alcoholic beverage made by lactic acid fermentation of cooked rice, was prepared and the microbial characteristics were investigated. The periodic removal of fermented product and the addition of newly made cooked rice and cold water as new substrate enhanced the growth of lactic acid forming bacteria but supressed the growth of proteolytic bacteria. The Important microorganisms in Jangsu were *Lactobacillus*, *Lactococcus*, *Pediococcus* and *Leuconostoc* species. *Lactococuus*, *thermophilus*, *Lactobacillus*, *coryniformis* and *Leuconostoc mesenterodes* were identified. The isolated strains were cultivated and used as starter culture of Jangsu. Some useful strains were selected which were able to produce acceptable flavor and sufficient amount of acid lowering the pH to near 4.0.

Properties of Dextransucrase from *Leuconostoc mesenteroides* Isolated from Sikhae

Suk-Hyung Rhee and Cherl-Ho Lee

J. Microbiol. Biotechnol., Vol 1, No. 3, 176-181. (1991)

Studies on the optimum conditions for dextran production and the properties of dextransucrase (DS) were performed with *Leuconostoc mesenteroides* from Sikhae and *Leuconostoc mesenterodes* NRRL B-512(F). Dextransucrases were partially purified by Iyophilization of the culture supernatant and subsequent gel chromatography on Bio-Gel A-5(m). The storage stabilities of Sikhae DS and B-512(F) DS were decreased by the addition of dextranase. The optimum conditions for the enzyme stability were pH 5 and below 30℃. The B-512(F) DS lost the activity at pH 4, while Sikhae DS had 30% of the activity at the same pH. The activity of DS was decreased by EDTA, confirming the metalloprotein character of the enzymes, and was restored by the addition of calcium ions. Concanavalin A completely removed the activity of DSs, confirming the glycoprotein character of the enzymes.

Debittering Effect of Lactic Acid Fermentation on the Partial Hydrolysate of Soymilk

Cherl-Ho Lee, Sook-Jong Lee, Moussa Souane and Kyung-Hee Koh

Foods and Biotechnology, Vol 1, No. 1, 40-45. (1992)

The debittering effects of lactic acid bacteria and malt on an enzymatic partial hydrolysate of soymilk were investigated. Enzymic hydrolysis with a neutral protease (Neutrase) could increase the protein solubility of soymilk in acidic pH (4.0) up to 65%, but the level of hydrolysis (DH 5-13) resulted in the production of bitter taste. The bitterness level could be reduced by lowering the E/S ratio and malt digestion. Among the 9 strains of lactic acid bacteria examined, *Leuconostoc mesenteroides* (sikhae), *Lactobacillus plantarum* and *Lactococcus lactis* diacetylactis DRC 3 showed debittering effect. The sensory bitterness of soymilk hydrolysate was slightly reduced by the treatment with malt extract, but it was not enough to reduce the bitterness below the recognition threshold level. Lactic acid fermentation with *Leuconostoc mesenteroides* (sikhae) could reduce the bitterness below the recognition threshold level.

Fermentation of Prefermented and Extruded Rice Flour by the Lactic Acid Bacteria from Sikhae

C.H. Lee, K.C. Min, M. Souane, M.J. Chung, T.E. Mathiasen and J. Adler-Nissen

Food Biotechnology, Vol. 6, No. 3, 239-255 (1992)

The acid- and flavor-forming properties of *Lactobacillus plantarum* and *Leuconostoc mesenteroides* isolated from Sikhae, a Korean traditional lactic acid fermented fish product, were examined and compared to those of *Lactobacillus casei* and *Lactococcus lactis* subsp. diacetylactis DRC3. The effects of prefermentation of rice flour in solid-state with *Bacillus laevolacticus* and *Saccharomyces cerevisiae*, extrusion cooking and addition of soymilk as the substrate of lactic acid fermentation were tested. Extrusion cooking and prefermentation of rice increased the soluble solid and sugar contents before malt digestion. The amount of sugar consumption during lactic fermentation varied with the type of bacteria. *Leuconostoc mesenteroides*(sikhae) and *Lactobacillus plantarum*(sikhae) increased up to 6 times of original cell number by 24 hrs of fermentation in rice + soymilk substrate, but *Lactococcus lactis* decreased in the same substrates. The final pH of the cereal lactic beverage was in the range of 3.4 - 4.1, *L. mesenteroides*(sikhae) had relatively higher pH compared to other lactic acid bacteria. *L. mesenteroides*(sikhae) produced apple juice-like flavor, while *L. plantarum*, *L. casei* and L. lactis yielded objectionable off-flavor. The HPLC analysis shoved that the lactic ferment of *L. mesenteroides*(sikhae) contained relatively small amount of lactic acid and malic acid which was not detected in other microorganisms tested.

Organic Acid Composition and Flavor Characteristics of Lactic Acid Fermented Cereal Beverages

Do-Youn Yl, Gi-Myung Kim, Ki-Yohng Lee and Cherl-Ho Lee

J. Microbiol. Biotechnol., Vol 3, No. 2, 129-133. (1993)

The effect of different compositions of organic acids on the flavor profile of 10% sugar solution was investigated by the response surface methodology, and the results were used to evaluate the flavor characteristics of lactic acid fermented cereal beverages. A mixture of extruded rice flour (10%) and soymilk (7.8% dry matter) was fermented with *Leuconostoc mesenteroides* (Sikhae). Depending on the substrate pretreatments, for example, the malt or amylase digestion and the proteolytic enzyme hydrolysis, the sugar and organic acid composition of the product varied. The organic acid composition of the fermented beverages was in the ranges of 0.44-0.55% lactic acid, 0.05-0.09% acetic acid and 0.07-0.09% citric acid, while that of commercial apple juice was 1.59% malic acid and

0.49% acetic acid. The flavor profiles of fermented beverages added with 10% sucrose were compared to those of apple juice and a model mixture containing 0.48% citric acid, 0.39% lactic acid and 0.12% acetic acid in 10% sugar solution. The QDA diagram of fermented beverages approached to that of apple juice, when the substrate was digested by amylase but not by protease.

Morphological Measurements of Submerged Culture of *Aspergillus* niger by Fully Automatic Image Analysis

Sung-Hoon Oh, Jong-Il Kim, Pyung-Su O and Cherl-Ho Lee

J. Microbiol. Biotechnol. Vol 3, No. 3, 204-208. (1993)

A fully automatic image analysis method was applied to obtain detailed data on morphological parameters of a glucoamylase fermentation broth with *Aspergillus niger* No. PFST-38, a mutant strain for glucoamylase hyperproducer. In the initial stage of fermentation, there was an increase in hyphal length, whereas at the end of the fermentation a decrease in hyphal length and increase in hyphal thickness were observed. The percentage of clumps declined with dilution and the influence of shear stress upon hyphal length was negligible. It was found that the slower the decrease in the main hyphal length and the number of tips with the fermentation time, the higher the glucoamylase production rate was recorded. The production rate of glucoamylase was closely related to the increase in the hyphal thickness.

Rheological Properties of Mycelial Broth in Submerged Culture of *Aspergillus niger* No. PFST-38

Sung-Hoon Oh, Pyung-Su O and Cherl-Ho Lee

J. Microbiol. Biotechnol., Vol 3, No. 3, 209-213. (1993)

The flow behavior of the mycelial broth of glucoamylase hyperproducer Asp. niger No. PFST-38 for the production of glucoamylase were studied. The mycelial broth followed Bingham-pseudoplastic flow model described by Herschel-Bulkley equation. The yield stress increased with the increase in mycelial concentration. The dependency of the consistency index and the flow behavior index on the mycelial concentration could be expressed by a linear relationship. The consistency index increased proportionally with the mycelial concentration while the flow behavior index decreased with the increase in mycelial concentration. The flow property of the broth was related to the morphological data obtain in the previous study. The changes in apparent viscosity of the broth could be expressed as a function of the hyphal thickness as shown below. $\eta_a = 1.51 L_d^{5.62}$

Effect of Aeration and Agitation Conditions on the Production of Glucoamylase with *Aspergillus niger* No. PFST-38

Sung-Hoon Oh, Pyung-Su O and Cherl-Ho Lee

J. Microbiol. Biotechnol., Vol 3, No. 4, 292-297. (1993)

Aspergillus niger No. PFST-38 was grown on complex media in 30L agitated fermentors at various aeration rates and stirrer speeds. We could correlate the mixing time as a function of the Reynolds' number and the apparent viscosity, as follows. θ_M=2.95 $NRe^{-0.52}$, θ_M=1.88 $\eta_a^{0.57}$ Also, the effects of the apparent viscosity (η_a), the impeller rotational speed (N), the air flow rate(Vs), and the mixing time (θ

M) on the oxygen transfer coefficient, K_La were determined experimentally, and equated as follows. $K_La=12.04N^{0.88}Vs^{0.71}\eta_a^{-0.83}$, $K_La=30.2N^{0.88}Vs^{0.71}\theta_M^{-1.45}$ K_La increased as the agitation speed and the air flow rate increased. The rate of K_La increase was dependent more on the rotational speed of impeller than on the air flow rate. The glucoamylase production increased with the increase of the agitation speed upto at 500 rpm and increased with the increase of air flow rate upto at 1.0 vvm. The values calculated from the above equation confirmed that the experimental maximum production of glucoamylase was achieved when the K_La and the apparent viscosity of the broth were 260 hr^{-1} and 1800 cps, respectively.

Application of Thermotolerant Yeast, *Candida rugosa* for the Production of Yeast Protein from Rye Stillages

Yeong-Keun Kim, Ki-Young Lee, Cherl-Ho Lee, Yong-Ick Lee, Kwan-Ho Lee and Man-Keun Kim

Korean J. Appl. Microbiol. Bioeng., Vol. 21, No. 3, 281-287. (1993)

Rye stillage was adopted as a substrate for the production of yeast biomass by a thermotolerant yeast *Candida rugosa* isolated from East Africa. In the batch fermentation, the yield of biomass and crude protein reached 4.9~8.4g/L and 2.2~3.5g/L, respectively, the rate of COD reduction was about 20%. Over 90% amount of main components such as glycerol and lactic acid were assimilated, but protein assimilation reached only to 38~45% of the initial content. Crude protein content of the dry yeast biomass produced was 42~47% and sulfur-containing amino acid was revealed as limiting essential amino acid.

Determination of the Shelf-life of Pasteurized Korean Rice Wine, *Yakju*, in Aseptic Packaging

Cherl-Ho Lee and Gi Myung Kim

Korean J. Food Sci. Technol., Vol 27, No. 2, 156-163. (1995)

The practical shelf-life of pasteurized Korean rice wine "*Yakju*", aseptically packed in Tetra-pak, was determined. The test sample products were stored at 4℃, 20℃, 30℃ and 35℃ for 19 weeks, and the quality assessment was made at two weeks interval. The quality parameters evaluated were pH, acidity, reducing sugar, absorbance at 370 nm, total and acid producing bacteria, yeast and mold, and sensory quality. No meaningful changes of pH and reducing sugar were noticed during the storage for 19 weeks at temperatures tested. The absorbance at 370 nm increased slightly during storage. The total numbers of microorganisms in the product decreased during storage and a drastic reduction of acid producing bacteria was observed after 6 weeks of storage. Both yeast and mold were not found in the pasteurized products. The sensory quality of stored rIce-wine was evaluated by triangle test and scoring test. The panels could distinguish the product stored at 4℃ from other products stored at the higher temperatures for over 6 weeks. The overall acceptance of the product decreased gradually during storage, and the rate constants for the changes were 7.93×10^{-3} at 20℃, 9.69×10^{-3} at 30℃ and 13.4×10^{-3} at 35℃, respectively. The activation energy estimated by Arrhenius equation was 24,795 kJ/kmol. The estimated shelf-life of Yakju pasteurized and aseptically packed was 24 months at 10℃, 16 months at 20℃ and 14 months at 25℃. The shelf-life of Yakju in Seoul was calculated to be 20 months, based on the monthly average temperature of the city.

Preparation of Yogurt Added with *Aloe vera* and Its Quality Characteristics

Yong-Seo Shin, Kap-Sang Lee, Jung-Sung Lee, and Cherl-Ho Lee

J. Korean Soc. Food Nutr., Vol 24, No. 2, 254-260. (1995)

Yogurt base were prepared from milk added with skim milk powder or *Aloe vera* powder and fermented with lactic acid bacteria (the single or mixed strain of *Lactobacillus bulgaricus* and *Streptococcus thermophilus*). The yogurt product were evaluated for acid production (pH, titratable acidity), number of viable cell, viscosity, sensory property and quality-keeping property. The composition of organic acid were also analyzed by HPLC. Addition of *Aloe vera* remarkably accelerated acid production, and titratable acidity of *Aloe vera* yogurts (1.293~1.407%) after 24 hours incubation was higher than that of yogurts added with only skim milk powder (9.98~1.110%). Yogurt fermented with the mixed strain of *L. bulgaricus* and *Sc. thermophilus* was more acidic than that of single strain. The propagation of lactic acid bacteria was stimulated by *Aloe vera* and the number of viable cell after 24 hours incubation were above 9.87 log CFU/ml. Viscosity of *Aloe vera* yogurt (3,860~4,300CPS) was higher than that of yogurt with only skim milk powder (2,402~2604CPS). The overall sensory score of *Aloe vera* yogurt fermented by mixed strain was the best of tested yogurt. When yogurt with *Aloe vera* was kept at 5℃ for 15 days, its quality-keeping property was relatively good. The major organic acid of *Aloe vera* yogurt was lactic acid, and lactic acid content of yogurt increased by addition of *Aloe vera* powder. The citric acid content decreased with fermentation and malonic acid, pyroglutaric acid and α-ketoglutaric acid concentrations also slightly decreased.

Isolation and Identification of *Staphylococcus sp.* from Korean Fermented Fish Products

Mi-Na Um, Cherl-Ho Lee

J. Microbiol. Biotechnol., Vol 6, No. 5, 340-346. (1993)

In order to find out if staphylococci occur in significant numbers in Korean fermented fish products, a total of 40 different fermented fish products were collected from different markets in Korea and analyzed for their physico-chemical and microbiological states. The pH, salt concentration and water activity of the products were measured and the total viable cell count and the number of *Staphylococcus* grown on mannitol salt agar were determined. The identification of the strains of *Staphylococcus* were made by API Staph Strip and MIS identification kits, and the physiological properties of the identified strains were further characterized by different conventional methods. The pH, salt content and water activity of fermented fish samples varied widely from 4.8 to 7.1, 7.4-28.7% and 0.77-0.84, respectively, depending in the type of product. The total viable cell count varied from 10^4-10^9 cfu/ml, and most of the samples had 10^5-10^6 cfu/ml. No correlation was found between the viable cell count and the pH, NaCl concentration and water activity of the samples. Among the 35 colonies identified as *Staphylococcus* strains by the identification kits, *S. xylosus* was the most frequently occurring strain marking 17, and *S. warnei* was 8, *S. epidermidis* 4 and *S. cohnuu* 2. *S. hominis*, *S. saprophyticus*, *S. haemolyticus* and *S. aureus* were also identified once each. In some samples (K-3, P-6, K-8, G-5 and G-10), 2-3 different species of *Staphylococcus* were found. Considering the region of sampling, among the 10 samples from Kunsan 5 were identified as *S. warneri*. while in the other region *S. xylosus* was predominant. Although the physiological characteristics of the identified strains were generally consistent with those in Bergey´s Manual, some discrepances were also observed. All the strains were highly salt tolerant, growing in the media containing over 18% NaCl. All the strains were except *S. aureus* (G-11) showed negative in hemolysis activity, plasma coagulation and DNase tests. All the strains including *S. aureus* (G-11) showed negative in enterotoxin test.

Lactic acid fermented foods and their benefits in Asia

Cherl-Ho Lee

Food Control, Vol. 8, No. 5/6, 259~269. (1997)

This paper reviews many types of the world's lactic acid fermented foods and discusses the beneficial effects of lactic acid fermentation of food by focusing on two examples taken from Korean cuisine, *kimchi* and *Sikhae*. *Sikhae* is the generic name for a class of Korean lactic acid fermented fish products that contain 6-8% salt and generally are at pH 4-5. Koreans are able to preserve fish for 1-2 months at ambient temperatures by this method. Due to the low salt content, *Sikhae* contributes much-needed protein to the Korean rice-based diet. *Kimchi* is the generic name for a class of Korean lactic acid fermented vegetables that contain 3-4% salt and generally are at pH 4.0-4.5. *Kimchi* is an important source of vitamins and minerals especially during the wintertime. It is a popular side-dish and provides a source of intestinal lactic acid bacteria. The physiological effects of *kimchi* have been studied widely in Korea and recent results are summarized in this paper.

Acid Tolerance of *Lactobacillus brevis* Isolated from *Kimchi*

Kap-Sang Lee, Yong-Seo Shin and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol 30, No. 6, 1399-1403. (1998)

We isolated wild lactic acid bacteria from *kimchi* and identified as *Lactobacillus brevis* by using API 50 CHL Kit, some morphological and physiological tests. In order to evaluate the acid tolerance of *Lactobacillus brevis*, its survivals rate, glycolysis assay, membrane permeability, and pH profiles of H^+-ATPase were also determined. When *Lactobacillus brevis* were incubated in Lactobacilli MRS broth adjusted to various levels of pH for 2 hours, the decreases in its population at pH 4.0 and 3.0 were about 2.61 log cycles/mL and 5.89 log cycles/mL, respectively, but there was no decrease at pH 6.0 and 5.0. Glycolysis by *Lactobacillus brevis* had optimal pH about 6.5 and glucose degradation was reduced by 50% at a pH of 5.2. Mg^{++} release from *Lactobacillus brevis* cells in medium with pHs of 4.0 and 3.0 was 24.3 and 71.2% of totals, respectively. The H^+-ATPase of *Lactobacillus brevis* showed a maximal activity between pH values of approximately 6.5 to 7.0.

Determination of the Degree of Gelatinization of Cooked Rice and Its Effect on the Enzyme Activity of the Korean Gokja Grown with *Aspergillus oryzae*

Byung-Il Lee, Sung-Won Yoon and Cherl-Ho Lee

Korean J. Food Sci. Biotechnol., Vol 8, No. 3, 162-167. (1999)

The degree of gelatinization (DG) of cooked rice was tested and compared by iodine binding, glucoamylase, and Korean Food Regulation (KFR) methods in order to select the most suitable method for the quality control of Gokja for Kochujang fermentation. It was found that the KFR standard method was the most appropriate for the quality control. Enzyme activity of Korean Gokja rice varied by the DG of rice substrate, cultivation time, and the mold strain, *Aspergillus oryzae*. The production of amylases in Korean Gokja required a certain level of DG of rice (30%) by the KFR standard method, while that of protease was less affected by DG. For most samples tested, the maximum enzyme production was attained after the 4th day of fermentation. The strains MJW001and MJR003 showed relatively high α-amylase activity, while the strains MJW001 and MJR001 gave high β-amylase activity. The protease activity was relatively high in the Korean Gokja made by the strains MHK001 and MJW001. The differences in mold growth rate with various DG of rice were demonstrated by optical microscopy. The higher the DG of rice, more vigorous was the growth of mold. The sporation accelerated under low DG with retarded hypae growth.

Suitability of Domestic Grape, Cultivar Campbell's Early, for Production of Red Wine

Won-Mok Park, Hyuk-Gu Park, Sook-Jong Rhee, Cherl-Ho Lee and Kyung-Eun Yoon

Korean J. Food Sci. Technol., Vol 34, No. 4, 590-596. (2002)

The domestic grape, cultivar Campbell's Early, was investigated for suitability for production of red wine. The factors for red wine fermentation and quality such as concentrations of sugar, acidity and organic acids in the fresh fruit and the wine from the grape were analyzed. The average concentration of sugar in the fruit was 14%. Since the concentration was not sufficient for fermentation, sugar was added up to 23%. It resulted in production of wine with 12% of alcohol. The total acidity and pH of the fruit were 0.8% and pH 3.4 respectively. Those were optimum levels for fermentation. The fruit contained 3,649 ppm of tartaric acid, 5,339 ppm of malic acid and 948 ppm of citric acid. The wines from Icheon and Youngdong, which were fermented from the grape and M wine which was an imported red wine, were tested. Their pH were 3.5, 3.4 and 3.7, and total acidities were 0.75%, 0.71% and 0.57%, respectively. They contained 1,881 ppm, 2,098 ppm and 8,534 ppm of tartaric acid, 3,033 ppm, 1,952 ppm and undetectable amount of malic acid, 769 ppm, 389 ppm and undetectable amount of citric acid, and 3,337 ppm, 2,368 ppm and 11,991 ppm of lactic acid. This results indicated that M wine contained much more amounts of tartaric acid and lactic acid than the wines of Icheon and Youngdong. The sensory analysis showed that Korean students preferred Youngdong and Icheon wine to M wine. The analytic results indicated that the domestic grape, cultivar Campbell's Early, is suitable source for high quality red wine.

Changes in Sensory Characteristics during Salt Aging of *Doenjang* (*Fermented Soybean* Paste) Made by Different Starters

Gang-Gweon Lee, Hyun-Duck Lee and Cherl-Ho Lee

Food Engineering Progress, Vol 7, No. 1, 13-19. (2003)

Three types of *Doenjang*, using *Korean meju* (*KM*), *Japanese koji* (*JK*) and modified *meju mix* of *A. oryzae* meju and *B. subtilis meju* (MAB) were manufactured and salt aged for 90 days at 30℃. The changes of sensory characters of flavor compounds in *Doenjang* during 90 days were examined. All results were analyzed with statistics such as ANOVA and principal component analysis (PCA). In the PCA result of three types of *Doenjang*, first two principal components could be explained by 90.73% of all taste and appearance components. *JK Doenjang* was highly correlated with sensory taste such as nutty, sweet and harmonized taste. MAB Doenjang was chiefly correlated with odor compounds, first two principal components could be explained 86.58% of all components. *JK Doenjang* was highly correlated with odor acceptability and MAB *Doenjang* was correlated with sweet odor, nutty odor, alcoholic odor, rancid odor and off odor. *KM Doenjang* was closely related with *meju* odor.

Changes in Flavor Components during Salt Aging of *Doenjang* (*Fermented Soybean* Paste) Made by Different Starters

Gang-Gweon Lee and Cherl-Ho Lee

Food Engineering Progress, Vol 7, No. 1, 20-30. (2003)

Three types of *Doenjang*, using *Korean meju*(*KM*), *Japanese Koji*(*JK*) and modified *meju* mix of *A. oryzae meju* and *B. subtilis meju*(MAB) were manufactured and salt aged for 90 days at 30℃. The major free amino acids of *Doenjang* were glutamic acid and leucine. Among the free amino acids in *Doenjang*, isoleucine was the most abundant component at the beginning of aging period. Among the organic acids in *JK Doenjang*, malic acid increased remarkably during salt aging. It contained higher amounts of free sugars than the others. The total amount of free sugars in *Doenjang* decreased during salt aging. In fatty acid compositions of *Doenjang*, myristic, palmitic, stearic, oleic, linoleic, linolenic acid were analyzed, and the most abundant fatty acid was linoleic acid, 38.56~56.86%. The volatile flavor compounds of *Doenjang* were analyzed and seventy eight compounds were identified. Ethanol was found to be one of the most abundant volatile flavor compound. In *JK Doenjang*, ethanol increased 400 times during fermentation. The number of volatile compounds detected immediately after salt aging of *JK Doenjang* were 28 and increased to 50 compounds after 60 days of salt aging. In MAB *Doenjang*, most of the volatile compounds were found after 30 days of salt aging Eight volatile compounds such as ethanol, 2,3-butanedione, pentyl-acetate, 3-methyl-butanal, 2-methyl-1-butanol, 2-pentylfuran, 1-limonene, 2-metoxyphenol, were found in all samples with relatively abundant amount.

Comparison of the Traditional (*Samhaeju*) and Industrial (*Chongju*) Rice Wine Brewing in Korea

Sook-Jong Rhee, Chung-Yung Jetty Lee, Ki-Kap Kim and Cherl-Ho Lee

Korean J. Food Sci. Biotechnol., Vol 12, No. 3, 242-247. (2003)

Significant differences in processing methods exist between traditional and industrial brewing of Korean rice wine, *Chongju*. The industrial method follows Japanese Sake brewing process using *Koji* and yeast, while traditional methods use natural-fermented *Nuruk* as the starter. In general, the industrial brewing undergoes relatively high temperature fermentation (25℃) for 15 days, whereas traditional *Samhaeju* processing adapts low temperature(5~10℃), long time fermentation for over three months, and further addition of rice known as *samyangju* or three-step brewing. Common parameters for controlling alcohol fermentation were measured including pH, reducing sugar content, beta-amylase activity and alcohol content. Cooking method of rice were varied, and different microorganisms were involved in each brewing step in traditional (*Samhaeju*) brewing. The contents of esters and higher alcohol increased proportionally with the multiplication of yeast. The concentration of ethylacetate was higher in *Samhaeju*, While alcohol content was higher in the industrial *Chongju*. Lactic and succinic acids were the major organic acids produced during the whole period of fermentation. In particular, at the end of the second brew of *Samhaeju*, the yeast growth was apparent, and the lactic acid content was high enough to inhibit the growth of other hazardous microorganisms. Products of industrial *Chongju* had higher contents of ethyl alcohol and succinic acid, and lower lactic acid and ethylacetate contents than those of *Samhaeju*.

Polyphenolic Compounds and Superoxide Radical Scavenging Activity of *Moru-Ju*

Kyung-Hee Koh, Hyeon-Wee Kim, Sang-Hwa Han, Yun-Hee Park, Cherl-Ho Lee

Korean J. Food Sci. Biotechnol., Vol 12, No. 3, 290-297. (2003)

Wild grape (*Vitis amurensis*) known as moru is a traditional fruit in Korea. Like the European grape (*Vitis vinifera*), moru is rich in polyphenols, but the role of phenolic compounds in *moru-ju* has never been reported. The total phenolic content of *moru-ju* was 1,758.2 mg/L (NM II), 3,812.5 mg/L (CM), and 2,004.7 mg/L (NM I). ESR spectrometer was used to measure the scavenging effect of superoxide radicals, and the order of superoxide scavenging activity was NM I (76.7%) > NM II (68.2%) = CM (67.7%). Nine polyphenolic compounds responsible for superoxide radical scavenging activity were confirmed by HPLC: catechin, epicatechin, 4-methyl-catechol, gallic, protocatechuic, chlorogenic, caffeic, p-coumaric, and syringic acids. The contents of gallic acid (49.4 mg/kg), catechin (56.0 mg/kg), chlorogenic acid (10.6 mg/kg), caffeic acid (8.3 mg/kg), and epicatechin (66.6 mg/kg) of NM I were higher than those of NM II. The strongest superoxide radical scavenging effect of *moru-ju* was provided from skin and seeds (NM I), which also contained the highest polyphenolics. The color change of *moru-ju* showed that the L value decreased, the a value increased, and the b value was more blue than yellow during fermentation.

Purification and characterization of proteases from *Bacillus amyloliquefaciens* isolated from traditional soybean fermentation starter

Seong-Jun Cho, Sung-Hoon Oh, R. David Pridmore, Marcel A. Juillerat, and Cherl-Ho Lee

J. Agric. Food Chem., Vol 51, No. 26, 7664-7670. (2003)

Bacillus amyloliquefaciens FSE-68 isolated from *meju*, a Korean soybean fermentation starter, was identified on the basis of biophysical tests and 16S rRNA gene sequence. A neutral metalloprotease (NPR68) and an alkaline serine-protease (APR68) were purified by ammonium sulfate precipitation and cation exchange chromatography and identified on the basis of their activities at different pH values and the selective protease inhibitors. The molecular weights of NPR68 and APR68 measured with ESI-MS were 32743 (± 0.8) and 27443 (± 0.5) Da, respectively. Against oxidized insulin chains, the NPR68 has a cleavage preference at the site where leucine is located as a P1' residue followed by phenylalanine, and the APR68 has broad specificity and favors leucine at the P1 site. These results indicate that the proteases are natural variants of subtilisin and bacillolysin.

Creative Fermentation Technology for the Future

Cherl-Ho Lee

J. Food Sci., Vol 69, No. 2, CRH31-32. (2004)

Fermentation technology is one of the oldest food technology appplications that has been developed and utilized for survival. The origin of Asiatic fermentation technology evolved as early as the littoral foragers period of the Primitive Pottery Age (8000-3000 B.C.), which led the Neolithic culture of agriculture in Northeast Asia. The importance of the Primitive Pottery Age for the dietary culture of the region was discussed during the 11th IUFoST World Congress in Seoul (Lee 2001a). Fermentation technology has developed indigenously all around the world by using natural products from the respective region to produce required food materials, from which the characteristic taste and aroma of each cultural society have been made. Steinkraus(1993) classified fermentation technology of the world, responsible for man’s survival, into six groups: alcoholic, lactic acid, leavened breads, meat substitutes, meat flavored sauces/pastes, and protein/flavoring agents. The meat-eating habit of Western culture needed food preservation technology in order to keep perishable meat and milk edible for longer periods. Meat sausage, cheese, and acid-fermented milk making were important food preservation technology methods until the time when refrigerators were available in homes. On the other hand, people who ate cereals as staple food in the East wanted to have meat-flavored and salty condiments, which make the bland taste of cereal foods more palatable. This demand led Asian people to develop soybean sauce and fish sauce fermentation procedures.

The role of biotechnology in modern food production.

Cherl-Ho Lee

J. Food Sci., Vol 69, No. 3, CRH92-95. (2004)

Modern food production technology is given great challenges by the emerging fields of biotechnology and molecular biology. Knowledge of conventional fermentation technology is upgraded by the gene level explanations of enzyme actions and physiological functions of biomaterials derived therefrom. The use of genetically modified organisms (GMOs) and their products in food widens the availability of resources while also raising public interest about safety and labelling. As an example of the application of molecular biology in conventional fermentation technology, the selection of proteases from a *Bacillus* species grown in Korean traditional soybean fermentation starter, *Meju*, and the production of peptides with blood cholesterol lowering effect, obtained from soyabean protein hydrolysate, are presented. Recent developments in the Korean bioindustry are reviewed as an example of the role of biotechnology in the food industry. The present status of GMO enzymes in food production is reviewed and safety issues about GMO use in the food system are discussed.

Potential antioxidant peptides in rice wine

Sook-Jong Rhee, Chung-Yung J. Lee, Mi-Ryung Kim, and Cherl-Ho Lee

J. Microbiol. Biotechnol., Vol 14, No. 4, 715-721. (2004)

Many food protein hydrolysates have been shown to have antioxidant activities, and recent research focuses on low molecular peptides produced during hydrolysis of food protein. Korean rice wine contains about 60- 70% of protein at dry base and originates from raw materials. It has been suggested that the protein is transformed into low molecular weight peptides, and have antioxidant activity during fermentation. The objectives of this study were to evaluate the antioxidant activity of the pre-purified and purified peptides found in Korean rice wine and to identify the responsible peptides. The wine extract of *Samhaeju*, a traditional Korean rice wine made by low temperature fermentation, was evaporated at 35C. The two methods employed in the evaluation of antioxidant activity were the DPPH radical scavenging method and the beta-carotene bleaching test. The pre-purified samples showed 808 AAC (Antioxidant Activity Coefficient) and 56.5% AOA (Antioxidant Activity), which were higher than α-tocopherol (572 AAC and 78% AOA). The rice wine extract was separated by reversed-phase HPLC. The protective effect of the four most antioxidant active fractions were tested for t-butyl hydroperoxide induced oxidation of healthy human erythrocytes and the byproduct was determined by malondialdehyde formation. Fraction No. 5 showed 35% lower MDA concentration as compared to the control. The peptides were further purified using consecutive chromatographic methods and 4 antioxidant peptides were isolated. The amino acid sequences of the peptides were identified as Ile-His-His, Val-Val-His(Asn), Leu-Val-Pro, and Leu(Val)-Lys-Arg-Pro. The AAC value of the synthetic form of the identified peptides was the highest for Ile-His-His.

Fibrinolytic, Immunostimulating, and Cytotoxic Activities of Microbial Strains Isolated from Kochujang

MI-Young Seo, Seung-Ho Kim, Cherl-Ho Lee, and Seong-Kwan Cha

Korean J. Food Sci. Technol., Vol 39, No. 3, 315-322. (2007)

This study was carried out to investigate the functional activities of microorganisms isolated from *kochujang*, such as fibrinolytic, immunostimulating, and cytotoxical activities, and to apply these microorganisms to *kochujang* products. Ninety-one microbial strains with proteolytic activity were selected from 294 strains isolated from traditional and commercial *kochujang*. Three strains (TPP 0014, TPP 6013, and TPP 6015) with high fibrinolytic activity were tested for their immunostimulating and cytotoxical activities. For the assessment of macrophage activation, cytokines such as tumor necrosis factor, interleukin-1α and nitrogen oxide were measured with the murine macrophage cell line RAW 264.7. In addition, the cytotoxical activities of the three strains were examined by MTT assay on the colon cancer cell line SNU-C4 and normal cell line CHO-K1. Using an API identifying kit, two of the microbial strains (TPP 0014 and TPP 6015) were identified as *Bacillus stearothermophilus* and the other strain (TPP 6013) was identified as *B. amyloliquefacience*.

1H Nuclear Magnetic Resonance-Based Metabolomic Characterization of Wines by Grape Varieties and Production Areas

Hong-Seok Son, Ki-Myong Kim, Frans Van Den Berg, Geum-Sook Hwang, Won-Mok Park, Cherl-Ho Lee and Young-Shick Hong

J. Agric. Food Chem., Vol 56, No. 17, 8007-8016. (2008)

1H NMR spectroscopy was used to investigate the metabolic differences in wines produced from different grape varieties and different regions. A significant separation among wines from Campbell Early, Cabernet Sauvignon, and Shiraz grapes was observed using principal component analysis (PCA) and partial least squares-discriminant analysis (PLS-DA). The metabolites contributing to the separation were assigned to be 2,3-butanediol, lactate, acetate, proline, succinate, malate, glycerol, tartarate, glucose, and phenolic compounds by PCA and PLS-DA loading plots. Wines produced from Cabernet Sauvignon grapes harvested in the continental areas of Australia, France, and California were also separated. PLS-DA loading plots revealed that the level of proline in Californian Cabernet Sauvignon wines was higher than that in Australian and French Cabernet Sauvignon, Australian Shiraz, and Korean Campbell Early wines, showing that the chemical composition of the grape berries varies with the variety and growing area. This study highlights the applicability of NMR-based metabolomics with multivariate statistical data sets in determining wine quality and product origin.

A novel approach for estimating sugar and alcohol concentrations in wines using refractometer and hydrometer

H.S. Son, Y.S. Hong, W.M. Park, M.A. Yu, and C.H. Lee

J. Food Sci., Vol 74, No. 2, 106-111. (2009)

To estimate true Brix and alcoholic strength of must and wines without distillation, a novel approach using a refractometer and a hydrometer was developed. Initial Brix (I.B.), apparent refractometer Brix (A.R.), and apparent hydrometer Brix (A.H.) of must were measured by refractometer and hydrometer, respectively. Alcohol content (A) was determined with a hydrometer after distillation and true Brix (T.B.) was measured in distilled wines using a refractometer. Strong proportional correlations among A.R., A.H., T.B., and A in sugar solutions containing varying alcohol concentrations were observed in preliminary experiments. Similar proportional relationships among the parameters were also observed in must, which is a far more complex system than the sugar solution. To estimate T.B. and A of must during alcoholic fermentation, a total of 6 planar equations were empirically derived from the relationships among the experimental parameters. The empirical equations were then tested to estimate T.B. and A in 17 wine products, and resulted in good estimations of both quality factors. This novel approach was rapid, easy, and practical for use in routine analyses or for monitoring quality of must during fermentation and final wine products in a winery and/or laboratory.

1H NMR-Based Metabolomic Approach for Understanding the Fermentation Behaviors of Wine Yeast Strains

Hong-Seok Son, Geum-Sook Hwang, Ki-Myong Kim, Eun-Young Kim, Frans van den Berg, Won-Mok Park, Cherl-Ho Lee and Young-Shick Hong

Anal. Chem., Vol 81, No. 3, 1137-1145. (2009)

1H NMR spectroscopy coupled with multivariate statistical analysis was used for the first time to investigate metabolic changes in musts during alcoholic fermentation and wines during aging. Three *Saccharomyces cerevisiae* yeast strains (RC-212, KIV-1116, and KUBY-501) were also evaluated for their impacts on the metabolic changes in must and wine. Pattern recognition (PR) methods, including PCA, PLS-DA, and OPLS-DA scores plots, showed clear differences for metabolites among musts or wines for each fermentation stage up to 6 months. Metabolites responsible for the differentiation were identified as valine, 2,3-butanediol (2,3-BD), pyruvate, succinate, proline, citrate, glycerol, malate, tartarate, glucose, N-methylnicotinic acid (NMNA), and polyphenol compounds. PCA scores plots showed continuous movements away from days 1 to 8 in all musts for all yeast strains, indicating continuous and active fermentation. During alcoholic fermentation, the highest levels of 2,3-BD, succinate, and glycerol were found in musts with the KIV-1116 strain, which showed the fastest fermentation or highest fermentative activity of the three strains, whereas the KUBY-501 strain showed the slowest fermentative activity. This study highlights the applicability of NMR based metabolomics for monitoring wine fermentation and evaluating the fermentative characteristics of yeast strains.

Metabolomic Studies on Geographical Grapes and Their Wines Using 1H NMR Analysis Coupled with Multivariate Statistics

Hong-Seok Son, Geum-Sook Hwang, Ki-Myong Kim, Hyuk-Jin Ahn, Won-Mok Park, Frans van den Berg, Young-Shick Hong and Cherl-Ho Lee

J. Agric. Food Chem., Vol 57, No. 4, 1481-1490. (2009)

Environmental vineyard conditions can affect the chemical composition or metabolites of grapes and their wines. Grapes grown in three different regions of South Korea were collected and separated into pulp, skin, and seed. The grapes were also vinified after crushing. 1H NMR spectroscopy with pattern recognition (PR) methods was used to investigate the metabolic differences in pulp, skin, seed, and wines from the different regions. Discriminatory compounds among the grapes were Na, Ca, K, malate, citrate, threonine, alanine, proline, and trigonelline according to PR methods of principal component analysis (PCA) or partial least-squares discriminant analysis PLS-DA). Grapes grown in regions with high sun exposure and low rainfall showed higher levels of sugar, proline, Na, and Ca together with lower levels of malate, citrate, alanine, threonine, and trigonelline than those grown in regions with relatively low sun exposure and high rainfall. Environmental effects were also observed in the complementary wines. This study demonstrates that 1H NMR-based metabolomics coupled with multivariate statistical data sets can be useful for determining grape and wine quality.

Metabolomic Insight into Soy Sauce through 1H NMR Spectroscopy

Bong-Kuk Ko, Hyuk-Jin Ahn, Frans van den Berg, Cherl-Ho Lee and Young-Shick Hong

J. Agric. Food Chem., Vol 57, No. 15, 6862-6870. (2009)

Soy sauce, a well-known seasoning in Asia and throughout the world, consists of many metabolites that are produced during fermentation or aging and that have various health benefits. However, their comprehensive assessment has been limited due to targeted or instrumentally specific analysis. This paper presents for the first time a metabolic characterization of soy sauce, especially that aged up to 12 years, to obtain a global understanding of the metabolic variations through 1H NMR spectroscopy coupled with multivariate pattern recognition techniques. Elevated amino acids and organic acids and the consumption of carbohydrate were associated with continuous involvement of microflora in aging for 12 years. In particular, continuous increases in the levels of betaine were found during aging for up to 12 years, demonstrating that microbial- or enzyme-related metabolites were also coupled with osmotolerant or halophilic bacteria present during aging. This work provides global insights into soy sauce through a 1H NMR-based metabolomic approach that enhances the current understanding of the holistic metabolome and allows assessment of soy sauce quality.

Metabolomic Characterization of Malolactic Fermentation and Fermentative Behaviors of Wine Yeasts in Grape Wine

Hong-Seok Son, Geum-Sook Hwang, Won-Mok Park, Young-Shick Hong and Cherl-Ho Lee

J. Agric. Food Chem., Vol 57, No. 11, 4801-4809. (2009)

Wine contains a number of metabolites that are produced during alcoholic and malolactic fermentations (MLF) or aging, which are important compounds for determining wine quality. This study investigated changes in metabolites in wines to characterize malolactic fermentation (MLF) and to assess fermentative behaviors of wine yeast strains using 1H nuclear magnetic resonance (NMR) spectroscopy coupled with multivariate statistics. Principal component analysis (PCA)showed clear differentiation between non- and induced-malolactic fermented wines by wine lactic acid bacteria (LAB) and between wines fermented with various wine yeast strains. Metabolites such as glycerol, lactate, 2,3-butanediol, succinate, leucine, isoleucine, alanine, valine, proline, choline, γ-aminobutyric acid (GABA), and polyphenols contributed to the differentiations. Decreased levels of malate and citrate along with increased levels of lactate were the metabolites most responsible for the differentiation of induced-MLF wines from non-MLF wines. In particular, high succinate levels provided evidence of an inhibitory effect of *Saccharomyces bayanus* against spontaneous MLF. Furthermore, dependence of metabolites on wine yeast strains was observed, demonstrating their different fermentative behaviors. This study demonstrates that wine fermentation by yeast and LAB can be characterized through global and multivariate statistical analysis of 1H NMR spectral data.

Characterization of Fermentative Behaviors of Lactic Acid Bacteria in Grape Wines through 1H NMR- and GC-Based Metabolic Profiling

Jang-Eun Lee, Young-Shick Hong and Cherl-Ho Lee

J. Agric. Food Chem. Vol 57, No. 11, 4810-4817. (2009)

The effects of five commercial Oenococcus oeni strains (MCW, Enoferm R, Wyeast, Vinibacti111, and Vinibacti222) on fermentative behaviors, and variations of metabolites in Meoru (Vitis coignieties) wines during malolactic fermentation (MLF) were investigated by metabolomic analysis of 1H NMR and GC data sets. In the development of MLF with various *O. oeni* strains, the fastest conversions of malic acid to lactic acid occurred in wines fermented with Enoferm R and Vinibacti111 strains. Seventeen primary metabolites and 65 secondary metabolites of volatile compounds in the wines were identified by 1H NMR spectroscopy and GC-MS, respectively. In pattern recognition models of principal component analysis (PCA) and orthogonal projection to latent structures discriminant analysis (OPLS-DA), significant differentiations between wines with *O. oeni* strains were identified by the secondary metabolites rather than by the primary metabolites, showing the effects of *O. oeni* strains only on the secondary metabolites. Twelve volatile compounds, 2-phenylethanol, isoamyl alcohol, 2-butanol, ethyl octanoate, ethyl hexanoate, hexadecanoic acid, diethyl succinate, butyl butyrate, octanoic acid, 9-hexadecanoic acid, isobutyric acid, and 2-ethyl-1-hexanol, contributed to the differentiation of wines according to *O. oeni* strain, including spontaneous MLF. This study demonstrates that *O. oeni* strains affect the secondary metabolites, which are easily identified through multivariate statistical analysis of GC-MS data set.

Evidence of vintage effects on grape wines using 1H NMR-based metabolomic study

Jang-Eun Lee, Geum-Sook Hwang, Frans Van Den Berg, Cherl-Ho Lee and Young-Shick Hong

Analytica Chimica Acta, Vol 648, No. 1, 71-76. (2009)

The chemical composition of grape wines varies with grape variety, environmental factors of climate and soil, and bacterial strains, which can each affect the wine quality. Using 1H NMR analysis coupled with multivariate statistical data sets, we investigated the effects of grape vintage on metabolic profiles of wine and the relationship between wine metabolites and meteorological data. Principal component analysis (PCA) showed a clear differentiation between Meoru wines that were vinified with the same yeast strain and Meoru grapes harvested from the same vineyard but with a different vintage. The metabolites contributing to the differentiation were identified as 2,3-butandiol, lactic acid, alanine, proline, γ-aminobutyric acid (GABA), choline, and polyphenols, by complementary PCA loading plot. Markedly higher levels of proline, lactic acid and polyphenols were observed in the 2006 vintage wines compared to those of 2007 vintage, showing excellent agreement with the meteorological data that the sun-exposed time and rainfall in 2006 were approximately two times more and four times less, respectively, than those in 2007. These results revealed the important role of climate during ripening period in the chemical compositions of the grape. This study highlights the reliability of NMR-based metabolomic data by integration with meteorological data in characterizing wine or grape.

Characterization of wines from grape varieties through multivariate statistical analysis of ^{1}H NMR spectroscopic data

Hong-Seok Son, Geum-Sook Hwang, Hyuk-Jin Ahn, Won-Mok Park, Cherl-Ho Lee and Young-Shick Hong

Food Research International, Vol 42, No. 10, 1483-1491. (2009)

1H NMR spectroscopic analysis coupled with multivariate statistical data was used to characterize wines vinified from four grape varieties: Muscat Bailey A (Vitis labrusca), Campbell Early (V. labrusca B.), Kyoho (V. labrusca L.) and Meoru (Vitis coignetiae). Pattern recognition methods, such as principal component analysis (PCA) and orthogonal projection to latent structure discriminant analysis (OPLS-DA), showed clear differentiation between wines made from these grape varieties. Metabolites responsible for the differentiation were identified as 2,3-butanediol, glycerol, malate, citrate, tartrate, succinate, lactate, proline, alanine, choline and trigonelline. The PCA score plot of quantitative analysis of targeted profiling data also showed clear separation between the wines. The highest levels of glycerol, 2,3-butanediol, succinate and alcohol were found in Kyoho wines, suggesting higher sugar content in the Kyoho grape berry compared to other grape varieties. Higher contents of citrate and trigonelline in Muscat Bailey A wines, alanine in Campbell Early wines and proline, malate and choline in Meoru wines demonstrated that the metabolites of the wines vary with the grape variety. This study provides insight into the relationship between grape variety and its wine through global and targeted analysis of 1H NMR spectral data.

Protein Technology

Microstructure of Soybean Protein Aggregates and Its Relation to the Physical and Textural Properties of the Curd

Cherl-Ho Lee and Chokyun Rha

J. Food Sci., Vol. 43, No 1, 79-84. (1978)

The microstructure of soybean protein aggregates was examined by the optical microscope and the scanning electron microscope. The effects of heat and coagulating agents on the microstructure of the aggregates and on the physical and texture properties of the protein curd were investigated. Isoelectric point precipitation and calcium coagulation did not change the globular structure of the native soybean protein. However, heating induced the destruction of the native protein body. Heat denaturation of the protein was necessary in forming the network structure of the aggregates. When the protein aggregates were frozen, their structure became better defined and enlarged. The three dimensional network structure of the aggregate derived from heated soybean protein showed a low sedimentation rate, high curd yield, high water-holding capacity, low value of hardness and high springiness compared to the unheated precipitates of globular structure.

Microstructure and mechanical properties of single cell protein curd

Tengiz D. Tsintsadze, Cherl-Ho Lee and Chokyun Rha

J. Food Sci., Vol. 43, No. 2, 625-635. (1978)

The microstructure and the physical and mechanical properties of yeast protein curds were investigated by using the scanning electron microscope and the Instron Universal Testing Machine, Model 1122. Heat treatment of the protein dispersion prior to precipitation did not remarkably influence the structure and water-holding capacity of the curds. Yeast protein curd precipitated with calcium had a micro-network structure which was not apparent in the isoelectric point precipitated curd. The calcium precipitated curd had a low value of hardness, high water-holding capacity, low value of adhesiveness and high cohesiveness compared to the isoelectric precipitated curd. The calcium precipitated curd also showed a strong structural potential which was revealed upon freezing. The freeze-thawing of the curd in general increased hardness and springiness but decreased the adhesiveness and cohesiveness. The physical, structural and mechanical properties of yeast protein curds were compared with those of soybean protein curds studied previously.

Disintegration of cell wall and extraction of protein from *Candida lipolytica*

Shekkwan Tsang, Cherl-Ho Lee and Chokyun Rha

J. Food Sci. Vol. 44, No. 1, 97-99. (1979)

The differences between extraction of protein from fresh and from spray-dried hydrocabon-grown yeast (*Candida lipolytica*) were investigated, and the effect of different protein extraction methods on protein yield was determined. The mechanisms and efficiency of the different methods of cell disintegration and protein extraction are illustrated by scanning electron microscopy. Autolysis of fresh yeast and acid treatment of dried yeast indiscriminately hydrolyzed whole cell and resulted in low yield of extracted protein. Homogenization of alkali-treated cell suspensions of both fresh and spray-dried yeast gave maximum yields of extracted protein. The effect of alkali treatment is due to weakening of the cell wall structure and removal of the hydophobic barrier around it; for dried yeast, alkali treatment has the additional effect of protein solubilization.

Disintegration of Dried Yeast Cells and Its Effect on Protein Extractability, Sedimentation Property, and Viscosity of the Cell Suspension

Cherl-Ho Lee, Shek Kwan Tsang, Rintaro Urakabe and Chokyun Rha

Biotechnology and Bioengineering, Vol. 21, No. 1, 1-17. (1979)

The morphology of dried *Candida lipolytica* yeast suspended in aqueous solutions (H2O, 0.4% NaOH, 2N HCl, and 6N HCl) and organic solvents (95% alcohol and acetone) was studied using a scanning electron microscope (SEM) and an optical microscope. The effect of high-pressure homogenization on cell-wall structure and cell clumps was also determined. The protein extractability, sedimentation property and viscosity of cell subjected to different mechanical and chemical treatments were also investigated. The dried yeast cells were in a spherical agglomeration consisting of 100s of closely bound cells. The clump was resistant to water, aqueous 2N HCl solution at 25℃, 95% alcohol and acetone, but vulnerable to 6N HCl, aqueous 0.4% NaOH solution, and homogenization. The homogenization of the cell suspension not only broke the clump but also cracked the cell-wall structure. The aqueous alkaline solution could have weakened the cell and increased the solubility of the protein released through the cracks in the cell wall. The destruction of the agglomeration and the cell-wall structure increased the hydration of the cell and thereby increased the stability of the suspension. The sedimentation and the viscosity of the cell suspension corresponded to the morphological changes and the extractability of protein in the cell suspensions with different treatments.

Effects of External Conditions on the Emulsifying Property of Proteins

Cherl-Ho Lee, Hak-Ryang Kim, Han-Chul Yang, Myung-Won Lee and Chong-Chan Bae

Korean J. Food Sci Technol., Vol. 14, No. 1, 49-56. (1982)

The effects of measurement conditions on the emulsifying capacity(EC) and emulsion stability(ES) of proteins were studied in order to develop laboratory standard methods for the evaluation of emulsifying properties. The EC of proteins decreased with the increments of protein concentration and mixing rate. It increased with the increasing oil addition rate up to 0.8 mL/sec, but did not change at 0.8-1.2 mL/sec. The addition of sodiumchloride enhanced EC of proteins. Attaining to the highest EC at 0.3M NaCl for Pro-Fam and 0.1M NaCl for Na-caseinate. The ES of Pro-fam was higher than that of caseinate. The ES was increased by the increments of protein concentration, oil addition volume, mixing rate and mixing time. The EC and ES showed a close relation to the NSI of proteins, reaching to the lowest values of EC and ES at the isoelectric regions of proteins. The laboratory methods for measurements of emulsifying properties of proteins were established. The emulsifying properties of a laboratory-made soybean protein isolate were compared to those of commercial products by using the methods.

Studies on the Enzymatic Partial Hydrolysis of Soybean Protein Isolates

Cherl-Ho Lee, Chan-Shick Kim and Sam-Pin Lee

Korean J. Food Sci Technol., Vol. 16, No. 2, 228-234. (1984)

A partial hydrolysis of soybean protein isolate was carried out by using pepsin and trypsin. The degree of hydrolysis was evaluated by chemical analysis, viscometric measurements and gel electrophoresis. The functional properties of the hydrolyzates such as flow behavior, emulsion properties and foaming properties were evaluated. A selective hydrolysis of 11S protein fraction by pepsin was observed from the SDS-PAG eletrophoresis. The changes in the molecular weight distribution by different condition of enzyme hydrolysis were evaluated. The changes in the intrinsic viscosity of the protein hydrolyzate by reaction time were highly correlated to the contents of TCA soluble protein and 0.03M $CaCl_2$ soluble nitrogen. The degree of hydrolysis (DH_{TCA}, DH_{Ca}) which were used to evaluate the effect of enzyme treatment on the protein solution decreased as DH increased, while the foaming capacity increased linearly with the increasing DH.

Studies on the Measurement of Protein Hydrophobicity II: Hydrophobic Gel Column Chromatography

Sung-Koo Kim, and Cherl-Ho Lee

Korean Biochem. J., Vol. 17, No. 4, 373-380. (1984)

The method for the measurement of effective protein hydrophobicity was introduced by using hydrophobic gel column chromatography and the data was related to the surface property of proteins. The hydrophobic index (Retention coefficient, Rc) of bovine serum albumin and lysozyme were 16.51 and 13.45, but that of ovalbumin was 2.39. In case of food protein, those of casein and soybean protein 7S fraction were 6.92 and 4.39, but that of soybean protein 11S fraction was 0.39. The reduction of surface tension and interfacial tension by the addition of these proteins was observed and the degree of reduction was increased as the effective hydrophobicity of protein increased. Especially, a good inverse correlation ($P<0.05$) was observed between the hydrophobicity and the interfacial tension of protein solutions.

Studies on the Measurement of Protein hydrophobicity ; Fluorometry and hydrophobic Partition

Sung-Koo Kim, Sam-Pin Lee, and Cherl-Ho Lee

Korean Biochem. J., Vol. 18, No. 2, 129-135. (1985)

The effective hydrophobicity of different proteins, BSA, lysozyme, α-chymotrypsin, trypsin, β-lactoglobulin, myoglobin, ovalbumin, casein, soybean protein 7S and 11S fractions, rapeseed protein isolate, were determined by fluorometric method using ANS as chromophore and hydrophobic partitioning technique using polyethylene glycol and PEG-palmitate bi-phasic system. The optimum excitation and emission wave lengths for the measurement of relative fluorescence intensity of protein-ANS complex were 380 nm and 465 nm, respectively. The relative intensity was influenced by the concentration indicating high level of hydorphobicity, whereas those of ovalbumin and soybean protein 11S fraction were low. The hydrophobic partition coefficient ($\triangle$logK) gave similar results as shown in fluorometric method. The $\triangle$log K of BSA and casein were 1.625 and 1.660, respectively, while those of ovalbumin and soybean 11s fraction were 0.216 and 0.170. The changes in the effective hydrophobicity of proteins in solutions at different pH, ionic strength and heat treatment, could be related to the structural characteristic of the proteins.

Partition Coefficient of Proteins of Different Surface Hydrophobicity in Poly (ethylene glycol)-Dextran Aqueous Two phase system

Sam-Pin Lee and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 19, No. 2, 140-145. (1987)

The partition coefficient of the proteins of known effective hydrophobicity was determined in a poly (ethylene glycol)-dextran aqueous two-phase system. The changes in the partition coefficient was also determined when a fraction of PEG-palmitate (PEG-P) was added to the system. The partition coefficient of the proteins increased as the concentrations of PEG and dextran increased at a constant phase volume ratio irrespective of the effective hydrophobicity of the proteins. When small amounts of PEG-P were added to the PEG phase, the partition coefficients of BSA and β-lactoglobulin, which had relative hydrophobicity (Rl) of 700 and 120, respectively, increased more than ten-fold, whereas ovalbumin whose Rl was 5 showed little change. The drastic increases in the partition coefficient were observed by the addition of PEG-P in 2% level to the PEG system. Addition of PEG-P over 5% level resulted in a slight further increase in the partition coefficient of all proteins tested.

Effects of Salts on the Partition of Proteins in Poly (ethylene glycol)-Dextran Aqueous Two Phase System

Sam-Pin Lee and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 19, No. 2, 146-150. (1987)

The effects of pH and added salts on the partition coefficients of proteins in a poly(ethylene glycol)-dextran aqueous two-phase system were investigated. The partition coefficients attained the lowest value at the isoelectric point of proteins in an equal volume aqueous two-phase system containing 5% PEG and 9.5% dextran in 5 mM phosphate buffer solution. The coefficients increased dramatically at pH 11; BSA which had highest effective hydrophobicity marked 50-fold increase, while β-lactoglobulin and ovalbumin which had low hydrophobicity 10-fold increase, respectively. The effect of added salts varied with the pH. The partition coefficient increased by the addition of salt at pH 3.0 but decreased drastically at pH 7.0. The partition coefficient increased in the order of added Li < Na < K at pH 3.0 and decreased in the order of added Li > Na > K at pH 11.0.

Purification of Intracellular β-Galactosidase from *Lactobacillus sporogenes* in an Aqueous Poly(ethylene glycol) Potassium Phosphate Two-Phase System

Sam-Pin Lee, Young-Man Kim and Cherl-Ho Lee

Korean J. Appl. Microbiol. Bioeng., Vol. 15, No. 2, 84-88. (1987)

Poly(ethylene glycol)-PPB two phase system was used for the purification of β-galactosidase from *Lactobacillus sporogenes*. The smaller the molecular weight of concentration of PEG phase increased, proteins as well as β-galactosidase was partitioned into the top phase. All cell debris were confined to the potassium phosphate phase (bottom phase), approached to the binodial line. The purification ratio increased by changing the polymer-salt composition of the tie line towards higher salt concentrations. It was also possible to obtain higher purification of the enzyme after two-step extraction using PEG 1000 and PEG 300. The top phase contained 74% of the total β-galactosidase with a purification factor of 2.1.

Factors Affecting Foam Separation of Proteins

Boo-Yong Lee and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 19, No. 3, 220-224. (1987)

The concentration ranges forming surface excess of bovine serum albumin(BSA) and ovalbumin solutions were determined, and the factors affecting the foam separation of BSA were investigated. The surface tension of BSA solution decreased from 72 to 61 dynecm, when the concentration changed from 5×10-3 to 3×10-2%, and the critical micelle concentration was appeared to be at 0.03% of BSA. At the isoelectric point (pH 4.9) of BSA, the foamate volume was maximum, but enrichment ratio was minimum, resulting in the maximum recovery rate. When the pH deviated from the isoelectric point, the foamate volume decreased and the enrichment ratio increased. The enrichment ratio increased, while the foamate volume decreased drastically as the temperature was elevated above 20℃, resulting in the decrease in recovery rate. As the gas flow rate increased, the enrichment ratio decreased and the foamate volume increased. When (NH4)3S04 was added, the enrichment ratio decreased, but the maximum foamate was obtained at ionic strength 7. The concentration to form the surface excess of ovalbumin, which has lower surface hydrophobicity than BSA, was 200 times higher than that of BSA. This fact indicates the possibility of selective foam separation by hydrophobicity difference of proteins.

Foam Separation of Bovine Serum Protein Fractions

Boo-Yong Lee and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 19, No. 3, 225-230. (1987)

The foam separation of bovine serum proteins was investigated and the protein fractionation by foam separation was analyzed by PAG electrophoresis. The protein concentration for the surface excess formation of bovine serum was in the range of 20-800 μg/ml. At pH 5, the foamate volume was maximum, but the enrichment ratio minimum. As the temperature was elevated, the foamate volume decreased and the enrichment ratio increase. As the gas flow rate increased from 25 to 100 ml/min, the foamate volume decreased and the enrichment ratio increased. The enrichment ratio became maximum when the added ionic strength of serum solution was in the range of 1~3 by the addition of different types of salt, and this was related to the reduction of surface tension of the solution. In general, BSA. α_1, and α_2-globulins, which have relatively small molecular weight and high hydrophobicity, moved easily to the foam, and the separation of protein fractions in the serum varied with the changes in pH, temperature, gas flow rate and ionic strength of the solution.

Protein Partition in an Aqueous Poly (ethyleneglycol)-salt Two-phase System

Sam-Pin Lee and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 19, No. 4, 285-289. (1987)

The partition behavior or proteins in an aqueous two-phase system of poly (ethyleneglycol)-potassium phosphate buffer (PEG/PPB) was investigated. The proteins of different surface hydrophobicity, i.e. Bovine serum albumin (BSA), β-lactoglobulin, ovalbumin, moved to the PPB-rich bottom phase in a PEG (12%)/PPB (12%) two-phase system resulting in very low partition coefficients. When the concentration of PPB increased to 15% level. the electric potential of bottom phase changed from +50 mV to zero and the partition coefficient tended to increase. The change In the molar ratio of K_2HPO_4/KH_2PO_4 in PPB from 1.43 to 9.55 caused the volume ratio of top to bottom phase (V_t/V_b) to be decreased and protein partition coefficient increased. When the concentration of PPB was elevated from 14% to 26%, the V_t/V_b decreased from 1.5 to 0.39 and the partition coefficient of proteins increased drastically; β-lactoglobulin 74 fold, BSA 32 fold, ovalbumin 12 fold and lysozyme 5 fold.

Effects of protein hydrophobicity on the surfactant properties of food proteins

Cherl-Ho Lee and Sung-Koo Kim

Food Hydrocolloids, Vol. 1, No. 4, 283-289. (1987)

Purified proteins and food protein isolates were used for the determination of effective hydrophobicity by hydrophobic column chromatography, the hydrophobic partition method and fluorometric measurement. The relationship between the measured hydrophobicity and the functional properties, such as surface tension, emulsion property and foaming property, were investigated. The surface active property of proteins was related to the effective hydrophobicity as measured by the partition method. The emulsifying capacity and foaming capacity of proteins in distilled water increased as the protein hydrophobicity increased. When NaCl was added to the protein solution, the surfactant properties changed drastically and did not show a significant relationship to the protein hydrophobicity.

Functional Properties of Lupinseed Protein Concentrate

Young-Wook Kim and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 19, No. 6, 499-505. (1987)

The functional properties of lupin seed protein concentrate (LPC) were examined and compared to those of soybean protein isolate (SPI) and Na-caseinate. LPC-50, of which protein level was 50%, was prepared by a two phase solvent (hexane:alcohol:water=10:7:3) extraction method. LPC-70 was made from LPC-50 by removing the fractions solubilized by carbohydrate decomposing enzymes. The solubilities of LPC-50 and LPC-70 were similar to that of SPI but slightly higher at pH 4-5, and less susceptible to the added salt. The apparent viscosity of LPC increased exponentially as the concentration increased over 6% level, and the change was similar to that of Na-caseinate. LPC showed strong pseudoplastic non-Newtonean flow behavior which was similar to that of SPI. The emulsifying capasity of LPC-70 was similar to that of SPI when salt was added. The foaming capacity of LPC was comparable to that of SPI. LPC showed high oil and water absorption capacities, which increased as the protein level was elevated. LPC-70 showed the highest oil absorption capacity of all the samples tested.

Changes in hydrophobicity of Proteins During thermal Aggregation

Il-Jun Kang and Cherl-Ho Lee

Korean Biochem. J., Vol. 21, No. 1, 88-93. (1988)

The changes in the hydrophobicity of model proteins (bovine serum albumin, ovalbumin, bovine globulins) were measured by heptane binding method, phenyl-Sepharose CL-4B gel column chromatography, critical micelle concentration and surface tension. The heptane binding capacity and retention time in phenly-Sepharose CL-4B gel column increased and the critical micelle concentration and surface tension of protein solution decreased as the hydrophobicity of proteins increased. When protein solutions (1% w/v, pH 6.8) were heated upto 90°C, the PAG electrophoresis pattern of each protein suddenly changes at a specific temperature indicating thermal aggregation, i.e. 60°C for BSA, 60-70°C for BGs and 80°C for OA. The hydrophobicity of proteins increased up to the thermal aggregation temperature and then rapidly decreased. It demonstrates the exposure of hydrophobic domain of proteins by heating and subsequent enclosure during aggregation.

Partition of *Bacillus subtilis* neutral protease in aqueous two-phase systems. I. Counter-current distribution using Polyethylene glycol/potassium phosphate buffer aqueous two-phase system

Jung-Hoon Han and Cherl-Ho Lee

Korean Biochem. J., Vol. 22, No. 4, 373-378. (1989)

Using Polyethylene glycol/Potassium phosphate buffer aqueous two-phase systems, the neutral protease from *Bacillus subtilis* was purified by the counter-current distribution, and the result were compared with the conventional methods including ammonium sulfate fractionation, DEAF-cellulose and CM-cellulose ion exchange chromatography. In the counter-current distribution transferring 31 tubes of PEG/PPB systems, the maximum protease activity was appeared at the 7th tube and the purification fold was 30.1 fold of the crude enzyme. This value was about 3 times larger than the purification fold of the conventional method.

Partition of *Bacillus subtilis* neutral protease in aqueous two-phase systems. II. The measurement of isoelectric points by the cross partition using Polyethylene glycol/Dextran aqueous two-phase systems

Jung-Hoon Han and Cherl-Ho Lee

Thesis Collection of Agricultures and Forestry, Korea University, Vol. 29, 181-185. (1989)

The isoelectric points of purified *Bacillus subtilis* neutral protease and other proteins were measured by the cross partition using different salts in PEG/Dextran aqueous two-phase systems. The cross partition confirmed the isoelectric points of purified *Bacillus subtilis* neutral protease, B.S.A., conalbumin and lysozyme to be pH 9.0, 4.9, 6.2 and 10.5, respectively, which were the same values as appeared in the literature.

Effects of pH on the Separation and Purification of Model Protein using Counter Current Distribution

Chang-Ho Lee, Boo-Young Lee and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 22, No. 1, 56-60. (1990)

The changes in the partition coefficient of model proteins (lysozyme, myoglobin, conalbumin, bovine serum albumin) in an aqueous two-phase system formed by polyethylene glycol and dextran were examined in order to improve the capacity of counter current distribution for the protein fractionation and concentration. The protein distribution patterns in CCD with 30 tubes varied with the pH of the system, and both theoretical and measured values agreed well. From the mixture of model protein, pure BSA fraction was appeared at the upper-phase of 14th tube having pH 4.5, pure myoglobin at the lower-phase of the 16th tube with pH 6.5 and conalbumin at the lower phase of 4th tube with pH 12. The result indicated the possible use of CCD method for protein fractionation, if the partition coefficient of proteins was manipulated by pH and other means.

Effect of Potassium Chloride on the Separation and Purification of Model Proteins using Counter Current Distribution

Chang-Ho Lee, Boo-Young Lee and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 22, No 2, 177-182. (1990)

The changes in the partition coefficient of model proteins (lysozyme, myoglobin, conalbumin, bovine serum albumin) in an aqueous two-phase system formed by polyethylene glycol and dextran were examined in order to improve the capacity of counter current distribution (CCD) for the protein fractionation and concentration. The protein distribution pattern in CCD with 30 tubes varied with the pH (4.5, 5.5, 6.5, 9.0, 12.0) and KCl concentration (0 mM, 50 mM, 250 mM, 500 mM) of the system. From the mixture of model proteins, pure myoglobin was appeared at the upper phase of 14th tube having 50 mM of KCl at pH 5.5 and the upper-phase of 13th tube having 250 mM of KCl at pH 6.5. Similarly pure BSA was obtained at the 14th tube having KCl 250 mM with pH 4.5, pure lysozyme at the 19th tube having 500 mM of KCI at pH 4.5 and the upper-phase of 16th tube 50 mM of KCl at pH 5.5.

Effects of Ammonium Sulfate on the Separation and Purification of Model Proteins Using Counter Current Distribution

Boo-Yong Lee, Chang-Ho Lee and Cherl-Ho Lee

Thesis Collection of Agricultures and Forestry, Korea University, Vol. 30, 149-157. (1990)

The changes in the partition coefficient of model proteins(lysozyme, myoglobin, conalbumin, bovine serum albumin(BSA)) in an aqueous two-phase system formed by polyethylene glycol and dextran were examined in order to improve the capacity of counter current distribution(CCD) for the protein fractionation and concentration. The protein distribution pattern in CCD with 30 tubes varied with the pH(4.5, 5.5, 6.5, 9.0, 12.0) and $(NH_4)_2SO_4$ concentration(0mM, 50mM, 250mM, 500mM) of the system. From the mixture of model proteins pure BSA appeared at the upper-phase of the 14th tube having 50mM of $(NH_4)_2SO_4$ at pH 5.5 and of the 12th tube having 250mM of $(NH_4)_2SO_4$ at pH 4.5. Similarly, pure conalbumin was obtained at the upper-phase of the 1th tube having 50mM $(NH_4)_2SO_4$ at pH 9.0. Pure lysozyme was obtained at the upper-phase of the 16th tube having 50mM $(NH_4)_2SO_4$ at pH 5.5, the 17th tube having 250mM $(NH_4)_2SO_4$ at pH 4.5 and the 18th tube having 500mM $(NH_4)_2SO_4$ at pH 12.0.

Effect of Type of Enzyme on the Bitterness of Partial Hydrolyzates of Soybean Protein

Chang-Hyun Kim, Mi-Ryung Kim and Cherl-Ho Lee

Food and Biotechnology, Vol. 1, No. 2, 79-84. (1992)

The effect of type of enzymes on the bitter flavor formation in partially hydrolyzed isolated soybean protein was investigated. The degree of hydrolysis (DH) was measured by pH-stat titration method, and the bitterness of hydrolysates was evaluated organoleptically. Among the five different types of proteolytic enzymes, which are bacterial neutral protease (Neutrase) and alkaline protease (Alcalase), papain, bromelain, and trypsin, Alcalase showed the highest DH with the same enzyme activity measured by the casein method. At the same DH of 10, the bitterness of hydrolysates varied with the type of enzyme used: Alcalase resulted in the highest bitterness equivalent of 6.4×10^{-5} mole Quinine-HCI, Neutrase and trypsin gave a relatively low level of bitterness equivalent of 3.36×10^{-5} mole Quinine-HCI. The bitterness intensity increased proportionally with the degree of hydrolysis. The protein solubility at the isoelectric point varied slightly with the type of enzyme used in the range of 45~60% at pH 3~7.

Effects of salts and poly(ethylene glycol)-palmitate on the partitioning of proteins and *Bacillus subtilis* neutral protease in aqueous two-phase systems

J.H. Han, C.-H. Lee

Colloids and Surfaces B: Biointerfaces, Vol. 9, No. 1, 109-116. (1996)

Polyethylene glycol (PEG) and dextran, and PEG and potassium phosphate buffer (PPB) create aqueous two-phase systems. In the PEG/dextran aqueous two-phase systems, the partition coefficient of bovine serum albumin (BSA), of which surface charged negatively in the neutral pH region, decreased by adding phosphate salt. However, the partition coefficient of lysozyme, which is charged positively at neutral pH, increased as phosphate salt was added. *Bacillus subtilis* neutral protease, produced by fermentation, showed increasing partition coefficient in PEG/PPB aqueous two-phase systems with increasing phosphate salt concentration. When PEG-palmitate was substituted for PEG, *Bacillus subtilis* neutral protease moved to the upper PEG-palmitate phase and was purified to 10.2-fold compared to the crude enzyme. Palmitic acid in PEG-palmitate showed not only high affinity to *Bacillus subtilis* neutral protease but also an activation effect (factor of 2.5) on the proteolytic activity. This affinity partitioning with palmitic acid is due to the high affinity of palmitic acid in PEG-palmitate for the enzyme via hydrophobic interactions giving increased proteolytic activity after binding. The results of this study show that aqueous two-phase systems are suitable for purifying proteins and enzymes by bulk liquid partitioning, and can also give useful information on the surface properties of proteins.

Determining isoelectric points of model proteins and *Bacillus subtilis* neutral protease by the cross partitioning using poly(ethylene glycol)/Dextran aqueous two-phase systems

J. H. Han and C.H. Lee

Colloids and Surfaces B: Biointerfaces, Vol. 9, No. 3, 131-137. (1997)

Bacillus subtilis neutral protease was produced, purified and partitioned in aqueous two-phase systems for determining isoelectric pH of the enzyme. The enzyme was purified through ammonium sulfate precipitation, DEAE-cellulose ion chromatography and CM-cellulose ion chromatography. DEAE- and CM-cellulose chromatography profiles showed that the protease was charged positively at neutral pH, unlike most proteins. *Bacillus subtilis* neutral protease was purified by a factor of 10.9 compared to the crude enzyme in the liquid culture broth. Cross partitioning with two different salts and various pHs using polyethylene glycol/Dextran aqueous two-phase systems was used for measuring the isoelectric points of model proteins (bovine serum albumin, conalbumin and lysozyme) and purified subtilis neutral protease. The crossing points of bovine serum albumin, conalbumin, lysozyme and *Bacillus subtilis* neutral protease were pH 4.9, 6.2, 10.6 and 9.0, respectively. These results were the same as values of isoelectric pH of the corresponding proteins and the protease in the literature. It is concluded that the cross partitioning of two different salts can determine the isoelectric points of proteins accurately.

The Bitterness of the Enzymatic Hydrolysate of Soybean Protein and the Amino Acid Composition of the UF Filtrate

Chang-Hyun Kim, Mi-Ryung Kim and Cherl-Ho Lee

Food and Biotechnology, Vol. 6, No. 4, 244-249. (1997)

The effect of the type of proteolytic enzyme on the bitterness of soybean protein hydrolysates was studied and the bitter peptide fractions were separated by ultrafiltration (UF) or 2-butanol extraction. The bitter peptide fractions were further fractionated by gel permeation chromatography, and the bitterness intensity of protein hydrolysates and the hydrophobic amino acid contents of the fractions were examined. At the same degree of hydrolysis (DH) of 10%, Alcalase gave the highest bitterness intensity (Quinine-HCl equivalent mole), and the result in the order of bitterness intensity was Alcalase>bromelain>papain>Neutrase>trypsin. The GPC molecular weight distribution of the UF (molecular weight<10,000 dalton) filtrate of the hydrolysate varied with the enzyme used. Secondary-butanol extraction increased the content of lower molecular peptide fractions, which were less than 3,456 dalton. There was a strong correlation between the bitterness intensity of the protein hydrolysates and the hydrophobic amino acid content of the UF filtrate of the hyrolysates.

Effects of pH and Potassium Chloride in Solvent System of High-Speed Counter-current Chromatography

Chang-Ho Lee, Boo-Yong Lee, Hyun-Yu Lee and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 29, No. 6, 1222-1227. (1997)

Effects of the physical properties of solvent system such as pH and polarity change by salt addition in solvent system were investigated by using high speed countercurrent chromatography apparatus (Model CCC-1000, Pharm-Tech Research Corp. USA). The changes of pH and interfacial tension in solvent system of high speed countercurrent chromatography did not significantly affect on retention of stationary phase, but induced remarkable changes in the partition coefficient of ginkgo flavonoids, kaempferol, quercetin and isorhamnetin. The partition coefficients of ginkgo flavonoid standard increase with an increased pH of solvent system and quercetin sharply increased at pH 10.0. Retention of stationary phase decreases with an increased concentration of KCl in butanol of solvent system. Interfacial tension between two phase in solvent system of hexane increases with an increased concentration of

KCl. The polarity of solvent system significantly changes the partition coefficients of ginkgo flavonoid.

Effect of Weak Acid Pretreatment on the Enzymic Hydrolysis against Wheat Gluten of High Concentration

Young-Shick Hong, Cherl-Ho Lee and Ki-Young Lee

J. Korean Soc. Food Sci. Nutr., Vol. 27, No. 6, 1110-1116. (1998)

To determine the optimum conditions for the enzymic hydrolysis against wheat gluten of high concentrations (6~14%, w/w, protein), a hydrolysis system combining weak acid pretreatment and enzymic hydrolysis was investigated. Alcalase showed the highest DH(degree of hydrolysis) of the tested proteases. After hydrolysis by Alcalase, subsequently peptidases were applied for the better DH of the wheat gluten hydrolyzate. Peptidase NP2 showed the highest DH of the tested peptidases, but flavourzyme was shown for the lowest bitter taste of the resulting hydrolyzate. In order to minimize aggregation or gelling at higher initial substrate concentration during heat treatment, wheat gluten suspension was pretreated with possibly low concentrations of hydrochloric acid at 105oC for 1 hour, and then enzymatically hydrolysed with Alcalase and subsequently with flavourzyme. Each required minimum concentration of hydrochloric acid in the wheat gluten suspension of 6, 8, 10, 12, and 14%(w/w, protein) was 0.10, 0.15, 0.20, 0.225, and 0.275N, respectively. After the subsequent enzymic treatment by Alcalase and peptidase NP2 for 24 hrs, the nitrogen solubility in the final wheat gluten hydrolysates was increased to 94.9, 86.4, 85.3, 89.3 and 95.0%, and their amino nitrogen content was increased to 2.87, 5.68, 7.34, 9.71 and 12.50mg/m, respectively.

The Separation of Major Flavonoglycosides from *Ginkgo biloba* L. Leaves by High-Speed Counter-current Chromatography

Chang-Ho Lee, Boo-Yong Lee and Cherl-Ho Lee

Korean J. Food Sci. Biotechnol., Vol 8, No. 3, 189-192. (1999)

Flavonoglycosides were fractionated from ginkgo (*Ginkgo biloba* L.) leaves by high-speed countercurrent chromatography (HSCCC). A series of preliminary studies was performed to optimize the physical properties of the two-phase solvent system and the operating parameters including the rotation speed of the column, elution mode of the mobile phase, and flow rate using a commercial multilayer coil HSCCC centrifuge. The best experimental conditions were found to be as follows: solvent system: chloroform I methanol I water (40:39:21, vi v/v); rotation speed: 800 rpm; flow rate: 3 mL/min; elution mode: upper phase in the tail to head mode or lower phase in the head to tail mode; sample size:100μL. HSCCC fractions were hydrolyzed and three major aglycones from the corresponding glycosides, i.e., quercetin, kaempferol, and isorhamnetin, were checked by HPLC analysis. The recovery ratio of these flavonoglycosides from dried ginkgo leaves extract were 83.3% with the upper mobile phase and 24.4% with the lower mobile phase.

Amino Acid Sequence Analysis of Bitter Peptides from a Soybean Proglycinin Subunit Synthesized in *Escherichia coli*

Mi-Ryung Kim, Sang-Yun Choi, Chan-Shick Kim, Chan-Wha Kim, Shigeru Utsumi, and Cherl-Ho Lee

Biosci. Biotechnol. Biochem., Vol 63, No. 12, 2069-2074. (1999)

The cDNA encoding A1aB1b proglycinin was expressed in *E. coli*, for the efficient isolation of a single peptide responsible for the bitterness. The 55-kD proglycinin was highly purified, hydrolyzed, and further purified through a series of chromatographic steps to yield fractions with the major bitter peptides. The most bitter-tasting fractions contained peptides with average molecular weights lower than 1,700 Da. An analysis of the amino acid sequences indicated that many small bitter peptides (< 1,000 Da) are composed of uncharged polar amino acids as well as hydrophobic amino acids, with a charged residue often being present at either end. This suggests the involvement of a certain structural requirement in taste perception.

Molecular Characterization and Bitter Taste Formation of Tryptic Hydrolysis of 11S Glycinin

Mi-Ryung Kim, Sang-Yun Choi, and Cherl-Ho Lee

J. Microbiol. Biotechnol., Vol 9, No. 4, 509-513. (1999)

The molecular size reduction and the formation of bitterness during a tryptic hydrolysis of soybean 11S glycinin were determined by using quantitative analysis and organoleptic evaluation. The 11S glycinin of 90% purity was prepared by cryoprecipitation and Con A Sepharose 4B affinity chromatography, and hydrolyzed with trypsin in a pH-stat reactor for 4 h. Bitterness was formed within 1 h of hydrolysis, and then slowly increased up to 3.5×10^{-5}M quinine-HCl equivalent. The extent of hydrolysis (DH) was 7% at 1 h and increased up to 12% by the end of the reaction. The alpha-amino nitrogen content increased from an initial 0.7 mM to 7 mM at the end of the period. The SDS-PAGE analysis showed that the acidic subunit of 11S glycinin was mostly hydrolyzed. The GP-HPLC analysis indicated that the bitterness was mainly contributed by the peptide fractions of molecular weights of 360-2,100 Da.

Large-Scale Purification of Protease Produced by Bacillus sp. from Meju by Consecutive Polyethylene Glycol/Potassium Phosphate Buffer Aqueous Two-Phase System

Seong-Jun Cho, Chan-Hwa Kim, Moo-Hyun Kim and Cherl-Ho Lee

J. Microbiol. Biotechnol., Vol 9, No. 4, 498-503. (1999)

Protease produced from *Bacillus* sp. FSE-68 was isolated from *Meju*, a Korean fermented soybean starter, and was purified by a two-consecutive aqueous two-phase system. The change of partition coefficient (K) in the polyethylene glycol (PEG)/potassium phosphate buffer (PPB) aqueous two-phase system was measured at different pHs (6.0-9.2), PPB concentrations (8-12%), and temperatures (4 and 20℃). As the PPB concentration in the aqueous two-phase system increased, the protease concentration in the top phase (PEG-rich phase) increased, thereby enhancing the partition coefficient. The minimum partition coefficient of the protease was achieved at pH 7.0, whereas that of the total protein was at pH 6.0. The biggest difference in partition coefficients of total protein and protease occurred at pH 6.0. It was interesting to note that the partition coefficient of protease decreased as the temperature increased. The optimum condition of the primary aqueous two-phase extraction of Bacillus sp. FSE-68 was pH 6.0, 14% (w/w) PPB, and 16% (w/w) PEG at 4℃, and the crude enzyme concentration in this system was 50% (w/w). The protease, which was concentrated in the top phase, was further mixed with 15% (w/w) PPB (pH 7.0) in the ratio of 1:1 at 20℃ to elute the bottom phase (PPB-rich phase). Using these steps, the purification fold achieved was 9.2 with a 44.7% yield.

Characterization of hydrolysates produced by mild-acid treatment and enzymatic hydrolysis of defatted soybean flour

Jin-Yeol Lee, Hyun-Duck Lee, Cherl-Ho Lee

Food Research International, Vol 34, No. 2, 217-222. (2001)

Acid (0.05-0.2 N HCl) pre-treatments and subsequent enzymatic hydrolysis (Alcalase™ and Flavourzyme™) of defatted soybean flour (DSF) were performed under aseptic conditions. The acid pre-treatment facilitated enzymatic hydrolysis of the protein in DSF by increasing the nitrogen solubility index. Protein was hydrolyzed primarily during the first 5 h of enzymatic hydrolysis. The degree of hydrolysis and α-amino nitrogen contents of the hydrolysates increased after acid pretreatment. The average peptide chain lengths were estimated at 7~8 amino acid units after 3 h hydrolyzation by Alcalase, and 3-5 amino acid units after 21 h by Flavourzyme/Alcalase mixture. Gel permeation chromatography provided molecular size distribution to determine the molecular weights of the corresponding hydrolysates. At the end of 24 h enzymatic hydrolysis, the amounts of free amino acid, dipeptide and tripeptide accounted for almost half of the proteins in the hydrolysate, while the oligopeptides constituted 40%.

Molecular Weight Distribution of Protein Hydrolysate by the Enzyme Hydrolysis of Weakly Acid-Treated Wheat Gluten

Young-Shick Hong, Ki-Young Lee and Cherl-Ho Lee

Food Sci. Technol. Res., Vol 7, No. 2, 126-130. (2001)

For the production of highly soluble HVP (hydrolysed vegetable protein) by enzymic hydrolysis, wheat gluten suspension (6% w/w, protein) was pretreated with weak acid (0.1 N HCl) at 95℃ for 1 h to overcome insolubility of the suspension. After treating it for 3h with Alcalase, flavourzyme was added to the wheat gluten hydrolysate and hydrolysis continued for a further 21h at 50℃. α-Amino nitrogen content (AN, mg/ml) and nitrogen solubility index (NSI, %) of the resulting wheat gluten hydrolysate product was 2.87 mg/ml and 94.9%, respectively. The wheat gluten hydrolysate product contained peptides and free amino acids with molecular weights below 300 dalton. Non-acid treated SPI (soy protein isolate) was also adopted as a protein substrate. The AN and NSI of the resulting SPI hydrolysate were 2.02 mg/ml and 70.4%, respectively. SPI hydrolysate contained proteins and peptides with molecular weights above 80 Dalton and below 7300 Dalton.

Isolation and identification of bitter peptides of tryptic hydrolysate of soybean 11S Glycinin by reverse-phase high-performance liquid chromatography

M.-R. Kim, Y. Kawamura, and C.-H. Lee

J. Food Sci., Vol. 68, No. 8, 2416-2422. (2003)

The 21 peptides purified from the bitter fraction of tryptic hydrolysates of soyabean 11S glycinin by using gel-permeation high-performance liquid chromatography (HPLC) and a series of 3 C18 reverse phase (RP)-HPLC were in the molecular weight range of 200-1400 Da and showed mostly the hydrophobicity of less than 1400 cal/mol. Although the primary structures of the bitter peptides from 11S glycinin were not exactly the same as those of the proglycinin, many bitter peptides were basic mimics of the common structure, indicating the significance of the primary structure of a peptide playing a role in the bitter taste perception.

Crystal Structure of CD14 and Its Implications for Lipopolysaccharide Signaling

Jung-In Kim, Chang-Jun Lee, Mi-Sun Jin, Cherl-Ho Lee, Sang-Gi Paik, Hay-Young Lee and Jie-Oh Lee

J. Biol. Chem., Vol. 280, No. 12, 11347-11351. (2005)

Lipopolysaccharide, the endotoxin of Gram-negative bacteria, induces extensive immune responses that can lead to fatal septic shock syndrome. The core receptors recognizing lipopolysaccharide are CD14, TLR4, and MD-2. CD14 binds to lipopolysaccharide and presents it to the TLR4/MD-2 complex, which initiates intracellular signaling. In addition to lipopolysaccharide, CD14 is capable of recognizing a few other microbial and cellular products. Here, we present the first crystal structure of CD14 to 2.5 Å resolution. A large hydrophobic pocket was found on the NH2-terminal side of the horseshoe-like structure. Previously identified regions involved in lipopolysaccharide binding map to the rim and bottom of the pocket indicating that the pocket is the main component of the lipopolysaccharide-binding site. Mutations that interfere with lipopolysaccharide signaling but not with lipopolysaccharide binding are also clustered in a separate area near the pocket. Ligand diversity of CD14 could be explained by the generous size of the pocket, the considerable flexibility of the rim of the pocket, and the multiplicity of grooves available for ligand binding.

Cholesterol Lowering Mechanism of Soybean Protein Hydrolysate

Seong-Jun Cho, Marcel A. Juillerat, and Cherl-Ho Lee

J. Agric. Food Chem., Vol. 55, No. 26, 10599-10604. (2007)

Numerous attempts have been made to find the mechanism and component of the cholesterol lowering activity of soybean. In this study, it was proved that the peptides in soybean protein hydrolysate (SPH) made by certain proteases have a hypocholesterolemic effect. Among the mechanisms suggested, that is, blockage of bile acid and/or cholesterol absorption, inhibition of cholesterol synthesis, and stimulation of low-density lipoprotein receptor (LDL-R) transcription, SPH appeared to stimulate LDL-R transcription. When Hep T9A4 cells were incubated with soy protein hydrolysates by using the proteases from *Bacillus amyloliquefaciens* FSE-68, LDL-R transcription was strongly stimulated, but the other mechanisms were not affected. Among the six types of SPH, F1-5, hydrolyzed with the neutral protease to a degree of hydrolysis (DH) of 15%, showed the highest LDL-R transcription. The fractions of molecular weight of 200 and 3000 Da showed LDL-R transcription stimulating activity. The bioactivity is due to soybean peptides because the ethanol extract of soybean protein which contains isoflavones does not stimulate LDL-R transcription. In conclusion, dietary upregulation of LDL-R transcription by soybean may be consequent to an enhanced catabolism or a reduced synthesis of intracellular cholesterol. Therefore, we suggest that soy peptides can effectively stimulate LDL-R transcription in the human liver cell line and reduce blood cholesterol level.

Identification of LDL-Receptor Transcription Stimulating Peptides from Soybean Hydrolysate in Human Hepatocytes

Seong-Jun Cho, Marcel A. Juillerat, and Cherl-Ho Lee

J. Agric. Food Chem., Vol. 56, No 12, 4372-4376. (2008)

Soybean protein and its hydrolysate have been reported to have cholesterol-lowering property, but the responsible components are still largely unknown. In previous study, we found that soybean protein hydrolysate (SPH) prepared with the protease from *Bacillus amyloliquefaciens* FSE-68, strongly stimulates transcription of low density lipoprotein receptor (LDL-R). To identify LDL-R transcription stimulating peptides in human hepatocytes, the SPH was fractionated with gel permeation chromatograpy and the active fraction was further separated by using reverse-phase chromatography. Several peptides in the most active fraction were identified by LC/MS and MS/MS analysis. LDL-R transcription stimulating peptides were synthesized on the basis of identified sequences, and their effect on LDL-R transcription was tested in vitro. Among the synthesized peptides, Phe-Val-Val-Asn-Ala-Thr-Ser-Asn (FVVNATSN) showed the strongest activity, and LDL-R transcription of hepatic cells was increased to 248.8% (compared to 100% of untreated control) by FVVNATSN at a concentration of 100 μM. This study provides direct evidence that peptides derived from soybean protein can influence LDL-R transcription in hepatocytes.

Tastes and Structures of Bitter Peptide, Asparagine-Alanine-Leucine-Proline-Glutamate, and Its Synthetic Analogues

Mi-Ryung Kim, Kawamura Yukio, Ki-Myong Kim and Cherl-Ho Lee

J. Agric. Food Chem., Vol. 56, No. 14, 5852-5858. (2008)

Asn-Ala-Leu-Pro-Glu (NALPE) is a strong bitter peptide with a minimum response threshold (MRT) of 0.074 mM. To elucidate the relationship of spatial structure and bitterness on peptides, NALPE and its analogues, NALPW, NALPS, NALPL, NALPP, NALPD, and NALPR, were synthesized and sensorially evaluated. Structural analysis using computer simulation for each peptide revealed that the presence of a polar group and hydrophobic bitter amino acids, the composition of hydrophobic regions, the spatial orientation of the polar group and hydrophobic regions, and the proximity between polar groups and hydrophobic regions faced within the same plane space may be the major determinants for the taste type and intensity of peptide bitterness.

Extrusion Technology

Construction of Single-screw Food Extruder and its Mechanical Properties and Product Characteristics for Corn Grits Extrusion-cooking

Lee, C. H., Lim, J. K., Kim, J. D. and Lee, M. H.

Korean J. Food Sci. Technol., Vol. 15, No. 4, 392-398. (1983)

A pilot single-screw food extruder was constructed, and its mechanical properties and product characteristics were investigated by using corn grits. The screw rotational speed was varied and the changes in temperature profile of the barrel for the start-up period of operation were measured. The rate of heat generation for the start-up period was affected by the screw speed and feed rate. The screw speed resulted in a great influence on the estimated dough viscosity. The changes in the dough viscosity could indicate the on-set of thermoplastic reaction on the barrel. The expansion ratio during the start-up period mainly depended on the barrel temperature and the degree of thermoplastic reaction in the barrel. The barrel temperatures for the gelatinization and burning of corn grits depended on the screw speed as well as feed rate.

Effect of Reverse Screw Elements on the Residence Time Distribution in Twin-Screw Extruder

J. K. Lim, S. Wakamiya, A. Noguchi and C. H. Lee

Korean J. Food Sci. Technol., Vol. 17, No. 3, 208-212. (1985)

The residence time distributions were measured experimentally to determine the effect of reverse screw elements at various screw configurations in twin screw extruder. A simple model was used to estimate the number of filled C-chamber on the forwarding screw. The inclusion of reverse-screw elements resulted in the increase of median residence time and the broadening of color distribution. True residence time was affected by using the reverse screw elements just before the die. The number of filled C-chamber was decreased with the increase of screw revolution speed at the same screw configuration.

Extrusion Technology for the Production and Processing of Korean Traditional Foods

Cherl-Ho Lee

Korean J. Dietary Culture, Vol. 3, No. 1, 95-99. (1988)

The recent research results and applications of extrusion cooking in Korean traditional food processing are reviewed. It covers the development of rice bran extrusion stabilizer, instant rice cake production and researches in cereal based lactic beverage and alcohol beverage by using extrusion cooking technology.

The Effects of the Type of Cereal Powder and Extruder Operation Conditions on the Barrel Temp.-distribution

Gi-Hyung Ryu and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 20, No. 3, 303-309. (1988)

The heat generation at the start-up period of an autogeneous single screw extruder was determined with various feed materials, die structure and operational conditions. The highest heat generation rate was observed with defatted soybean meal, while the lowest value was obtained with rice flour, and wheat and barley flour showed the intermediate rate. As the moisture content of the flour decreased and the screw speed increased, the electric power requirement and heat generation rate increased. The temperature at compression section increased with the decrease in the particle size. The same effect was also observed as breaker plate was installed. The optimum operation was established as the temperature profile was maintained in decreasing order of metering section, die and compression section.

Effects of Moisture Content and Particle Size of Rice Flour on the Physical Properties of the Extrudate

Gi-Hyung Ryu and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 20, No. 4, 463-469. (1988)

The effects of moisture content and particle size of rice flour on the physical properties of the extrudate were examined by using a autogeneous single screw extruder. The moisture contents tested were in the range of 17~28% and the particle sizes were 18~60 mesh and 60~120 mesh. Samples were taken at different temperatures from the start-up period to the steady state operation. The expansion ratio increased and bulk density decreased as the moisture content and particle size of the flour decreased. The cutting force decreased and the air cell size became uniform as the moisture content and particle size of the flour decreased. As the moisture content increased, the yellowness of the extrudate powder decreased, while the lightness increased, the apparent viscosity increased and the water soluble index decreased. Gelatinization and partial dextrinization were apparent during the extrusion process, and the degree of dextrinization was appeared to be influenced by the levels of moisture content and particle size of rice flour.

Effects of Prefermentation and Extrusion Cooking on the Lactic Fermentation of Rice-Soybean Based Beverage

Cherl-Ho Lee, Moussa Souane and Ki-Hyung Rhu

Korean J. Food Sci. Technol., Vol. 20, No. 5, 666-673. (1988)

The enhancement of the growth of lactic bacteria in rice-based beverage was achieved by the prefermentation of cereals with a mixed culture of *Bacillus* and yeast followed by extrusion cooking. The rice-soybean milk blend was inoculated with a mixed culture of *Bacillus laevolactis* and *Saccaromyces cerevisiae*, and fermented in solid state at 45℃. It was extruded in an autogenous single screw extruder for sterilization as well as for partial digestion, and subjected to lactic fermentation in liquid state. The combined prefermentation and extrusion cooking increased the content of water soluble solid. It estimated the growth of lactic bacteria as well as the acid production and increased dispersion stability and sensory acceptability.

The Effects of Screw Speeds and Moisture Contents on Soy Protein under Texturization Using a Single-screw Extruder

Ouk Han, Sang-Hyo Lee, Hyun-Yu Lee, Sang-Lyong Oh and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 21, No. 6, 772-779. (1989)

The effects of screw speeds and moisture contents on the physical properties of texturized extrudate from isolated soy protein were examined by using a single-screw extruder. The screw speeds and moisture contents tested were in the range of 122-334 rpm and 20-35%, respectively, and die temperature were 90-145℃. The texturization characteristics such as nitrogen solubility index, integrity index, chewiness, density, rehydration ratio, and lightness after rehydration were appeared to be influenced by screw speed and moisture content. As the screw speed increased and moisture content decreased, die temperature, nitrogen solubility index, integrity index, lightness before and after rehydration were increased, while chewiness, density, water content of final extrudate were decreased. The rehydration rate was changed drastically at the feed moisture content of 30% in particular. As the moisture content decreased, the air cell size became large and its number was increased. The effects of interaction between screw speed and moisture content of raw materials on the extrudate characteristics were tested by the analysis of variance.

Manufacture of Pork Rind Snack by Extrusion Cooking Process

S.Y. Yang, Y.H. Kim, C.J. Kim, M.H. Lee and C.H. Lee

Korean J. Food Sci. Technol., Vol. 22, No. 4, 451-455. (1990)

The extrusion characteristics of pork rind mixed with corn flour were investigated. The blends of pork rind to corn flour in the ratio of 1:2, 1:1, 2:1 and 3:1 (w/w) were made and each blend was dried up to 5, 10 and 15% moisture content. The blends were extruded by single screw extruder. The extrusion characteristics of each extrudate were as follow. The highest value of expansion ratio was attained by mixing pork rind and corn flour in ratio of 1:1, containing 5% moisture content. As the rind content to the corn flour mixture was increased, the bulk density, water absorption index, breaking strength and redness, of the extrudate increased, but the lightness and yellowness decreased. It was concluded that a high quality snack food could be produced by extrusion-cooking the mixture of pork rind and corn flour.

Manufacture of Pork Thigh and Chicken Meat Snack by Extrusion Cooking Process

S.Y. Yang, Y.H. Kim, C.J. Kim, M.H. Lee and C.H. Lee

Korean J. Food Sci. Technol., Vol. 22, No. 4, 456-460. (1990)

The processing condition for the production of meat snack were investigated by using a Bonnot Single-screw extruder. Pork and chicken meat were mixed with corn flour in various ratios. respectively, and extruded at different screw speeds (120~260rpm). As the meat content was increased, the expansion ratio, water absorption index, lightness and yellowness of the extrudate were decreased. The expansion ratio tended to increase with an increase in screw speed, but the opposite relationship was observed with the maximum meat content (meat:corn flour=2:1). The maximum water absorption ratio was obtained at the screw speed of 190 rpm when the meat content was relatively low, but it moved to 120 rpm as the meat content was increased. The bulk density of the extrudate was significantly increased as the meat content exceeded 50%, and no significant differences in bulk density was found at the higher meat content. The redness increased as the moisture content was increased. The maximum breaking strength was attained at the meat-corn flour ratio 1:1, and the breaking strength tended to decreased as the screw speed increased.

Effect of Extrusion-Cooking on the Molecular Structure and Alcohol Yield of Wheat Starch

Cherl-Ho Lee, Gi-Myung Kim, Ji-Young Kim and Jae-Gak Lim

Korean J. Food Sci. Technol., Vol. 23, No. 6, 683-688. (1991)

Wheat flour was extruded by a single-screw extruder, and used for the ethanol production of takju. The molecular structure and enzymic susceptability of extruded starch were compared to those of steam cooked one. The gel permeation chromatographic pattern of wheat flour extrudates was not significantly different from those of raw and steam cooked starches. However the conversion rate of extruded starch into maltose by α-amylase hydrolysis was significantly faster than those of raw and steamed starch. The molecular weight of starch estimated from GPC pattern and the intrinsic viscosity were remarkably reduced by extrusion cooking followed by the enzymic hydrolysis for 30 min, while steam cooking and enzymic hydrolysis for 30 min did not change them significantly. Extrusion-cooked flour produced alcohol 26% higher than that of steamed flour in the laboratory takju fermentation, and 10% more alcohol in the pilot plant scale takju production.

Development of Wheat Germ Nut Processing by Using Extrusion Cooking Method

Hun Kim, Ji-Yong Kim, Yoon-Gyu Choi and Cherl-Ho Lee

Thesis Collection of Agricultures and Forestry, Korea Univ., Vol. 31, 151-158. (1991)

A process for the production of imitation nut from wheat germ by direct extrusion cooking was studied by using different configuration of a single extruder(D: 53.4mm, L/D: 11~15, tip angle 70°, 120° and flat, Die hole D: 3mm). Both the screw length and screw tip angle influenced the operational condition of the extruder and the quality of the extruded products. Flat tip which had larger void volume between screw tip and die hole produced most acceptable quality of product. The addition of flour increased the hardness of extrudate and resulted in an adverse effect to the preference of the product. The addition of shortening(in the range of 5~10%) and non-fat dry milk(5%) to wheat germ was favorable for the quality of imitation nut products. The response surface analysis revealed that the optimum conditions for texture were shortening addition 7~10%, screw speed 100rpm and metering section temperature 100℃. The optimum conditions for color were 7% shortening addition, temperature 100~110℃ and screw speed 300rpm.

Prediction of Wheat Flour-Extrudate Properties by Using Near Infrared Reflectance (NIR) Analysis

G. H. Ryu, C. E. Walker and C. H. Lee

Food and Biotechnology, Vol. 3, No. 1, 1-5. (1994)

A near-infrared reflectance (NIR) analysis was evaluated for the determination of moisture and protein contents, expansion ratio, bulk density, breaking strength, and pasting properties of wheat flour extrudates containing various baking ingredients, A Wenger TX-52 twin-screw extruder was operated under fixed conditions to prepare samples. Measured moisture and protein contents of extrudates were highly correlated with NIR-predicted values for moisture and protein (R=0.99 and R=0.98, respectively). Expansion ratio, bulk density, and breaking strength of extrudates had lower correlation coefficients for the calibration sets. For pasting properties of extrudates, measured breakdown viscosity showed relatively high correlations with NIR-predicted breakdown viscosity. However, a quick measurement of extrudate properties with NIR spectroscopy could provide process operators with a means to monitor an extruder and optimize operating conditions.

Studies of the Effects of Amylase Addition to Rice Extrusion on the Rheological Properties of the Extrudate for Weaning Food Base

Gang-Gweon Lee, Ji-Yong Kim, and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 26, No 6, 670-678. (1994)

The effect of amylase addition during extrusion cooking of rice on the physico-chemical properties of the extrudates were investigated in order to develop rice-based Korean style weaning food products. A laboratory-built single screw extruder was used, the enzymes used were Termamyl 120LS (amylase from *Bacillus licheniformis*, NOVO Co.), BAN 240L (amylase from *Bacillus amyloliquefaciens*, NOVO Co.) and malt powder. By the addition of enzymes, the water soluble index of the extrudates increased by 3 times compared to that of the extrudates without enzyme and the concentration of reducing sugar in the extrudates increased drastically at 28% feed moisture. The gel permeation chromatographic pattern showed that the large molecular starch fractions diminished by the addition of enzyme during extrusion and the low molecular fraction increased. The residual enzyme activity in the extrudate were 27% for the most thermo-resistance enzyme by treating at 14 0℃ in the metering section of the extruder. The sediment volume of the extrudate dispersion increased as the metering section temperature increased to 140℃. By the addition of enzymes the viscosity of extrudate dispersion was reduced 1/4-1/200 of that of the extrudates without enzyme. It allowed us to use 1.8 times of solid material to the weaning food formulation to attain the same level of consistency as the commercial products. It proves that the addition of amylase during rice extrusion is effective to increase the energy density of weaning food by starch degradation, which results in the increases of water solubility, reducing sugar content, dispersibility and fluidability.

Formation of Enzyme Resistant Starch by Extrusion Cooking of High Amylose Corn Starch

Ji-Yong Kim and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 30, No. 5, 1128-1133. (1998)

Extrusion cooking treatment was compared with autoclaving/cooling treatment for formation of enzyme resistant starch of high amylose corn starch (HACS). Effects of barrel temperature (100℃, 120℃, 140℃) and feed moisture content (25%, 35%, 45%) on extrusion processing in a co-rotating twin-screw extruder under fixed screw speed (100 rpm) were investigated by measuring enzyme resistant starch (RS) yield. RS yield were estimated by in-vitro pancreatin digestion method and enzymatic-gravimetric method using termamyl. Barrel temperature and yield of RS were negatively correlated and feed moisture content and yield of RS was positively correlated as determined by in-vitro pancreatin method. The highest yield (38.4%) of RS was obtained from HACS extrudate processed at the barrel temperature of 100℃ and the feed moisture content of 45%, while the yield of RS by 5 times of autoclaving/cooling was 25%. The yield of RS by in vitro pancreatin digestion method was 20.7% with high amylose corn starch and 8.2% with ordinary corn starch (CS), respectively, under the same extrusion condition (barrel temperature 120℃, feed moisture content 35%). At the same condition, the yields of RS by enzyme-gravimetric method were 14.6% with HACS and 6.8% with CS, respectively. The yield of RS increased during the storage at 4℃ for 4 weeks and the highest yield (60%) was obtained by the storage of HACS extrudates extruded at 100℃ and 45% feed moisture content.

Crystalline Structure of the Extrudate of High Amylose Corn Starch

Ji-yong Kim and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 30, No. 5, 1024-1028. (1998)

Crystalline structure of the extrudate of high amylose corn starch was studied by X-ray diffractometer and ^{13}C NMR. The X-ray diffraction crystal ratio of the extrudates (barrel temperature 100℃) of high amylose corn starch slightly increased from 6.08% to 8.37% by increasing feed moisture content from 25% to 45%. But extrudates of high amylose corn starch showed similar crystal ratio on various extrusion conditions. Extrudates of high amylose corn starch (feed moisture content 20%, barrel temp 140℃) showed more enlarged crystal structure than that of non-extrudates. The perpendicular distance of crystal increased by extrusion. Crystal ratio was changed from 6.3~8.3% to 4.5~5.8% during storage at 4℃. Starch configuration was examined with 13C NMR. Double helical content was measured by ^{13}C NMR method. The highest double helical content (60%) was obtained from high amylose corn starch extrudate (barrel temp.: 100℃, feed moisture content 45%). Double helical contents and resistant starch (RS) yield (pancreatin) were positively correlated. However, double helical content of the extrudates was not changed by the storage at 4℃.

Food Irradiation

Batch Scale Storage of Sprouting Foods by Irradiation Combined with Natural Low Temperature, I. Storage of Potatoes

Han-Ok Cho, Myung-Woo Byun, Joong-Ho Kwon, Ho-Sook Yang and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 14, No. 4, 355-363. (1982)

In order to develop the commercial storage method of potatoes by irradiation combined with natural low temperature, two varieties of potatoes, Irish cobbler and Shimabara were stored at natural low temperature storage room (450×650×250cm; year round temperature change. 2-17℃; 70-85% R.H.) on a batch scale followed by irradiation with optimum dose level. Irish cobbler and Shimabara were 100% sprouted after 3 months storage in control, whereas in 15Krad irradiated group, sprouting was completely inhibited at Irish cobbler for 9 months storage, and at Shimabara for 12 months. The extent of loss due to rot attack after 9 months storage was 6% in control, 6-8% in 10-15 Krad irradiated group at Irish cobbler and weight loss was 16.5% in control, 5.1-5.6% in irradiated group, whereas rotting rate of Shimanara after 12 months storage was 100% in control, 15% in irradiated group and the weight loss of its was 12.6% in control, 7.3-7.4% in irradiated group. The moisture content in whole storage period of two varieties were 72-82% without remarkable changes. The total sugar and ascorbic acid contents were slightly decreased according to the dose increase and elapse of storage period, whereas reducing sugar content was increased. Irish cobbler was 90% marketable after 9 months storage and 85% in Shimabara after 12 months storage.

Batch Scale Storage of Sprouting Foods by Irradiation Combined with Natural Low Temperature, II Suitability for Potato Chip Processing of Irradiated Potatoes after Storage

Myung-Woo Byun, Cherl-Ho Lee, Han-Ok Cho, Joong-Ho Kwon and Ho-Sook Yang

Korean J. Food Sci. Technol., Vol. 14, No 4, 364-369. (1982)

Two varieties of potatoes, Irish cobbler and Shimabara stored for seven and nine months respectively by irradiation combined with natural low temperature (year-round temperature change: 2-17℃) on a batch scale were investigated on the suitability for processing of potato chip. Nine months after storage, irradiated potatoes (Irish cobbler) tended to maintain somewhat better texture and sensory quality than untreated in potato chip processing. Peel rate, closely related to potato chip yield, of untreated potatoes were 20-25% higher than those of irradiated and Agtron color determination of potato chip from both irradiated were commercially acceptable. Preservation of potatoes by irradiation combined with natural low temperature was evaluated as an alternative method of the supply for raw materials of potato chip processing in the off-season in Korea.

Effects of Gamma Irradiation on Quality in the Processing of Low Salted and Fermented Shrimp

Kyong-Haeng Lee, Hyun-Joo Ahn, Cherl-Ho Lee, Jong-Goon Kim, Myung-Gon Shin and Myung-Woo Byun

J. Korean Soc. Food Sci. Nutr., Vol 29, No. 3, 430-436. (2000)

Irradiation technology was applied to develop low salted and fermented shrimp that has better sensory quality and a longer shelf-life without any food additives. Different levels of salt (10, 15, and 20%, w/w) were added to the salted and fermented shrimp and the samples were irradiated at 0, 2.5, 5.0, 7.5, and 10.0 kGy with a gamma source (Co-60). Proximate composition, salinity, water activity (a_w), pH, total bacterial count, and general acceptance were analyzed during fermentation at 15℃ after irradiation. The proximate analysis, salinity, and aw were not affected by gamma irradiation during fermentation. However, pH and total bacteria, as well as sensory evaluation, were changed variously with processing conditions such as sodium chloride concentration and irradiation dose. The combinations of 15% salt concentration with 10 kGy irradiation dose and 20% with 5 kGy or above were effective for shelf-life enhancement of the salted and fermented shrimp by adequate suppression of microorganisms during fermentation at 15℃. The results showed that the sensory quality of the sample was maintained up to 10 weeks after fermentation. Therefore, it was considered that gamma irradiation was effective in processing low salted and fermented shrimp and extending their shelf-life without adding any food additives.

Processing of Low Salted and Fermented Shrimp Using Gamma Irradiation Before Optimum Fermentation

Hyun-Joo Ahn, Cherl-Ho Lee, Kyong-Haeng Lee, Jae-Hyun Kim, Bo-Sook Cha and Myung-Woo Byun

Korean J. Food Sci. Technol., Vol 32, No. 5, 1107-1113. (2000)

Gamma irradiation technology was applied to develop salted and fermented shrimp with lower salt concentration, high sensory quality and storage stability. Shrimp was prepared with 15 and 20% of salt and fermented at 15℃ for 10 weeks. The sample was irradiated at 0, 5.0 and 10.0 kGy right before optimum stage of fermentation. Fermented shrimp with 30% of salt concentration was also prepared as a control. The proximate composition, salinity and Aw were not affected by gamma irradiation. However, pH of irradiated samples was lower than that of non-irradiated samples, probably because irradiation effectively suppressed excessive fermentation by controlling microorganisms. From the results of sensory analysis, it was concluded that fermented shrimp with 15% of salt and irradiated at 10 kGy before optimum fermentation, or 20% of salt and 5 kGy or above were the most effective in terms of sensory quality and storage stability.

Effects of Gamma Irradiation on Changes of Chemical Compounds in the Processing of Fermented Shrimp with Law Salt

Hyun-Joo Ahn, Kyong-Haeng Lee, Cherl-Ho Lee, Bo-Sook Cha and Myung-Woo Byun

J. Korean Soc. Food Sci. Nutr., Vol 29, No. 4, 629-634. (2000)

The effects of gamma irradiation on changes of chemical compounds of fermented shrimp with low salt were studied. The shrimp was salted with NaCl concentration of 10%, 15% and 20%, and irradiated at 0, 2.5, 5.0, 7.5 and 10.0 kGy. Amino nitrogen (AN), volatile basic nitrogen (VBN), trimethylamine (TMA) and neutral protease activity were examined during fermentation at 15℃. A sample with 30% salt concentration was also prepared as a control. The initial contents of AN, VBN, TMA and protease activity were not affected by gamma irradiation. The contents of AN, VBN and TMA were increased with fermentation period. But, the more increased NaCl concentrations and the higher irradiation dose, the less increased content of chemical compounds and protease activity were found. Protease activity was increased until 4~5 weeks and then decreased gradually. The results showed that the chemical compounds and protease activity of salted and fermented shrimp prepared with 15% NaCl concentration and 10 kGy irradiation dose, or 20% and 5 kGy or higher were maintained the appropriate level of quality up to 10 weeks of storage compared with the control.

Change of Chemical Properties in Processing of Low Salted and Fermented Shrimp Using Gamma Irradiation immediately before Optimum Fermentation

Kyong-Haeng Lee, Hyun-Joo Ahn, Cherl-Ho Lee, Yeung-Ji Kim and Myung-Woo Byun

Korean J. Food Sci. Technol., Vol 32, No. 5, 1051-1057. (2000)

Gamma irradiation was applied to develop fermented shrimp product with lower salt concentration, high sensory quality and storage stability. Shrimp was prepared with 15 and 20% of salt and fermented at 15℃. The sample was irradiated for 15% added salt at the 4th week and for 20% at the 6th week during fermentation with 0, 5 and 10 kGy absorbed doses. The irradiation was applied at optimum stage of fermentation determined when the content of amino nitrogen(AN) arrived approximately 400 mg%. Chemical properties such as amino nitrogen(AN), volatile base nitrogen(VBN), trimethylamine(TMA) and neutral protease activity were examined during whole fermentation. The AN, VBN, TMA and protease activity were not affected immediately after gamma irradiation. The more NaCl concentrations and irradiation dose, the less content of chemical compounds and protease activity was found. From the results of chemical properties, it was concluded that fermented shrimp with 15% of salt and irradiated at 10 kGy before optimum fermentation, or 20% and 5 kGy or above were maintained the sound quality during storage compared with the control.

Application of Gamma Irradiation on Breakdown of Hazardous Volatile N-Nitrosamines

H.J. Ahn, H.S. Yook, M.S. Rhee, C.H. Lee, Y.J. Cho, and M.W. Byun

J. Food Sci., Vol. 67, No 2, 596-599. (2002)

Gamma irradiation was applied for the breakdown of the volatile N-nitrosamines (VNAs), nitrosodimethylamine (NDMA), and nitrosopyrrolidine (NPYR). NDMA and NPYR were dissolved in distilled water, dichloromethane, or ethanol, and irradiated at 2.5, 5.0, 7.5, 10, 15, 20, and 25 kGy by gamma ray. Samples were analyzed by GC-TEA. NDMA and NPYR in distilled water and dichloromethane were easily broken at 5 kGy or above. NPYR was the most sensitive to irradiation, while the NDMA is relatively resistant to irradiation. NDMA and NPYR dissolved in ethanol was the most resistant to irradiation and the breakdown was 90% or above at 20 kGy. VNA formation was not observed by in vitro test from decomposed compounds without nitrite, while the VNAs were found by exposure of irradiated products to nitrite. Results indicated that the gamma irradiation technology may be effective to reduce carcinogenic VNA contents in food and other industry.

Monitoring of Nitrite and N-Nitrosamine Levels in Irradiated Pork Sausage

Hyun-Joo Ahn, Cheo-Run Jo, Jae-Hyun Kim, Young-Jin Chung, Cherl-Ho Lee and Myung-Woo Byun

J. Food Protection, Vol. 65, No 9, 1493-1497. (2002)

Residual nitrite and N-nitrosamine levels were monitored on irradiated emulsion-type cooked pork sausage in aerobic or vacuum packaging states during storage. The sausage was irradiated at 0, 5, 10, and 20 kGy and stored at 4℃ for 4 weeks. The residual nitrite levels were significantly reduced by gamma irradiation ($P < 0.05$), whereas the vacuum packaging was more effective for nitrite reduction than aerobic packaging during storage. N-nitrosodimethylamine (NDMA) and N-nitrosopyrrolidine (NPYR) levels were significantly reduced in the vacuum packaged sausage irradiated with 20 kGy after 4 weeks. Reduction of NPYR in aerobically packaged sausage was also found after 4 weeks by irradiating with a 5-kGy or higher dose. NDMA reduction was shown in vacuum packaging and irradiation at 20 kGy. Gamma irradiation was effective in reducing the residual nitrite all throughout storage and N-nitrosamines in sausage after storage.

Reduction of Carcinogenic N-Nitrosamines and Residual Nitrite in Model System Sausage by Irradiation

H.J. Ahn, J.H. Kim, C. Jo, C.H. Lee and M.W. Byun

J. Food Sci., Vol. 67, No. 4, 1370-1373. (2002)

Gamma irradiation was used to reduce the N-nitrosamines and residual nitrite in model system sausage during storage. Aerobic or vacuum packaged sausage was irradiated at 0, 5, 10, 20, and 30 kGy. The residual nitrite levels were significantly reduced by gamma irradiation, and, in vacuum packaging, the reduction was dose dependent. The N-nitrosodimethylamine of the sausage irradiated at 10 kGy or above reduced in aerobic packaging, while a dose of 20 kGy was needed in vacuum packaging. The N-nitrosopyrrolidine reduction was found at 20 and 30 kGy irradiation. Results indicated that high dose irradiation (>10 kGy) was needed to reduce the carcinogenic N-nitrosamine and nitrite levels in pork sausage during storage.

Irradiation Effects on Kinetics and Nitrosation of Volatile N-Nitrosamine in Different Solvent Systems

Hyun-Joo Ahn, Jae-Hyun Kim, Hong-Sun Yook, Cherl-Ho Lee and Myung-Woo Byun

Food Sci. Biotechnol., Vol. 11, No. 1, 62-65. (2002)

Gamma irradiation was applied to destroy the volatile N-nitrosamine and its kinetic studies were performed. N-nitrosodimethylamine (NDMA) and N-nitrosopyrrolidine (NPYR) were dissolved in ethanol, dichloromethane or distilled water, respectively, and irradiated at 2.5, 5.0, 7.5, 10, 15, and 20 kGy. The concentration of NDMA or NPYR was determined by GC-TEA. NDMA and NPYR dissolved in ethanol were most resistant to irradiation and their breakdown rates were 90% or above at 20 kGy. However, NDMA and NPYR in distilled water or dichloromethane were easily broken at 5 kGy or above. The breakdown rate constant (K) of NDMA in distilled water and NPYR in dichloromethane has relatively increased. NDMA and NPYR reformation was not observed by in vitro test from degraded compounds without nitrite, while NDMA and NPYR were found by exposure of irradiated products to nitrite. Gamma irradiation showed a potential to reduce carcinogenic N-nitrosamine in food and other materials.

Changes in Microbial and Chemical Composition and Sensory Characteristics of Fermented Soybean Paste, Chungkukjang, by High Dose Gamma Irradiation (10~120 kGy)

Bo-Sun Ahn and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol 35, No. 2, 166-172. (2003)

Changes in the number of microorganisms, chemical composition, and sensory quality of chungkukjang by gamma-irradiation up to 120kGy were investigated. The total viable cell counts in chungkukjang irradiated with 10kGy decreased from 109 CFU/g of the control to 105 CFU/g. Proximate chemical composition and pH of chungkukjang were not much affected by irradiation. Acidity of chungkukjang decreased by irradiation with over 20 kGy. Fatty acid contents of chungkukjang irradiated under 20 kGy were the same as those of the nonirradiated ones. Polyunsaturated fatty acids content, decreased at over 40 kGy. Unpalatable oder ($p<0.01$), off-flaver($p<0.001$), and fish-odor ($p<0.001$) increased, and brown intensity ($p<0.05$) and acceptability ($p<0.001$) decreased at over 20 kGy. Results indicate 20kGy is sufficient to decrease the microbial count of chungkukjang and prevent decrease in the content of polyunsaturated fatty acids.

Identification of radiolytic products from N-nitrosodimethylamine and N-nitrosopyrrolidine by gas chromatography and mass spectrometry

Hyun-Joo Ahn, Cherl-Ho Lee, Jae-Hyun Kim, Sang-Bae Han, Cheorun Jo, Sung Kim, Myung-Woo Byun

Radiation Physics and Chemistry Vol. 69, 99-102. (2004)

The radiolytic products of N-nitrosodimethylamine (NDMA) and N-nitrosopyrrolidine (NPYR) dissolved in dichloromethane (DCM) were identified after gamma irradiation. The UV spectra of NDMA and NPYR indicated that irradiation reduced the typical peak of NDMA at 258nm and NPYR at 260 nm.The major radiolytic components identified in irradiated NDMA were ethyl acetate and 2-dimethyl propanol. The irradiated NPYR dissolved in DCM and produced 2-butanone and 2-methyl-6-propyl piperidine as the major radiolytic components. 2-Methyl-6-propyl piperidine was the component detected in the greatest concentration in irradiated NPYR.

Effects of Irradiated Phytic Acid on Antioxidation and Color Stability in Meat Models

Hee-Ra Park, Hyun-Joo Ahn, Jae-Hyun Kim, Hong-Sun Yook, Sung Kim, Cherl-Ho Lee and Myung-Woo Byun

J. Agric. Food Chem., Vol. 52, 2572-2576. (2004)

Lipid oxidation and color stability of meats treated with irradiated phytic acid were investigated during storage for 2 weeks at 4 °C. The phytic acid in deionized distilled water (DDW) was degraded by irradiation at 10 and 20 kGy, and the irradiated phytic acid showed a strong antiradical activity. For measuring the antioxidant effects of irradiated phytic acid in food models, beef and pork were prepared with DDW (control), irradiated (10 and 20 kGy) or non-irradiated phytic acid, and ascorbic acid as a model system. Irradiated phytic acid significantly inhibited the lipid oxidation in meats compared to the control and ascorbic acid treated samples during storage ($P < 0.05$). The redness of the meats treated with phytic acid had a higher value than did the control and ascorbic acid treated samples, but a significant difference was not observed in the samples treated with phytic acid regardless of irradiation treatment. Irradiated phytic acid was also effective in inhibiting the loss of heme iron and metmyoglobin formation during storage. Results indicated that irradiation might be helpful for improving the antioxidant activity of phytic acid in meats.

Effects of gamma irradiation on the microbiological, nutritional, and sensory properties of fresh vegetable juice

Hyun-Pa Song, Myung-Woo Byun, Cheorun Jo, Cheol-Ho Lee, Kyong-Soo Kim and Dong-Ho Kim

Food Control, Vol. 18, No. 1, 5-10. (2007)

The radiation pasteurization process was performed to improve the microbiological quality of fresh vegetable juice. Carrot and kale juice were irradiated and their microbiological, nutritional, and sensory properties were evaluated. The contaminating bacteria in the juices before irradiation ranged from 10^6 to 10^7 CFU/ml. All the aerobic and coli-form bacteria in the carrot juice were eliminated by irradiation at a dose of 3 kGy, whereas about 10^2 CFU/ml of the bacteria survived in the kale juice irradiated at up to 5 kGy. However, the cells that survived from irradiation in the kale juice did not grow, whereas those of the non-irradiated samples reached 10^9 CFU/ml after 3 days of storage at 10℃. Amino acids were stable at up to 5 kGy of an irradiation. Radiation resulted in a dose-dependent reduction of the ascorbic acid content. However, the contents of the total ascorbic acid, including dehydroascorbic acid, were stable at up to 3 kGy of an irradiation. The sensory evaluation results immediately after irradiation were not different in any of the samples. At a 3-day storage, the sensory quality of the irradiated juice was adequate, while the quality of the non-irradiated control was deteriorated.

Food Rheology and Sensory Evaluation

Thickening of Soy protein Suspensions with Calcium

Cherl-Ho Lee and Chokyun Rha

J. Texture Studies, Vol. 7, 441-449. (1977)

The objective of this study was to increase the apparent viscosity of 1-7 % soy protein suspensions using calcium. The thickening effect, measured by apparent viscosity, depended upon the calcium concentration. Maximun apparent viscosity was obtained with a calcium to protein molar ratio of 20-50 moles of calcium required per mole of protein (M.W. 100,000) decreased with an increase in the protein concentration. Effective stirring was necessary during and after calcium addition to attain maximum thickening and stability. Heat treatment of the protein suspension prior to calcium addition enhanced the extent of apparent viscosity increase. Higher protein concentration, improved stability of the thickened mixture. The established optimum thickening condition leading to a stable homogenous suspension involved addition of 12.5 mM $CaCl_2$ to 5 % protein suspension preheated at 80℃ for 30 min.

Evaluation of Cheese texture

Cherl-Ho Lee, Elaine M. Imoto and Cho-kyun Rha

J. Food Sci., Vol. 43, No. 5, 1600-1605. (1978)

The textural characteristics of cheese were surveyed for consumer preference and sensory perception. The important textural characteristics of cheese - hardness, chewiness, springiness and adhesiveness - were evaluated by a panel. The mechanical properties of cheese were measured with an Instron Universal Testing Machine. In making the instron measurements, the effects of the condition (i.e., rate of compression, rate of loading and cheese temperature) on the mechanical properties of cheese were determined. The melting property of cheese was determined by viscosity changes upon heating using a Brookfield Viscometer, Model RVT with T-F bar. The correlation between sensory evaluation and the mechanical properties of cheese were resolved. The panel concluded that the important textural characteristics of cheese were hardness, springiness and adhesiveness. The hardness evaluated by the panel was related to the Instron determination of the compression force, work ratio, adhesive force, force at the inflection point and viscometer determination of the melting property. The sensory assessment of springiness correlated with elastic recovery and force at the inflection point. The sensory adhesiveness rating was related to the adhesive force but inversely related to force at the inflection point.

Effect of compression ration on the mechanical properties of cheese

Elaine M. Imoto, Cherl-Ho Lee and Cho-kyun Rha

J. Food Sci., Vol. 44, No. 2, 343-345. (1979)

The effect of compression ratio on the following mechanical properties of cheeses was studied: compression force, work ratio, adhesive force, recovered height and compression ratio at the inflection point. The mechanical properties changed with compression ratio in a unique pattern for each type of cheese; changes in work ratio and recovered height produced the most distinctive patterns. The mechanical responses of imitation processed American cheese to changes in the compression ratio clearly differed from those of natural ripened cheeses. The correlation between sensory evaluation of hardness, chewiness, springiness, and adhesiveness, and the mechanical properties measured by instrument changed with the compression ratio used for the instrumental determinations. Therefore, the optimum compression ratio to be used for instrumental determination of mechanical properties must be evaluated for each property with the fitness test correlating instrumental and sensory evaluations.

Accelerated Sedimentation test for the Determination of Dispersion Stability of Protein Isolates

Cherl-Ho Lee and Cho-Kyun Rha

J. Food Sci. Vol. 44, No. 2, 419-424. (1979)

An accelerated sedimentation test using a low range of centirifugal force was developed to determine and evaluate the physical stability of a protein dispersion. The dispersion stability of commercial soybean protein isolates was tested with this method. The effect of hydrocolloids and calcium salts on the dispersion stability of soybean protein isolate was also studied. The accelerated sedimentation test could distinguish differences in dispersion stability of soybean protein isolates produced by different manufacturers. Neutralization and subsequent heat treatments had a stabilizing effect on the dispersion of isoelectric type soybean protein isolates. Dispersion stability was related to the hydration and swelling of the protein particles, and distintegration and aggregation type of hydrated particles.

Studies on the Changes in the Carbohydrates and Color of Ginseng Extract during the Processting and Stroage

Myung-Han Park, Hyun-Soon Sung and Cherl-Ho Lee

Korean. J. Ginseng Sci., Vol. 5, No. 2, 155-162. (1981)

This study was aimed at elucidating the composition and color in ginseng extracts during the processing and the long periods of the storage. The types of sugar were determined by using HPLC. In the model study with the fresh ginseng extracts stored at the elevated temperatures between 70-100℃ for 24-96 hrs, it was shown an overall increase in the concentration of fructose and the overall reduction in the concentrations of sucrose and maltose with increase in the storage temperature and time. The concentration of glucose increased for 34 hrs of stroage at all temperatures studied and then decreased with the storage time. Rhamnose in the extracts stored at 80℃ for 72 hrs was identified and its concentration was increased at the higher storage temperature. The reduction of the concentrations of sugars related to the development of brown color during the processing and the storage.

Studies on the Texture Describing Terms of Korean

Cherl-Ho Lee and Sang Hee Park

Korean J. Food Sci. Technol., Vol. 14, No. 1, 21-29. (1982)

The texture describing terms used for the Korean staple foods, cooked rice, noodles and Kimchi, were surveyed by questionaire. A total of 154 kinds of terms were collected from 68 answers, in which 95 words were found with definite textrural meaning in Korean dictionaries. The terms were classified according to their physical properties by Szczesniak's method. The important textrual properties of different types of Korean foods were pointed out by the frequency of mentioning and by the preference expressions. The representative Korean words expressing each textural property of different type of food were selected. The important textural properties for Korean were hardness, brittle-gumminess, chewiness, springiness, adhesiveness, particle size and shape, moisture content and fat content of cooked rice, chewiness, hardness, springiness and particle size and shape of noodles, and hardness, brittle-gumminess, chewiness, springiness and particle shape and orientation of *Kimchi*.

Microstructure and Hydrodynamic Properties of Soybean Protein Bodies in Solutions

Cherl-Ho Lee, Chan-Shick Kim and Han-Chul Yang

J. Food Sci., Vol. 48, No. 3, 695-702. (1983)

The changes in the size and shape of soybean protein bodies in different solvent systems were observed, and their influence on hydrodynamic properties in solutions was investigated by capillary viscometer. The intrinsic viscosity of the isolated protein bodies varied with the type of dispersion media; 0.063 cm^3/g in CCl4 benzene solution, 0.355 cm^3/g in 50% glycerol-water mixture, 0.574 cm^3/g in water at pH 7, and 1.18 cm3/g in the aqueous solution at pH 12. The hydration of the protein bodies in different dispersion media was estimated by Oncley's method and Mooney's method. The estimated degree of hydration agreed well with the swelling of the protein bodies as observed by microscope.

Studies on the Rheological Property of Korean Noodles, I. Viscoelastic Behavior of Wheat Flour Noodle and Wheat-Sweet Potato Starch Noodle

Cherl-Ho Lee and Cherl-Won Kim

Korean J. Food Sci. Technol., Vol. 15, No. 2, 183-188. (1983)

The viscoelastic behavior of traditional Korean noodles was examined by using a tensile tester built in the laboratory. The creep test of cooked noodle strand showed that a linear viscoelastic response could be expected for a short time of creep, i.e. 120 sec for wheat flour noodle and 60 sec for wheat-sweet potato starch noodle, with the stress range between 4×10^4 and 14×10^4 dyn cm^{-2}. The elastic modulus was estimated to be 7.0×10^5 dyn cm^{-2} for wheat flour noodle and 3.9x105 dyn cm^{-2} for wheat-sweet potato starch noodle. A peculiar increase in viscosity with increasing stress, i.e. stress-hardening, was observed in the noodles studied.

Studies on the Rheological Property of Korean Noodles, II. Mechanical Model Parameters of Cooked and Stored Noodles

Cherl-Ho Lee and Cherl-Won Kim

Korean J. Food Sci. Technol., Vol. 15, No. 3, 295-301. (1983)

The mechanical models representing the rheological property of traditional Korean noodles; i.e. wheat flour nooldle and wheat-sweet potato starch noodle, were investigated from the data obtained by creep and creep recovery test using a tensile tester. The rheological behavior of the noodle products could be expressed by the 6-elements Voigt model. The instantaneous elasticity, retarded elasticity, retardation time, retarded viscosity and Newtonian viscosity of the noodle products were evaluated. With the increasing cooking time, 4-elements Burger's model was applicable to represent the mechanical behavior of wheat-sweet potato starch noodle.

Studies on the Rheological Property of Korean Noodles, III. Correlation between Mechanical Model Parameters and Sensory Quality of Noodles

Cherl-Ho Lee and Cherl-Won Kim

Korean J. Food Sci. Technol., Vol. 15, No. 3, 302-306. (1983)

The changes in the mechanical model parameters during cooking and subsequent storage, were related to the sensory quality of the noodles. The sensory hardness and chewiness were tested by Milestone method and the overall preference was evaluated by hedonic scale test. Hardness was affected primarily by increasing cooking time and in lesser degree by storage time after cooking. Chewiness was diminished by increasing cooking time and subsequent storage. The preference of wheat flour noodle was not significantly affected by cooking time, while that of wheat-sweet potato starch noodle decreased significantly by excess cooking time. Instantaneous elasticity represented the softness of noodle. The elastic components and viscosity components had significant relationship with the sensory quality of wheat noodle. On the other hand the retardation time was important for the sensory of wheat-sweet potato starch noodle.

Effects of the Addition of Starch, Salt and Soda Ash on the Mechanical Property of Naengmyon

O-Hun Kwon and Cherl-Ho Lee

J. Food Sci., Vol. 16, No. 2, 175-178. (1984)

The effects of the addition of starch, salt and soda ash to the dough for Naengmyon (wheat-sweet potato starch) on the mechanical property of Naengmyon noodle were evaluated by using creep test. The strain measurement was made by taking photograph with VTR system. The creep curve of noodle strand could be fitted to the 4 element Burgers model. The instantaneous elasticity and Newtonian viscosity of the noodle strand decreased by the addition of starch. The instantaneous elasticity decreased by the addition of salt up to 4%. The mechanical parameters of the noodle varied inconsistently by the addition of soda ash.

Milling Property of Australian Wheats and Physicochemical Properties of the Flours

Cherl-Ho Lee, Hyun-Duck Lee, O-Hun kwon, and Hak-Gil Chang

J. Korean Agricultural Chemical Society. Vol. 27, No. 1, 21-28. (1984)

The milling property of 6 different Australian Wheat varieties (Australian Prime Hard (APH), Australian Hard (AH), Western Australian Wheat (WAW), South Australian Wheat (SAW), Australian Standard White (ASW) and Australian Soft Wheat (SW)) was investigated by using Bühler test mill. The flour characteristics were evaluated by farinograph. mixograph, amylograph, sedimentation and pelshenke test. The milling rate of Australian wheats varied from 59% to 66%, and that of Suwon 219 (Korean variety) was 65.5%. The milling rate was significantly related to the seed weight but less extent to the bulk density of grain. The flours obtained from the wheat varieties exhibited distinctly different chemical compositions and dough properties. The protein content of the flour varied from 14.47% (APH) to 6.59 % (SW). The gluten forming ability of APH and AH was verv high, but very low with ASW and SW. On the other hand, ASW and WAW showed very high gelatinized viscosity, while SAW marked exceptionally 1ow viscosity.

The Quality of Korean Dried Noodle made from Australian Wheats

Hyun-Duck Lee and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 17, No. 3, 163-169. (1985)

Korean dried noodles were prepared from 6 different types of Australian wheats and tested for their cooking property and sensory quality. The flours from different wheat types were characterized by the fractionation of starch and gluten. The flow property of fractionated starch and flour suspensions were determined. The protein content of flour influenced many aspects of dried noodle quality. The Cooking rate decreased as the protein content increased. The higher protein content resulted in the higher of shear extrusion force and lower grade of appearance of cooked noodle. The flours containing about 10% protein, i. e. Australian Standard White flours, were appeared to be most adequate to make Korean dried noodle.

The Textural Properties of Imitation Cheese by Response Surface Analysis

Cherl-Ho Lee and Hye-Sook Son

Korean J. Food Sci Technol. Vol. 17, No 5, 361-370. (1985)

The effect of major ingredients (Water, Soybean oil, Na-caseinate, Soybean protein isolate, Corn starch, Lactic acid and disodium phosphate) on the textural properties of imitation cheese were studied by response surface methodology and evaluated by contour diagram. The hardness of imitation cheese was directly influenced by the contents of water, oil and Na-caseinate and also affected by the interactions between water and oil and corn starch and lactic acid/phosphate. The adhesiveness was strongly affected by the interactions between caseinate and lactic acid/phosphate, SPI and corn starch and corn starch and lactic acid/phosphate. The springiness was directly influenced by the contents of oil, caseinate and lactic acid/phosphate, and also affected by the interactions between SPI and lactic acid/phosphate and corn starch and lactic acid/phosphate. The melting property was strongly influenced by the contents and interactions of lactic acid/phosphate.

Microstructure of Lupin Seed; a Comparative Study With Soybean

Cherl-Ho Lee and Jeong-Kyo Kim

Korean J. Food Sci. Technol., Vol. 17, No. 6, 454-459. (1985)

The structure of the seed of *Lupinue angustifolius* was studied in order to investigate the food quality of lupin seed in comparision with soybean. The cotyledonary cells of lupinseed was in egg-like shape and much (more than 4 times) larger than those of soybean. The microstructure of cotyledonary cells of lupinseed was characterized with thick cell wall having distinct pit-pairs. The protein bodies in lupinseed cotyledon cell contained numerous crystaloids, which was absent in soybean. The middle lamella of soybean cell was partially disintegrated by excessive heat treatment (120℃, 20 min), whereas those of lupinseed did not change much by heating at 120℃ for 130 min.

The Soaking and Cooking Properties of Soybean and Lupinseed

Cherl-Ho Lee, Chan-Shick Kim and Sung-Hoon Oh

Thesis Collection of Agricultures and Forestry, Korea Univ,, Vol. 25, 179-188. (1985)

The rate of water absorption during soaking and the texture softening kinetics during cooking of soybean and lupinseed were investigated. The soaking rate of lupinseed was faster than soybean, in spite of the thicker seed coat and larger fiber content in the seed coat of lupinseed. The texture softening of lupinseed and soybean during cooking followed the first order reaction rate. The texture softening of lupinseed and soybean during cooking followed the first order reaction rate. The rate constants of 100℃ were 6.7×10^{-3} for lupin seed and 2.69×10^{-2} for soybean. The changes in rate constant by cooking temperature fitted to the Arrhenius plot, and the activation energies were estimated to be 11.62Kcal/g mole for lupinseed and 14.96Kcal/g mole for soybean. The decimal reduction time for texture softening were 344.9min at 100℃ and 163.9min at 121℃ for lupinseed and 84min at 100℃ and 32.2min at 121℃ for soybean. The cooking constant varied between 0.6~0.95 for both beans, and the calculated cooking time were 231min at 100℃ for lupinseed and 79.8min at 100℃ for soybean. The Z values were 55.4℃ and 39.1℃ for lupinseed and soybean, respectively. Soaking in $NaCl+NaHCO_3$ solution increased the rate constant of lupinseed and decreased the cooking time by 1/3. However, soaking in salt solution did not affect significantly the cooking rate of soybean.

Effects of Wheat Variety, Protein Content and Extraction Rate of Flour on the Color Preference of Korean Dried Noodle

C.H. Lee, H.D. Lee, B.S. Yoo and S.H. Hong

Thesis Collection of Agricultures and Forestry, Korea Univ,, Vol. 26, 119-131. (1986)

The color preference of Korean dried noodle made from 33 different types of Australian wheat flours investigated; 17 samples were made from different protein levels of 7 varieties of wheat and 16 samples from different extraction rate of 4 classes of Australian wheat. The variety of wheat and protein content were the most important factors governing the color preference of Korean dried noodle, but extraction rate in the range of 45~75% did not appeared to influence the color of dried noodle much. Gamenya, Eradu, Gutha, cultivated at Western Australia in 1983/84, resulted in excellent color preference in the noodle. Australian Soft and Australian Standard White (ASW) containing 9~10% protein produce excellent quality of dried noodle and Australian Hark, which contain 12% protein, was also acceptable for Korean dried noodle making. The ash content of flour may reflect the extraction rate of flour, but not directly related to the color preference of cooked noodle. The sensory panel preferred white noodle and the color preference was directly related to the overall eating quality of cooked noodle. The Hunter L and YI values could represent the eating quality of Korean dried noodle. A higher correlation coefficient was obtained by using both L and YI value in multiple regression than in simple regression using L and YI values, respectively.

Development of Shear Extrusion Test for the Texture Evaluation of Cooked Noddle

Byoung-Seung Yoo and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 19, No. 2, 171-175. (1987)

An objective method for the evaluation of eating quality of cooked noodle was established by using a specially designed shear extrusion cell of Rheometer. From the force-distance curve, the maximum force, initial force, extrusion work, and the slope were determined. In a test with Korean dried noodles made from 17 types of Australian wheat flour, the maximum and initial forces and extrusion work could represent the firm-soft and chewy character, which govern mostly the preference of cooked noodle. On the other hand, the slope could distinguish the textural changes of cooked noodle during the storage after cooking. The parameters showed significant correlation with the protein content, water absorption, development time and extensibility of flour, but no correlation was obtained with the maximum viscosity of viscogram. For the estimation of textural preference, the correlation coefficient obtained from a multiple regression analysis using the maximum viscosity of viscogram and the maximum force of shear extrusion test as the two independent variables was not significantly higher than the coefficient obtained from a simple regression with the maximum force only.

Microstructure and Textural Properties of Cell Mass from Cooked Kidney bean and Soybean

Jeong-Kyo Kim, Tokuji Watanabe and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 19, No. 2, 164-170. (1987)

The microstructure, contents of pectic substances and textural properties of cell masses separated from cooked kindey bean and soybean were investigated. Cooked kidney bean could be easily separated to the individual cells, while soybean yielded mixture of individual cells and cell clusters. The break down of the middle lamella was observed, but cell wall was not injured. Separated cells from kidney bean were spherical, while those from soybean were long sack shape as observed in both optical microscope and SEM. Cooked soybean cell mass, which had higher content of pectic substances, showed higher cohesiveness and adhesiveness compared to kidney bean cell mass.

Studies on the Sensory Characteristics of traditional Korean Cookies, *Hankwa*

Cherl-Ho Lee, Hyun-Suok Ahn and Young-Sun Maeng

Korean J. Dietary Culture, Vol. 2, No. 1, 71-79. (1987)

The sensory quality characteristics of 5 different types of traditional Korean cookies, i.e. Yackwa, Gangiung, Sanja, Dasik and Yutgangjung were investigated. A total of 77 questionnaires were collected and over 90 different terms describing the sensory characteristics of *Hankwa* were appeared, among which 58 terms were explained in Korean Dictionary. The important quality characteristic of Korean cookies were identified from the frequency of the appearance of sensory describing terms. The cookies were stored at room temperature for 10 days in various relative humidity of 0~68%, and the changes in the quality characteristics were examined organoleptically by scalar scoring test. The changes in overall acceptance were evaluated by hedonic test. The results were shown by quantitative descriptive analysis(QDA) diagram. The QDA diagram could visualize the effects of storage relative humidity on the sensory quality profile of the cookies.

Studies on the Sensory Characteristics of Korean Tea and Related Products

Cherl-Ho Lee, Sung-Hie Hong, Sung-Yun Hwang and Ae-Ja Shin

Korean J. Dietary Culture Vol. 2, No. 2, 133-147. (1987)

The sensory quality characteristics of 7 different types of Korean traditional tea products were analyzed. For the standardization of sensory testing condition, the optimum drinking temperature were measured with 50 students, and all the samples tested were found to fall in the range of 60~70℃. The optimum concentrations of tea for drinking were generally met with the amount recommended by the producer. A total of 45 sensory describing terms expressing the taste, odor, and mouthfeel were collected. Using the sensory describing terms as the character notes, flavor profile analysis was made for each tea product with 8 members of trained panel. The differences in quality characteristics of 29 test samples were evaluated and shown in the chart constructed by the quantitative descriptive analysis method.

Measurement of Viscoelastic Properties of Heat Denatured Gluten Network

Sung-Hie Hong and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 20, No. 2, 148-156. (1988)

A method for the measurement of viscoelastic properties of heat denatured gluten network was developed in order to evaluate the noodle making quality of wheat flour. The stress relaxation of elongated heat denatured gluten network could be expressed by 6-element generalized Maxwell model. The tensile force of heat denatured gluten network increased by the heating time. The elasticity and viscosity of the first exponential term which covers 70~74% of the total relaxation increased as cooking time was extended up to 19 min. The addition of gluten network strengthening agent, potassium bromate, at 1000 ppm level reduced the elasticity and viscosity, while weakening agent, L-cystein, increased them. The relaxation time decreased after 11 min of cooking in both cases. The elasticity and viscosity of heat denatured gluten were affected differently by the concentration of added urea.

Macro-and Microstructure of Chinese Cabbage Leaves and Their Texture Measurements

Cherl-Ho Lee, In-Ju Hwang and Jeong-Kyo Kim

Korean J. Food Sci. Technol., Vol. 20, No. 6, 742-748. (1988)

The macro-and microstructure of chinese cabbage used for Korean Kimchi preparation were examined and the texture characteristics of raw cabbage leaf and salted or blanched leaves were evaluated by cutting test. The length and thickness of leaf stalk increased with the order of phyllotaxis, but the thinning effect of outermost leaves was observed. The microstructure of cut-profile of stalk showed densely compacted vascular systems aligned in the center of stalk and the outer space was filled with large parenchyma cells. Due to this structure, characteristic cutting curves were obtained by cutting test, composing three peaks of cutting for inner surface skin, center vascular system and outer surface skin. Salting and blanching increased the cutting force mainly due to the increase of cutted cell wall number caused by the structure collapse.

Comparison of Cutting and Compression Tests for the Texture Measurement of Chinese Cabbage Leaves

Cherl-Ho Lee and In-Ju Hwang

Korean J. Food Sci. Technol., Vol. 20, No. 6, 749-754. (1988)

The texture measurement of Chinese cabbage leaves used for Kimchi preparation were conducted by cutting and compression test and the results were compared to the sensory evaluation. The cutting force of cabbage leaf stalk increased by blanching or salting, and a maximum cutting force was attained by salting in 15% salt solution for 5 hours. The compression force and recovered height measured by compression test of Chinese cabbage leaf stalk decreased by blanching or salting, and the breaking point disappeared. Treatment with $CaCl_2$ solution increased the cutting force, compression force and breaking strength of fresh leaves, but the effect disappeared by salting or blanching. Cutting strength could be used as a parameter indicating the hardness and chewiness of salted cabbage. Compression force and breaking strength could indicate the textural changes of blanched leaves, but were not useful for the measurement of hardness and chewiness of salted leaves.

Effects of Processing Method and Storage Temperature and Time on the Texture of Yaksik (cooked and seasoned glutinous rice)

Hei-Jeung Lee, Young-Keun Lee, Sung-Ja Koo, Sung-Hee Hong and Cherl-Ho Lee

Korean J. Dietary Culture, Vol. 3, No. 4, 391-396. (1988)

The method for the measurement of texture hardening phenomena, which is the limiting factor of shelf-life of Yaksik in the market, was established. The changes in the hardening rate by the processing conditions and the storage temperature and time were examined. The standard sample made by traditional method could be kept at room temperature(20℃) for 3 days and the multipuncture force measured at the end of marketable quality was 700 g. The hardening rate increased rapidly by storing at 6℃ and the ratio of hardening rate constants between room temperature and 5℃ storage reached to 1.3~3.3 depending on the processing condition. The largest ratio was observed by the sample made from pressure cooker. The addition of corn syrup retarded the hardening rate. The pressure cooking resulted in making too soft product, which diminished the panel preference, but it extend the shelf-life when products were stored at 5℃ microwave cooking resulted in making too hard texture which was not acceptable. The overall quality preference of Yaksik was decided by the textural preference and the latter showed significant inverse correlation with the maximum force of multipuncture test. Therefore, it was concluded that multipuncture test was useful for the measurement of the quality of Yaksik.

Changes in the Force-distance Curve of Chinese Cabbage Leaf-stalk by the Type of Puncture and Cutting Probes and Their Relations to the Textural Parameters

Ewi-Jung Yoon and Cherl-Ho Lee

Korean J. Rheology, Vol. 2, No. 1, 46-52. (1990)

The force-distance curves of Chinese cabbage leaf-stalk obtained from puncture using different types of probe were compared and the results were analyzed in relation to the sensory characteristics. The force-distance curve varied with the tip angle, tip area and perimeter of the probe of puncture test.

The breaking force increased as the tip area and perimeter increased. In cutting test typical three peaks were obtained indicating the cutting forces for the surface epidermal layers and inner vascular system. By salting of cabbage leaf, the maximum force of puncture test decreased while the breaking force increased resulting in a remarkable increase in the ratio of breaking force to the maximum force (a/c), particularly with the probes having large tip area and perimeter. The length to the elastic limit increased, and elasticity (a/1) at the initial deformation increased by salting. In cutting test, the cutting force increased by salting of cabbage leaf. The sensory crispness was related to the changes of maximum force and a/1, toughness to the changes of breaking force and a/c in puncture test and cutting force in cutting test, and the juicy-crunchiness to the a/c of puncture test.

Studies on the Rheological Properties of Sugar Derivative Sweeteners

Cherl-Ho Lee, Choon-Sang Park, Bok-Jin Han, Bong-Chan Kim and Ji-Hyang Jang

Korean J. Food Sci. Technol., Vol. 22, No. 7, 852-857. (1990)

The rheological properties and food functionality of the novel sugar derivatives, fructo-oligosaccharide, high maltose syrup(HMS), maltitol and sorbitol were examined and compared to those of sucrose. All samples tested showed Newtonian fluid property at the concentration range of 10% to the original concentrated products containing 69～81%w/w solid. HMS showed the highest viscosity. The viscosity increased(r=0.8038) as the average molecular weight of sugar derivatives were increased. The viscosity increased exponentially as the concentration increased, and sugar alcohols had lower value of the exponent compared to HMS and fructo-oligosaccharide. The viscosity of sugar derivatives solutions decreased by the increasing temperature following the Arrhenius equation. The flow activation energies of sorbitol and HMS were higer than that of sucrose. Substitution of sucrose with fructo-oligosaccharide in apple jam processing did not change the textural characteristics, but in red bean jelly (yanggaeng) it reduced the hardness, adhesiveness, springiness and cohesiveness. When sucrose was 100% replaced by HMS, the texture of apple jam and red bean jelly was not changed, but by mixing sucrose and HMS 1 : 1 ratio, the hardness decreased substantially. The sugar alcohols reduced the hardness, adhesiveness, springiness of apple jam and red bean jelly significantly. Addition of fructo-oligosaccharide and HMS to sucrose did not influence the solidifying rate of candy, but sorbitol, even at 10% addition, retarded the candy moulding.

Studies on the Functional Properties of Sugar Derivative Sweeteners

Cherl-Ho Lee, Moussa Souane, Hyun-Duck Lee and Sun-Young Kim

Korean J. Dietary Culture, Vol. 5, No. 4, 431-436. (1990)

The functional properties of novel sugar derivative sweeteners, fructo-oligosaccharide, maltitol, sorbitol and high maltose syrup(HMS) were examined for their humactant effect, lactic acid bacterial growth, *Steptococcus mutants* growth and relative sweetness compared to sucrose. Sorbitol exhibited remarkably high water activity reducing capacity, whereas fructo-oligosaccharide and maltitol showed the same level as sucrose. Maltitol showed distinct anti-bacterial(bacteriocidic) effect against *Stc. mutants* and most of lactic acid bacteria tested except for *L. plantarum*. The molar basis relative sweetness of sugar derivatives in comparison with 1%(w/w) level of sucrose were 0.69 for Neosugar (fructo-oligosaccharide), 0.21 for sorbitol, 0.50 for maltitol and 0.27 for HMS.

Studies on the Taste Describing Terms of Monosodium Glutamate and the Interactions Between MSG and Other Basic Taste Substances

Hae-Kyung Hong, Hyun-Duck Lee and Cherl-Ho Lee

Korean J. Dietary Culture, Vol. 5, No. 4, 425-430. (1990)

The taste describing terms of Monosodium glutamate(MSG) was surveyed by questionnaires, and the sensory threshold value of MSG solution was compared to those of other basic taste substances. The effects of MSG addition to the other basic tastes were also evaluated. From the 96 responders, the taste of MSG itself was expressed as greasy(58%) or nauseous(24%), but the taste expected when MSG was added to food was expressed as sapidity and relish(79%). From the sensory evaluation, the panel expressed greasy, bitter or sweet at the absolute threshold level(0.002 M) of MSG solution, but changed to greasy and salty at the recognition threshold level(0.006 M). When MSG was added to salt solution, it expanded the salty taste, but with citric acid solution it suppressed the sourness. When MSG was added to sugar solution, it expanded sweet taste at the lower concentration of MSG(0.01M), but suppressed the sweet taste as MSG concentration increased.

Effect of Monosodium Glutamate on the Taste Response of Chorda Tympani Nerve of Cat

Hae-Kyung Hong, Hyun-Duck Lee, Cherl-Ho Lee and Seung-Kil Hong

Korean J. Food Sci. Technol., Vol. 23, No. 1, 37-43. (1991)

The nerve impulse pattern of Chorda tympani(CT) of cat was tested with Monosodium glutamate (MSG) solutions as well as some basic taste substances applied on the tongue of cat. The effect of MSG applied in the tongue prior to the stimulation of other taste substances was also investigated. The response impulse frequency of CT of cat was changed by the kind and concentration of taste substances. The response to citric acid was the highest among the tested substances, NaCl, KCI and MSG showed similar responses. When different concentrations of MSG were applied on the tongue prior to other substances, the response to NaCl increased with the maximum response at the MSG concentration of 0.02 M. The response to sucrose tended to be reduced, but the response to citric acid was distinctly supressed by the previous MSG stimulation. These results were well consistent with the sensory evaluation on the effect of MSG to some basic taste substances. previously reported by the authors.

Effect of Reaction Time on the Rheological Properties of Dextran Formed Solution Produced by Crude Dextransucrase from *Leuconostoc mesenteroides* Sikhae

Choon-Sang Park and Cherl-Ho Lee

Korean J. Appl. Microbiol. Biotechnol., Vol. 20, No. 3, 316-323. (1992)

Studies on the changes in rheological properties, molecular weight distribution and dextran yield after being reacted in 10%(w/w) sucrose concentration were performed with crude dextransucrase produced from *Leuconostoc mesenteroides* isolated from Sikhae. The reaction rate of dextran formation was monitored by sugar analysis with HPLC and by the changes in apparent viscosity. According to the periodate oxidation test, the dextran produced in this experiment was estimated to have 89% α-(1→6) main linkages and 11% α-(1→3) side linkages. The rheological properties of the dextran solution formed changed with reaction time, and it was related to the changes in molecular weight distribution of dextran as determined by GPC analysis. As the reaction proceeded, the rheological behavior changed from Newtonian to non-Newtonian, showing Bingham pseudoplastic and thixothropic flow behavior. The apparent viscosity of dextran formed solution increased with increasing reaction time, reached a maximum value of 2680 cP (γ=33.75s^{-1}, 25℃) by enzyme reaction for 8 hours, and then decreased. The temperature dependency of dextran formed solutions was well expressed by the Arrhenius equation and the activation energy reached a maximum value of 1.69 kcal/mole by enzyme reaction for 8 hours.

Studies on the Quality Evaluation of Korean Red Pepper by Color Measurement

Hyun-Duck Lee and Cherl-Ho Lee

Korean J. Dietary Culture, Vol. 7, No. 2, 105-112. (1992)

The general properties(size, shape, fruit constituents) of ten different varieties of dried red pepper and the proximate chemical composition, carotenoids content and Hunter color values of their powders were examined in order to establish an objective instrumental method to evaluate the consumer acceptability of red pepper powder. The results of instrumentally measured color values were compared with the sensory acceptability data obtained from 100 housewives in Korea. Red carotenoid consisted of 68-85% of total carotenoids, while β-carotene content showed close relationship with the sensory color preference. The values of Hunter color system, L,a,b and a x L, showed significant relationships with the sensory color preference. Especially, a x L value had close relationship with both color preference and pungency intensity of red pepper. Therefore, we suggest the consumer acceptability of red pepper powder can be determined instrumentally by a x L value of colorimeter. Sensory acceptability=0.02001(a x L)-12.5774.

Relationships between the Taste Components and Sensory Preference of Korean Red Peppers

Hyun-Duck Lee, Mi-Hee Kim and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 24, No. 3, 266-271. (1992)

The contents of capsaicinoids, free sugars and organic acids of 10 Korean varieties of red pepper powder were measured and the sensory properties of their water extracts were compared in order to investigate the influence of the composition of taste components on sensory acceptability of Korean red pepper. The composition of taste components in red pepper powder varied widely depending on the varieties; total capsaicinoid content varied from 0.029 to 0.296%, free sugar 8.45～15.21% and organic acid 4.58～17.54%. Capsaicinoid contents, especially dihydrocapsaicin content, were highly correlated with the pungent taste of the water extract of red pepper powder (r=0.870), but did not show significant relationship to the overall sensory acceptability. The sensory overall acceptability was highly influenced by the contents of total sugar (r=+0.815), reducing sugar (r=+0.805), glucose (r=+0.814) and fructose (r=+0.787). Multiple regression with total sugar (X_1), total capsaicin (X_2) and total organic acid contents (X_3) increased the correlation coefficient for sensory acceptability(Y) to R=0.9008. From the result, a regression equation of $Y=0.9808X_1-10.7526X_2-0.1664X_3-4.1147$ was obtained.

Physical Properties of Chitosan Film made from Crab Shell

Jeong-Suk Cho, Jeong-Jun Han and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 24, No. 6, 574-580. (1992)

Chitin was isolated from the residue of enzymatically hydrolyzed crab, *Portunus trituberculatus*, and further deacetylated by alkaline boiling to make chitosan. The physical properties of chitosan solution and its film forming properties were examined. The functional characteristics of chitosan film were compared to those of cellophane, polyvinyl chloride (PVC) and polyethylene (PE) films. The proximate chemical composition of chitin obtained from crab residue was 6.95% nitrogen, 0.3% crude ash and 4.57% moisture and the product yield was 12.8% based on a dry material basis. The degree of deacetylation of chitosan was 79～92% and 70～86% as determined by IR spectroscopy, and 70～86% as determined by colloid titration method each respectively. The chitosan at 1% acetic acid solution showed distinct pseudoplastic flow behavior. The flow behavior index and consistency index were 0.8886, 0.2084 $MPa \cdot s^n$ for 0.4% solution and 0.8498, 0.6190 $MPa \cdot s^n$ for 0.8% solution, respectively. The chitosan film had the highest tensile strength (888 kg/cm^2) and water permeability (100 $g/m^2 \cdot 24$ hrs) among the tested films, but relatively low elongation property (49%). It showed the similar tear strength (90 kg/cm) and light permeability (87.7%) to other films tested in spite of the relatively high haze value (12.5%). As the thickness of chitosan film increased from 0.025 to 0.050 mm, the tensile strength of film decreased distictively, and the degree of elongation, tear strength, and water permeability of film also decreased slightly. Whereas the light permeability of film did not change and the haziness of film slightly increased by the increase of film thickness.

A terminological study of trilingual (Chinese-Korean-Japanese) presentation on food texture

Cherl-Ho Lee, Yasuhiro Ota and Rong Huei Chen

Korean J. Dietary Culture, Vol. 9, No.. 2, 171-177. (1994)

The present study compares the texture describing terms used in East-Asian countries, China, Korea and Japan. The terms and definitions enlisted in the International Standard Sensory Analysis-Vocabulary, ISO 5492 (second edition 1992) were used as the reference. It includes hardness, fracturability, chewiness, gumminess, viscosity, springiness, adhesiveness, granularity, conformation, moisture and fatness. The Chinese scripts used for the description of each textural terms in these three countries were compared and their native expressions were collected. The food items representing typical textual characteristics in the East Asian countries were also listed.

Kinetic Study of Acid Hydrolyzate of Dextran

Bue-Young Imm and Cherl-Ho Lee

Foods and Biotechnology, Vol. 3, No. 3, 198-200. (1994)

The kinetics of acid hydrolysis of dextran, produced by *Leuconostoc mesenteroides* isolated from Sikhae, a Korean fermented fish product, was studied. Hydrolysis reactions were carried out at various temperatures between 50 and 80℃. A simple first-order reaction model was used for dextran hydrolysis reaction. Kinetic parameters were evaluated for three different hydrochloric acid concentrations (0.01, 0.1, and 1N). Activation energy, 25Kcal/mol, remained constant regardless of these reaction conditions.

Acid concentration was more effective than time of acid treatment for the molecular weight reduction.

Single Point Viscosity Measurement for Estimating Intrinsic Viscosity of Dextran

Bue-Young Imm and Cherl-Ho Lee

Foods and Biotechnology, Vol. 3, No. 3, 201-204. (1994)

Intrinsic viscosity determination for polymers can be simplified and considerable time and effort saved via a single measurement of relative viscosity at a known concentration. Several workers have proposed single point intrinsic viscosity methods for synthetic polymers. These equations were tested in this experiment and found to have good applicability for dextran. Of the methods in the literature, single-point equation proposed by Solomon and Ciuta was found as accurate as the multiple-point graphical extrapolation procedure. A monographical technique proposed by Khan and Bhargava was successfully applied for the intrinsic viscosity determination of dextran without limitations.

Gelatinization Properties of Starch Dough with Moisture Content, Heating Temperature and Heating Time

Boo-Yong Lee, Chang-Ho Lee and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 27, No. 3, 428-438. (1995)

The gelatinization properties of corn and waxy corn starch doughs were examined at various moisture contents, heating temperatures and heating times. The onset temperatures of gelatininzation with 1% CMC using Brabender Amylograph were 64℃ for both corn and waxy corn starch. In the gelatinization properties using DSC, onset temperature(To), maximum peak temperature(Tp), completion temperature(Tc) and enthalpy of the corn starch were 68.15℃, 74.01℃, 85.65℃ and 3.2cal/gram respectively. While those of the waxy corn starch were 68.24℃, 75.43℃, 93℃ and 4.2 cal/gram respectively. In enzymatic analysis, when the moisture content increased from 36% to 52% and heating temperature from 60℃ to 100℃, the gelatinization degree of starch dough increased from about 10% to about 62%. The gelatinization degree of waxy corn starch dough was 15~20% higher than that of corn starch dough under the same gelatinization conditions. The regression equations of gelatinization degree (Y) of starch dough in the range of 36~52% moisture content (X_1), 60~100℃ heating temperature (X_2) and 0~2.0 min heating time (X_3) were examined using response surface analysis. The regression equation of corn starch dough was:

$Y = 28.659+8.638X_1+15.675X_2+7.770X_3-1.620X_1^2+10.790X_1X_2-4.220X_2^2+0.510X_1X_3+1.980X_2X_3-6.850X_3^2(R^2=0.9714)$ and that of waxy corn starch dough was: $Y=32.617+12.535X_1+20.470X_2+8.608X_3+4.093X_1^2+13.550X_1X_2-4.467X_2^2+1.560X_1X_3+2.160X_2X_3-9.527X_3^2(R^2=0.9621)$ As the moisture content, heating temperature and heating time increased, the reaction rate constant(k) of gelatinization increased. The greatest reaction rate constant was observed at initial 0.5 min heating time of 1st gelatinization stage. At the heating temperature 90℃, gelatinization of starch dough was completed almost in the initial 0.5 min heating time. The reaction rate constant of waxy corn starch dough was higher than that of corn starch dough under the same gelatinization conditions. At the 52% moisture content, the regression equation between reaction rate constant(k) and heating temperature(T) for corn starch dough was $\log k=11.1140-4.1226\times10^3(1/T)(r=-0.9520)$ and that of waxy corn starch dough was $\log k=10.1195-3.7090\times10^3(1/T)(r=-0.9064)$.

Effect of Moisture Content on Viscosity of Starch Dough

Boo-Yong Lee, Chang-Ho Lee and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 27, No. 4, 582-592. (1995)

To measure rheological properties of the starch dough, an Extrusion Capillary Viscometer (ECV) cell was self-made and attached to Instron machine (Model 1140). Apparent viscosities of corn and waxy corn starch doughs were measured and their gelatinization degrees were determined by enzymatic analysis. When corn and waxy corn starch doughs with 36~52% moisture content were heated at 60~100℃, come-up time of the cold point of doughs decreased from 220 sec to 140 sec with increased in the moisture content. In the measurement range of 36~52% moisture content and 60~100℃ heating temperature, both corn and waxy corn starch doughs showed pseudoplastic flow behaviors. At the same shear rate, both shear stress and viscosity of starch dough decreased as the moisture content increased. At the moisture content above 44%, the shear stress and viscosity of starch dough decreased as the heating temperature increased from 60℃ to 70℃, but increased as the heating temperature increased from 80℃ to 100℃. When the moisture content increased and heating temperature, the gelatinization degree of starch dough increased from about 10℃ to about 62℃. The gelatinization degree of waxy corn starch dough was 15~20% higher than that of corn starch dough under the same gelatinization conditions. The effects of moisture content on the viscosity of starch dough were examined by Arrheuius equation. As the moisture content increased, viscosity of starch dough decreased. But the effect of moisture content was greater in the range of 80~100℃ than in the range of 60~70℃ heating temperature.

Effect of Heating Temperature on Viscosity of Starch Dough

Boo-Yong Lee, Chang-Ho Lee and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 27, No. 4, 593-597. (1995)

To measure rheological properties of the starch dough, an Extrusion Capillary Viscometer (ECV) cell was self-made and attached to Instron machine (Model 1140). Apparent viscosities of corn and waxy corn starch doughs were measured and their gelatinization degrees were determined by enzymatic analysis. The effects of heating temperature on the viscosity of starch dough with 36~52% moisture contents were examined in terms of Arrhenius equation. The activation energy (Ea) of the dough viscosity from the effect of heating temperatures changed from negative (-) to positive (+), as the moisture content increased from 44% to 48% in the corn starch dough and from 40% to 44% in the waxy corn starch dough.

Studies on the Physicochemical Factors Influencing the Optimum Amount of Added Water for Cooking in the Preparation of Korean Cooked Rice

Ho-Young Kim, Hyun-Duck Lee and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 28, No. 4, 644-649. (1996)

The purpose of this study was to investigate the relationship between physicochemical properties and optimum amount of added water for cooking in the preparation of Korean cooked rice (bab). Seven different kinds of rice samples were tested for their chemical and physical properties in relation to the quality after cooking with various amount of water added. The amylose content and water content of rice did not show significant correlation with the amount of added water for optimum cooking. The width of rice kernel, expansion ratio, Amylogram maximum viscosity showed significant correlation with the optimum ratio of added water for cooking.

Characteristics of food rheology and the research trends in Korea

Cherl-Ho Lee

Korean J. Rheology, Vol. 9, No. 2, 47-52. (1997)

Food rheology deals mainly with the physical properties of living materials and their inter or intra-cellular bioploymers which are used for food ingredient. The rheological parameters, such as viscosity, plasticity and viscoelasticity, are used for the evaluation of the functional properties of the ingredients and the process control in food manufacturing. They also provide the parameters indicating the sensory quality, especially textural properties, of food products. This paper discusses the characteristics of food rheology and its history of development and reviews the research reports on liquid foods, gels and plant tissue published in Korea since 1990.

Studies on Physicochemical Properties of Erythritol, Substitute Sugar

Sang-Hee Byun and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 29, No. 6, 1089-1093. (1997)

The physicochemical properties of erythritol were examined by measuring water absorption, solubility, water activity, heat stability, and viscosity compared to those of sucrose, xylitol, sorbitol and fructo-oligosaccharide. Erythritol showed the lowest water absorption and the highest water activity reducing capacity. In the solubility test of sweeteners, the saturation concentration of erythritol at 20℃ was 35.8%, which was the lowest solubility. Caramelization test and Maillard reaction test showed that erythritol was stabler than sucrose in heat treatment, while fructo-oligosaccharide showed the strongest reaction. The viscosity of erythritol was similar to that of other sweeteners at the same concentration (10%, 30% w/w). The viscosity of sweeteners increased exponentially with increasing concentration but decreased with increasing temperature following Arrhenius equation. The activation energy for flow of 30% erythritol solution was estimated to be 10.8 kcal/g · mol.

Changes of Sensory Characteristics in Red Pepper by Different Extraction Conditions

Hyun-Duck Lee and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 30, No. 3, 535-541. (1998)

The soluble solid of red pepper extracted by water was evaluated with descriptive analysis by 10 trained sensory subjects. In the result of the sensory evaluation, the character notes on the flavor of soluble solid were expressed as pungency, sweet, fresh sour, bitter, alcoholic, meaty, chalkiness and astringent. The score of redness was the highest at 4℃ and decreased after 2 hr at 90℃ and the score of sensory pungency was more than 50 and was especially higher at 40℃ and 90℃. Principal component analysis of the mean ratings showed that *kochoojang* (fermented red pepper paste) and *chigae* (meat and vegetable stew) differed from *kimchi* (unfermented *kimchi*) and that they had unique sensory attributes. The first two principal components could be explained by 51% of all the components and the taste of soluble solid at 40℃ was highly correlated with sensory attributes such as meaty, fresh sour and sweet, and that at 4℃ was chiefly correlated with color components and the taste of soluble solid at 60℃ showed close relation to astringent, alcoholic and pungency.

Effect of Compression Test Conditions on the Textural Parameters of Imitation Crab-leg Product

Won-Seok Choi and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 30, No. 5, 1077-1084. (1998)

The optimum conditions for the measurement of texture profile of imitation crab-leg products were investigated by different conditions using Texture Analyser and the data were compared to those of sensory evaluation. The textural characteristics of surimi gels were compared with those of imitation crab-leg products. The TPA values of 5 different kinds of commercial imitation crab-leg product and 2 kinds of surimi gel products purchased in a market in Seoul were measured. In surimi gels, instrumental hardness and cohesiveness were higher than those of imitation crab-leg products, especially chewiness and gumminess were significantly higher than those of imitation crab-leg products. In imitation crab-leg products, hardness and cohesiveness increased and springiness decreased as the probe diameter increased from 12.5 mm to 24.6 mm. In the different compression ratio (60, 70, 80%), hardness increased and cohesiveness and springiness decreased as the compression ratio increased. The chewiness, gumminess, cohesiveness and hardness increased slightly as the cross-head speed increased from 0.8 to 2.4 mm/sec. Significant correlations between mechanical and sensory values were observed in gumminess, chewiness, cohesiveness and hardness. The optimum conditions for the TPA measurement of imitation crab-leg products were a cross-head speed of 2.4 mm/sec and 60% compression ratio with a flat probe having twice of the sample diameter (24.6 mm).

Determination of Rheological Properties of Surimi Gels and Imitation Crab-leg Products by Stress-Relaxation Test

Won-Seok Choi and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 30, No. 5, 1085-1091. (1998)

The purpose of this study was to investigate the rheological properties of surimi gels and imitation crab-leg products by stress-relaxation test and to examine the correlations between stress-relaxation parameters and T.P.A. parameters. The linear viscoelasticity of surimi gels and imitation crab-leg products was observed in the range of the strain of 5~20% at cross-head speed 2.4 mm/sec. The average tensile forces of surimi gels and imitation crab-leg products were similar, 370.4 g and 436.4 g, respectively, but surimi gels showed higher relaxation time and viscous component (17256.1 sec, 1.357×10^{10} poise) than those of imitation crab-leg products (6110 sec, 0.519×10^{10} poise). Estimated tensile force of each exponential term in relaxation test was highly related with hardness, gumminess and chewiness of T.P.A (r=0.93, 0.93, 0.95, $p<0.01$), the relaxation time of each exponential term was rrelated with cohesiveness (r=0.89, $p<0.01$) of T.P,A. and the elastic component of exponential term with gumminess, chewiness and hardness (r=0.92, 0.94, 0.93. $p<0.01$) of T.P.A.. The viscous component of exponential term was related with cohesiveness (r=0.83, $p<0.05$) of T.P.A.. The degree of texturization was negatively related with the relaxation time and viscous component (r=-0.92, -0.96, $p<0.01$).

Changes in the Gelation Mechanism and the Rheological Behavior of Surimi on the Different Heating Methods

Won-Seok Choi and Cherl-Ho Lee

Food Engineering Progress, Vol. 2, No. 2, 108-116. (1998)

Mechanism for the changes of rheological property of surimi gel by different heating methods, Ohmic heating and water-bath heating, was examined by using creep/recovery test. In Ohmic heating, time for gelling surimi from 10℃ to 90℃ and for heating it from 50℃ to 70℃ which is ranged for optimal proteolytic activity of proteases was needed less than that in water-bath heating. But between 10℃ to 30℃ which are important ranges for hydrophobic interaction and cross-linking by transglutaminase, time for Ohmic heating was needed more than that for water-bath heating. Elasiticity of Hookean body and viscosity of Newtonian body for Ohmic heated surimi gel were 3.03kPa and 3.51×10^6 Pas, respectively, which values were greater than those of water-bath heated gel, 2.51kPa and 2.94×10^6 Pas. Surimi gels which contained 100mM guandine hydrochloride (G-HCl), sodium dodecyl sulfate (SDS) and β-mercaptoethanol (β-ME), respectively, were treated by different heating methods, Ohmic heating and water-bath heating. The rheological differences between gel contains G-HCl and not G-HCl, which were heated with different methods, had similar tendency. While rheological differences of gels contain SDS and β-ME, respectively, which were heated with different methods, were less than those not contain SDS and β-ME. Presumably the reactions of disulfide bond and hydrophobic interaction during gel formation were different in Ohmic heating and water-bath heating, respectively.

Effects of Cryoprotectants on the Textural Changes of Whole-coagulated Soybean Curd (Tofu) during Frozen Storage

Sun-Hwa Chung, Won-Seok Choi, Hye-Sook Son and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 31, No. 4, 957-963. (1999)

Effects of cryoprotectants on protein denaturation of soybean curd, tofu, during frozen storage were examined. A whole-coagulated non-press tofu was prepared by adding 2% of isolated soybean protein to soy milk in order to prevent loss of added cryoprotectants. The cryoprotectants added were glucose, glycerol, sorbitol, propylene glycol, and tripolyphosphate. The texture characteristics of soybean curds before and after frozen storage were measured by sensory evaluation and Texture analyzer, and the results were evaluated by response surface methodology (RSM). Glucose, glycerol, sorbitol, and sodium tripolyphosphate were effective as single cryoprotectant, and the mixtures of glucose and sodium tripolyphosphate, and sorbitol and propylene glycol were also effective in minimizing textural change during freezing. Overall, the mixture of cryoprotectants were more effective than single cryoprotectant. According to the RSM, the maximum effect of cryoprotectants in minimizing textural changes during freezing was obtained with the mixture of 2.1% glucose, 6.7% glycerol, 2.1% sorbitol, 0.4% propylene glycol, and 0.3% sodium tripolyphosphate. However, considering the sensory acceptability, the optimum use of cryoprotectants in frozen tofu was 1% glucose, 2% glycerol, 1% sorbitol, 0.2% propylene glycol, and 0.5% sodium tripolyphosphate.

Rheological Properties of β-Glucans Isolated from Non-waxy and Waxy Barley

Hee-Don Choi, Yong-Gon Park, Eun-Hee Jang, Ho-Moon Seog and Cherl-Ho Lee

Korean J. Food Sci Technol. Vol. 32, No 3, 590-597. (2000)

The rheological properties of β-glucans isolated from non-waxy and waxy barley were investigated. β-Glucan solutions showed pseudoplastic properties and their behaviors were explained by applying Power law model in the range of concentrations(1~4%) and temperatures(20~65℃). The effects of temperature and concentration on the apparent viscosity at 700 s^{-1} shear rate were examined by applying Arrhenius equation and power law equation, and their effect was more pronounced in waxy β-glucan solutions. The activation energy for flow of β-glucan solutions decreased with the increase of concentration, and the concentration-dependent constant A increased with the increase of temperature. The intrinsic viscosity of waxy β-glucan was higher than that of non-waxy β-glucan. The transition from dilute to concentrate region occurred at a critical coil overlap parameter $C^*[\eta]=0.02$. The slopes of non-waxy and waxy β-glucan at $C[\eta]>C^*[\eta]$ were similar, but the slope of waxy β-glucan at $C[\eta]>C^*[\eta]$ was higher than that of non-waxy β-glucan. Dynamic viscoelasticity measurement showed that cross-over happened, and storage modulus was higher than loss modulus at frequency range above cross-over. β-Glucan solutions formed weak gels after stored for 24 hrs.

Comparison of Rheological Properties of Powder *Chlorella* sp. Cultivated in Fermentor and Pond

Ki-Rim, Kang, Chung-Yung J. Lee and Cherl-Ho Lee

J. Microbiol. Biotechnol., Vol 12, No. 5, 740-745. (2002)

The current study was conducted to identify the differences in the rheological properties of *Chlorella* sp. powder cultured in a fermentor and in a pond-like environment. Cells cultured in the same media were harvested and spray dried. The biomass yield from the fermentor culture was 4.7% (dry basis), while that from the pond was 4.3% (dry basis). Measurements of the loose bulk density, tapping test, Hausner's ratio, and compressibility test all revealed differences between the rheological properties of the *Chlorella* sp. from the two cultivation systems. Although both the fermentor and pond cultured *Chlorella* sp. showed the same angle of repose, the mean size of the cells was 2.26 μm and 2.89 μm, respectively. The weight of the *Chlorella* sp. tablets cultured in the fermenter and pond was 0.663 g/tablet and 0.593 g/tablet, respectively, while the friability of the tablets was 21% and 41%, respectively. Observation by Transmission Electron Microscope (TEM) showed that the cell wall of the *Chlorella* sp. cultured in the fermentor was thinner and more spherical than that cultured in the pond, thereby providing the main characteristic rheological properties of the powder.

Effect of β-Glucan on Gelatinization of Barley Starch

Hee-Don Choi, Ho-Moon Seog, Sung-Ran Kim, Yong-Kon Park and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 35, No. 4, 545-550. (2003)

The effect of β-glucan on gelatinization of barley starch was studied. By the Rapid Visco-Analyzer measurement, gelatinization of starch became rapid and viscosity increased largely on the RVA pattern by addition of β-glucan to starch. The results of differential scanning calorimeter showed that molecular structure of starch was getting stabilized through shifting up of gelatinization temperature and increase in enthalpy by addition of β-glucan. X-ray diffraction pattern also showed the same results as differential scanning calorimeter. But it was revealed that addition of β-glucan to starch didn't affect characteristics such as microscopic observation, solubility, swelling power, and iodine binding properties during gelatinization of starch.

Effect of Barley β-Glucan on Dynamic Viscoelasticity of Barley Starch

Hee-Don Choi, Ho-Moon Seog, Yun-Sook Kim and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 35, No. 6, 1022-1027. (2003)

The effect of β-Glucan, prepared from waxy barley, on the dynamic viscoelasticity of non-waxy and waxy barley starch during gelatinization and gelation was studied. Although no significant effect was observed on waxy starch, there were drastic changes in the dynamic viscoelasticity of non-waxy starch. The gelatinization onset temperature of non-waxy starch shifted to a higher temperature and showed a drastic increase in storage modulus and loss modulus at the range of 80~90℃. During the gelation of non-waxy starch, β-Glucan increased the rate of gel formation and weakened the network of starch and amylose by prohibiting their association. Therefore, we proved that there was no specific interaction between amylose and β-Glucan. The addition of β-Glucan to waxy starch seemed to have no effect on the gelation of waxy starch.

Rheological Properties of Erythrocytes from Male Hypercholesterolemia

Chung-Yung J. Lee, Ki-Chan Kim, Hong-Wook Park, Jin-Ho Song, and Cherl-Ho Lee

Microvascular Research, Vol. 67, No. 2, 133-138. (2004)

Diet and general health status has close relation to the flow behavior of blood, which influences the circulation of the blood in the body. In this study, we have compared the rheological properties of erythrocyte, plasma and whole blood from high-cholesterol male subjects with healthy male subjects. Intravenous blood was taken from healthy males ($n = 10$) and males with high cholesterol ($n = 14$). Basic health profile, BMI, hematological count and lipid profile (total cholesterol, LDL, HDL and triglyceride) of the blood were determined. Viscosity and shear rate dependent flow behavior of the subjects blood were measured by cone and plate rheometer, and permeability of erythrocytes by pulsed field gradient NMR. Using the microchannel flow analyzer (MC-FAN), the microcirculation of erythrocyte and plasma were investigated. Our data showed a difference in viscosity and consistency index of the whole blood, and permeability ($P < 0.05$) of erythrocytes between the two groups. Also, the time taken for the flow of erythrocyte and plasma through the MC-FAN was slower for the high-cholesterol group. Correlation study showed that consistency index of the blood is closely related to the level of LDL ($P < 0.05$), and total cholesterol, HDL and LDL ($P < 0.01$) highly correlated with the microcirculation of erythrocyte and plasma. A negative correlation ($P < 0.05$) was found between total cholesterol, HDL and LDL, and permeability of erythrocytes. It is concluded that high level of cholesterol, LDL and HDL in vivo alter the morphology and flow behavior of blood cells that can subsequently increase the risk of impairing physical function and microcirculation.

Large and Small Deformation Studies of Ohmic and Water-Bath Heated Surimi Gel by TPA and Creep Test

Won-Seok Choi and Cherl-Ho Lee

Food Sci. Biotechnol., Vol. 15, No. 3, 409-412. (2006)

Interrelationship between results of large deformation (texture profile analysis, TPA) test and small deformation (creep) test on ohmic heated surimi gel, water-bath heated surimi gel, and commercial fish gel products (kamabokos) was examined. Creep test revealed Ohmic heated gels have higher elastic modulus and viscosity values than water-bath heated ones, with differences of elastic modulus and viscosity between Ohmic and water-bath heated gels being 18 and 28.5%, respectively. These differences were reflected in the higher hardness, cohesiveness, and chewiness values of Ohmic heated gels in TPA. In TPA test, the differences of hardness and chewiness between Ohmic heated gel and water-bath heated gel were 29.3 and 38.7%, respectively. It was concluded that with proper experimental design, the small deformation creep test which gives molecular level deformation data can be related to the large deformation TPA test indicating the sensory textural properties.

Food Processing and Physiological Function

Comparison of the Efficacy of Steam Sterilization Indicators

Cherl-Ho Lee, Thomas J. Montville and Anthony J. Sinskey

Appl. Environmental Microbiol., Vol. 37, No. 6, 113-117. (1979)

Twenty-one commercially available chemical steam sterilization indicators were processed in an empty autoclave for various times at temperatures between 240 and 270 ˚F (ca. 116 and 132 ℃). The time required to reach a sterilized reading at each temperature was plotted on a semilogarithmic time-temperature polt and compared with the time-temperature sterilization curve for *Bacillus stearothermophilus*. Five of the indicators had time-temperature kinetics similar to those of *B. stearothermophilus*, but three of these overestimated the effect of processing. Two of the indicators overestimated the effect of processing and were less sensitive to temperature changes than was *B. stearothermophilus*. Thirteen of the indicators had time-temperature curves that crossed the *B. stearothermophilus* plot. One indicator produced such ambiguous results that no determinations could be made with it. Out of 21 indicators tested, only 2 appear to be capable of accurately integrating the time-temperature effect at temperatures between 240 and 270˚F. The other indicators should be used only after careful analysis of their suitability for use at a given temperature.

The Destruction of Bacterial Spores Upon Compressional Pressure

Cherl-Ho Lee, Young-Man Kim, Jung-Chi Lee and Pil-Keun Jung

Korean J. Food Sci. Technol., Vol. 12, No. 4, 272-277. (1980)

The tolerance of useful bacterial spores to the condition of tablet making, specifically, the destruction of bacterial spores upon compressional pressure was investigated. The damage of bacterial spores occurred mainly during the tabletting. The bacterial spores obeyed a logarithmic destruction rate upon compressional pressure. The spore destruction rate was dependent upon the strains of microorganism. The decimal reduction pressure, designated as P-value, were 2.9 ton/cm^2, 2.6 ton/cm^2 and 2.1 ton/cm^2 for the spores of *Bacillus subtilis*, *Bacillus coagulans* and *Clostrudium butyricum*, respectively, and 1.7 ton/cm^2 for the vegetative cell of *Streptococcus faecalis*. The spore destruction upon compressional pressure was influenced by the type of filler. The P-value of the spore of *B. coagulans* was 2.8 ton/cm^2 in the lactose filler, but 2.0 ton/cm^2 in the starch filler. The number of viable spores was inversely proportional to the hardness and density of tablet, in case that the same type of filler was used. The starch filler, which resulted in the lower hardness and lower density of tablet, caused higher spore destruction rate compared with the lactose filler.

Effect of Hot Air Recycling and Humidistat Control on the Thermal Energy Efficiency of Solar Drier Supplemented with Coal Heater

Cherl-Ho Lee, Jae-Kag Lim, Dae-Hwan Kim, Hyung-Woo Park

Thesis Collection of Agricultures and Forestry, Korea Univ,, Vol. 22, 125-133. (1982)

The effects of air velocity and the air recycling on the thermal energy efficiency of drier and on the drying rate of red pepper were tested by using both a cabinet drier heated by electric heater and the vinyl house solar driers supplemented with coal heater. The drying rate, the humidity of drier air and the temperature difference between surface of dried product and drier air changed remarkably by the air velocity, and these results were used for controling the humidity of solar drier. The relative humidity of drier air, which is an important parameter indicating the drying potential of drier, was heavily influenced by the air velocity and drying time. Controlling the relative humidity of solar drier to 70% at the first day of red pepper drying decreased the drying rate, while the humidistat control at lower than 60% RH from the second day of drying did not greatly change the drying rate and could increase the energy efficiency of the drier.

Hot-air Drying Characteristics of Oyster Mushroom, *Pleurotus ostreatus*

Cherl-Ho Lee and Dae-Hwan Kim

Thesis Collection of Agricultures and Forestry, Korea Univ,, Vol. 23, 137-147. (1983)

The drying characteristic of oyster mushroom was studied by using a cabinet hot-air drier. The effects of air temperature and air flow rate on the drying rate, critical moisture content, mass transfer coefficient and drying capacity of mushroom drier were determined. The effect of drying rate on the rehydration property of dried mushroom was also examined. Oyster mushrooms exhibited a typical drying curve containing constant rate period and first and second falling rate periods. The critical moisture content was observed at the vicinity of 4.4~5.0g H_2O/g dry solid, and did not vary greatly by the drying conditions. A marked wet-bulb temperature depression was observed for the constant rate period. The exit air temperature reached to the drier hot air temperature at the end of constant rate period, whereas the surface temperature of drying mushroom approached to the drier hot air temperature at the end of drying. The drying capacity estimated from a psychrometric chart analysis generally underestimated(25%) the actual capacity calculated from the weight loss. The mass transfer coefficient estimated for the first falling rate period varied from 1.203m/s at 80℃, 7m/s of wind speed, to 0.731m/s at 30℃, 7m/s. The rehydration rate increased with the increasing drying temperature. The stalks absorbed greater amount of water than the cap of mushroom.

Peeling Operations of Root Vegetables, Potato, Sweet Potato and Carrot

Cherl-Ho Lee and Soon-Woo Lee

Korean J. Food Sci. Technol., Vol. 16, No. 3, 329-335. (1984)

The effect of peeling methods, sphericity and weight of potatoes and carrots on the peeling efficiency were investigated. The changes in the surface texture by peeling were estimated by Rheometer and were related to the changes in the microstructure. The optimum mechanical peeling conditions using abrasion type rotary peeler were 90 sec. at 300 rpm for potatoes, 70 sec. at 300 rpm for sweet potatoes and 60 sec. at 300rpm for carrots. The peeling loss was influenced by the sphericity and weight of the sample. The optimum conditions for alkali peeling were 90 sec. immersion in boiling 10% NaOH solution for potatoes, 300 sec. in boiling 10% NaOH solution for sweet potatoes and 60 sec. in boiling 6% NaOH solution for carrots. Severe damage of surface structure was noticed by alkali peeling, demonstrated by denaturation of starch granules in the cell. The structural damage observed by microscope was related to the reduction of cutting force after peeling.

Lupin Seed for Human Consumption

Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 18, No. 5, 398-405. (1986)

The food quality of lupin seed, i.e. soaking, cooking, sprout growing and mold growing for fermentation, was investigated by using the seed of *Lupinue angustifolius* harvested in Western Australia. A method to produce lupin seed protein concentrate (LPC) was developed, and the usage of LPC in Korean food system was investigated. The water soaking rate of lupin seed was faster than that of soybean, but the cooking rate of lupin seed was much slower compared to soybean. The thermal softening time, D100, was 345 min for lupin seed and 84 min for soybean. A two-phase solvent extraction system consisting of hexane-alcohol-water could effectively remove the residual bitter taste, lipid and yellow pigments of lupin seed flour, and the resulting LPC contained over 50% protein and had bland flavor and milky white color. Treatment of LPC with carbohydrate decomposing enzymes resulted in a product of more soluble and higher concentration of protein. Methods to produce lupin seed vegetable milk and lactic beverages from LPC products were discussed.

Utilization of Australian Wheat for Korean Style Dried Noodle Making

C-H LEE, P. J. GORE, H-D. LEE, B-S. YOO and S-H. HONG

J. Cereal Science, Vol. 6, 283-297. (1987)

Korean style dried noodles were prepared from 33 different Australian wheat flours; 17 samples were made from seven wheat varieties of various protein levels and 16 samples were prepared from four classes of Australian wheat, each milled to four levels of extraction. The chemical composition and physical properties of each four were analysed and the fresh, dried and cooked noodle qualities were evaluated by both instrumental and organoleptic methods. Wheat variety and district of cultivation, protein content, flour pasting properties and flour colour grade were seen as important factors in determining the quality of noodles. Hunterlab colour difference meter measurements and the shear-extrusion test were evaluated as being useful objective measures of the appearance and texture of noodles, respectively.

Studies on the Browning Reaction of Sugar Derivative Sweeteners

Cherl-Ho Lee, Bok-Jin Han, Na-Young Kim. Jae-Kak Lim and Bong-Chan Kim

Korean J. Food Sci. Technol., Vol. 23, No. 1, 52-56. (1991)

The browning reaction of sugar derivatives, fructo-oligosaccharide, high maltose syrup(HMS), sorbitol and maltitol, and their effect on the appearance of jam and candy were investigated. The spectrophotometric scanning of the absorbance between 230nm and 700nm could demonstrate the heat induced browning of the sugar derivatives. Fructo-oligosaccharide and HMS showed sharp increase in absorbance at 270-330nm range by heating at 100-120℃ for 1 hr but sorbitol and maltitol did not show the increase in absorbance. When the pH was lowered from neutral to 2.0, the absorbance of HMS and sucrose increased sharply, showing that these substances are relatively unstable in acidic heating compared to fructo-oligosaccharide. The addition of glycine enhanced the browning reaction of fructo-oligosaccharide and HMS, whereas little change was observed with sucrose, sorbitol and maltitol. These browning characteristics of sugar derivatives were reflected to the color development of apple jam and candy where they were used. Both fructo-oligosaccharide and HMS increased the yellowness of these products, while sugar alcohols reduced the yellowness compared to sugar.

Comparison of Differential Scanning Calorimetry with Enzymatic Method for the Determination of Gelatinization Degree of Corn Starch

Boo-Young Lee, Chul-Kyoon Mok and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol 25, No. 4, 400-403. (1993)

Gelatinization degrees of corn and waxy corn starches in the low-moisture environment were determined by DSC thermogram and enzymatic analysis, the results were compared each other. As the moisture content increased from 20% to 70%, the enthalpy of endothermic peak of starch increased linearly in DSC thermograms. When the moisture content exceeded above 70%, the DSC enthalpy of starch remained constant in DSC thermogram. The enthalpies for gelatinization of corn and waxy corn starches were 3.23 cal/g and 4.2 cal/g, respectively. When gelatinization degrees of starches were measured by enzymatic analysis, the gelatinization degree increased linearly as the moisture content increased from 20% to 80%. A linear correlation between DSC and enzymatic analysis was obtained only when the moisture content was under 70%.

Effect of the Aloe arborescens Added - Diet on the Cadmium Toxicity in Rat

Seung-Hwa Baek, Cherl-Ho Lee, Seong-Jo Kim, Kwang-Hyun, Moon, Un-Sung Kim, Joo-Don Lee

Korean J. Food Sci. Technol., Vol. 27, No. 4, 555-563. (1995)

This study was performed to investigate the effect of Aloe arborescens on the cadmium toxicity in rats. Thirty male Sprague-Dawley strains were divided into five groups consisting of a control group, a cadmium treatment group and 3 aloe (0.5%, 0.75%, 1%) treatment groups and observed for 9 weeks. The weight increment of the cadmium and 0.75% aloe group was higher than that of the cadmium treatment group($p<0.01$). The food intake did not show the consistency rule among the experimental groups and the decrement tendency of food intake affected by cadmium feeding group. The decrement tendency of water intake affected by cadmium appeared to be suppressed by aloe treatment, especially cadmium and 0.75% aloe treatment group showed the remarkable increment of water intake. The diet efficiency of the control group was the highest among the experimental groups and that of cadmium and 0.75% aloe group was higher than other aloe treatment groups. The weight of each organ did not show consistency among the experimental groups but only the testicle of cadmium and 0.75% aloe treatment group was heavier than that of the control group. The cadmium accumulation was high in order of kidney > liver > spleen > heart > lung > testicle > brain. The cadmium content of the cadmium treatment group was more than that of cadmium and 0.5% aloe group, cadmium and 0.75% aloe group, cadmium and 1% aloe group. The cadmium content of cadmium and 0.75% aloe group was the lowest among other aloe treatment groups. Therefore, cadmium and 0.75% aloe is the most recommendable aloe treatment to eliminate the cadmium accumulated in organ.

Changes of Soluble Solid Content in Red Pepper by Different Extraction Conditions

Hyun-Duck Lee and Cherl-Ho Lee

Korean J. Dietary Culture, Vol 11, No. 3, 385-392. (1996)

The soluble solid of red pepper was extracted by water in order to investigate changes of soluble solid content by different extraction temperature (4~90℃) and time (1/2~3 hrs), and the contents of carotenoid, capsaicinoids, free sugar, organic acid, free amino acid in soluble solid were measured. Most of soluble solid in red pepper was extracted within the first 2 hrs and 93~98% of total soluble solid was extracted during the first 30 min. The contents of carotenoid increased by increasing extraction time and temperature, but decreased by increasing extraction time at 60℃ and 90℃. β-carotene content was sharply decreased after 2 hrs at 90℃. The content of capsaicinoid was sharply increased between 1 hr and 2 hr. Fructose and glucose in red pepper were extracted in the range of 83.8～96.4% and the contents of free sugar gradually increased by increasing extraction time and temperature. The content of organic acid was gradually increased by increasing extraction time and temperature and the greatest amount of organic acid was extracted during the first 30 min of extraction time. The content of free amino acid was decreased by increasing extraction temperature.

Ohmic Heating Characteristics of Foods Having Different Chemical Composition and Microstructure

Sung-Jin Choi, Sung-Won Yoon and Cherl-Ho Lee

Food Engineering Progress, Vol 1, No. 1, 5-10. (1997)

The Ohmic heating properties of foods having different chemical compositions and microstructures were examined by using low frequency alternating current (50 Hz-50 kHz, sine wave). The selected samples were radish root as an intact plant cell tissue, acorn starch gel as an ordered gel structure, sausage as an protein/fat emulsion system, and hot pepper-soybean paste as an non-structured free moving system with high concentration of salt. The heating rate of samples increased as the electric field strength as 15 V/cm with hot pepper-soybean paste and sausage, while acorn starch gel and radish root required 25 V/cm and 35 V/cm, respectively, for commercially meaningful heating rate. The heating rate of phosphate buffer solution by Ohmic heating increased linearly with its ionic strength, indicating that direct involvement of electric conductivity to the heating. The frequency of alternating current influenced in different manner to different structure of food. The heating rate of hot pepper-soybean paste and sausage increased linearly with the increasing frequency in the ranges of 50 Hz-50 kHz. Heating of acorn starch gel, which has relatively ordered network structure, was not influenced much with the changing frequency. In case of radish root, low frequency current was required for the heating, and more effective heating with the current direction perpendicular to the vascular system was observed. It was the indication of the electroporation effect due to the transmembrane potential developed on the cell membrane during Ohmic heating.

Dental Caries Suppression Effect and Other Physiological Properties of Erythritol

Sang-Hee Byun and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 30, No. 2, 446-449. (1998)

Dental caries suppression effect and other physiological properties of erythritol were measured in comparison with those of sucrose, xylitol and sorbitol. The susceptibility test for dental caries by using *Streptococcus mutans* KCTC 3065 and *Lactobacillus acidophillus* indicated that erythritol was as effective as xylitol in suppressing dental caries. In lactic acid fermentation test, erythritol showed the least growth of bacteria among the tested sweeteners. The tolerance test by using mice showed that diarrhea began by feeding once 1500 mg erythritol/kg b.w., 1500 mg xylitol/kg b.w. and 1000 mg sorbitol/kg b.w., respectively.

Protective Effect of Selected Amino Acids and Food Extracts on Ethanol Toxicity Decrement in Rat Liver

Ja-Hyun Lee, N.-K. Kim, Do-Youn Lee and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 31, No. 3, 802-808. (1999)

An rat liver enzyme test was carried out in order to investigate preventing effect of selected amino acids and some food extracts on ethanol induced liver toxicity *in vitro*. Solutions of aspartic acid, arginine, glutamic acid were prepared and treated on ethanol treated rat liver preparation. Protective effect of amino acids on lipid peroxidation was determined. Same experiments were conducted using aqueous extracts of dried soybean sprout, dried Alaskan pollack and *Ganoderma lucidum*. The TBA value indicating the lipid peroxidation decreased significantly ($p<0.05$) by addition of aspartate, glutamate and arginine, repectively at concentrations of 6.25~50μg/mL. Similar results were observed by adding the aqueous extracts of soybean sprout, dried Alaskan pollack and Ganoderma lucidum. The aqueous extracts added after ethanol treatment presented more effect than added before the treatment.

A Method for the Separation of Mouse Pancreatic Islets Using Discontinuous Percoll Gradient Centrifugation

Yu-Ree Cho, Sang-Duk Kim, Hyo-Ihl Chang, Ha-Chin Sung, Cherl-Ho Lee, and Chan-Wha Kim

J. Microbiol. Biotechnol., Vol. 9, No. 4, 522-524. (1999)

A discontinuous Percoll gradient was used to separate islets from the collagenase-treated mouse pancreas easily and rapidly. Since the osmolality of Percoll is very low, adjustment of its osmolality to 340 mOs/kgH_2O was essential for securing the optimal separation. A discontinuous gradient layering with Percoll solution of 1.09g, 1.07g, and 1.05g/ml, respectively, when centrifuged at 800×g for 10 min, resulted in an optimal condition for separation and yielded a banding pattern with an even distribution of islet cells. No significant difference was observed in the morphological features between the Percoll-isolated and the manually-isolated islets. In conclusion, the discontinuous Percoll gradient can be effectively used to isolate the pancreatic islets from mice with four-fold higher efficiency compared to the handpicking method.

Effective Components of Commercial Enzyme Food Products and Their HACCP Scheme

Eun-Joo Lee and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 33, No. 4, 461-468. (2001)

The effectiveness and safety of Enzyme Food, a group of dietary supplements designated by Korean Food Law, were evaluated and the possibility of HACCP (Hazard Analysis Critical Control Point) application was investigated. Chemical composition, enzyme activities and the degree of bacterial contamination in 12 samples of different brands sold in Korean market were measured. The chemical composition of the selected products varied and inconsistent to those claimed in the label description. It is known that effectiveness of Enzyme Food depends on enzyme activity, but enzyme activities of α-amylase varied from 1,793μg/min · g to 159μg/min · g and those of β-amylase ranged from 171μg/min · g to 11μg/min · g. The protease activities varied from 27.57μg/min g to 0.18μg/min · g. In coli-form bacterial test, positive reactions were appeared in the 50% of the samples. Numbers of bacteria ranged from 1.3×10^5 to 1.2×10^9. Five CCPs were identified; heating, inoculation, cultivation, drying and granulation. Consideration of HACCP system indicated that the pretreatment of raw material, checking of bacterial contamination and stability of enzyme activity during fermentation process were important factors for the quality of Enzyme Foods.

Quality Assessment of Commercial Chlorophyll Products in Korea

Eun-Joo Lee, Yong-Joo Cho, Sun-Young Park and Cherl-Ho Lee

Food Engineering Progress, Vol. 5, No. 2, 96-102. (2001)

The effectiveness and safety of commercial chlorophyll products, a group of dietary supplements designated by Korean Food Law, were investigated. The chemical composition, effective or hazardous components and the degree of bacterial contamination on 6 samples of different brands sold in Korean market were measured. The proximate chemical composition of the products varied and inconsistent to those claimed in the label description. Total microbial and coli-form counts of the products were not detected in all samples except for 2 samples which was high moisture content. In the analyses of effective components, the contents of total dietary fiber were ranged 13.6~37.6%, which was enough to be claimed as an dietary fiber food. The content of vitamin B1 and B2 in some products was high, and it seemed to be added with synthetic vitamin B_1 and B_2 in the processing. The content of minerals and phenolic compounds were relatively high. Hazardous heavy metals including As, Pb, Cd were detected in the ppb level, suggesting they are within the range of safety. The content of total chlorophyll and pheophorbide were also investigated within the range of safety according to Korean Food Law.

Effective Components of Commercial Fermented Plant Extracts and their HACCP scheme

Y.J. Cho, S.Y. Park, E.J. Lee and C.H. Lee

Food Engineering Progress. Vol. 5, No. 3, 165-174. (2001)

Twelve kinds of commercial fermented plant extracts were collected in the markets in Seoul, and evaluated for their useful or hazardous components, and a quality control system was studied on the basis of HACCP. The proximate chemical analyses of the products revealed that the actual contents of each product were generally less than those on the level. Acidity, reducing sugar content, water activity (a_W), and the pH of each product were measured to evaluate the storage conditions, and they were ranged 0.3~2.8%, 12.0~64.2%, 0.700~0.855(4℃), and 2.9~4.7, respectively. Total counts determined by PCA medium and coli-form counts of the products were less than <1 CFU/ml, and yeast could be detected only by a direct microscopic observation. Lactic acid bacteria were detected in the level of 10^2 CFU/ml from 3 samples. In the analyses of useful components, the contents of total dietary fiber ranged 0.2~0.8%, which was too low to be claimed as an useful components. The contents of vitamin B_1 and B_2 were slightly high(B_1: 0.2~8.2 mg/100g, B_2: 0.07~14.8 mg/100g), and it seemed to be added during the processing. The content of vitamin C was generally low (1.5~ 412.4mg/100g), however, those of minerals and phenolic compounds were relatively high (total phenol 0.54~8.73 mg/ml). Hazardous heavy metals including As, Pb and Cd were detected in the ppb level, suggesting that they are within the range of safety. The content of ethanol ranged 175~17,400ppm, however, methanol was not detected in all samples. When the HACCP(Hazard Analysis Critical Control Point) was applied, CCP(Critical Control Point) was determined at the culture and inoculation stage of yeast following fermentation, deodorization process and sterilization process.

Leakage of Cellular Materials from *Saccharomyces cerevisiae* by Ohmic Heating

Sung-Won Yoon, Chung-Yung Lee, Ki-Myung Kim and Cherl-Ho Lee

J. Microbiol. Biotechnol., Vol 12, No. 2, 183-188. (2002)

The Ohmic heating of foods for sterilization provides a shorter come-up time compared to conventional thermal processes. The electric fields as well as the heat generated by Ohmic heating facilitate germicidal effects. In the present study, the effect of Ohmic heating on the structure and permeability of the cell membrane of yeast cells, *Saccharomyces cerevisae*, isolated from Takju (a traditional Korean rice-beer), was investigated. The Ohmic heating was found to translocate intra-cellular protein materials out of the cell wall, and the amount of exuded protein increased significantly as the electric field increased from 10 to 20 V/cm. As higher frequencies were applied, more materials were exuded. Compared to conventional heating, more amounts of proteins and nucleic acids were exuded when these cells were treated with Ohmic heating. The molecular weights of the major exuded proteins ranged from 14 kDa to 18 kDa, as analyzed by Tricine-SDS PAGE. A TEM study also confirmed the leakage of cellular materials, thus indicating irreversible damage to the cell wall by Ohmic heating. It was, therefore, concluded that the electric fields generated by Ohmic heating induced electroporation, causing irreversible damage to the yeast cell wall and promoting the translocation of intracellular materials.

Short-term Control of Capsaicin on Blood and Oxidative Stress of Rats *In Vivo*

Chung-Yung Jetty Lee, Min-Sun Kim, Sung-Won Yoon and Cherl-Ho Lee

Phytother. Res., Vol. 17, 454-458. (2003)

Capsaicin (8-methyl-n-vanillyl-6-nonenamide), a pungent component found in red pepper can induce body heat and possibly enhance blood flow as well as increase energy expenditure, and prevent oxidative stress. Male Wistar rats were divided into vehicle, 1 mg/kg body weight capsaicin and 3 mg/kg body weight capsaicin groups. Samples were taken from the animals on day 1 of i.p. treatment with capsaicin and on 3 consecutive days of i.p. treatment with capsaicin. Our investigation demonstrated that blood flow measurements in rats was negatively correlated with LDL after treatment with capsaicin. Although capsaicin did not show a noticeable effect on the serum total cholesterol level, LDL decreased while HDL and triglyceride increased in rats treated with 3 mg/kg capsaicin for 3 days. The antioxidant effect of capsaicin was not shown when the rats were treated with 1 mg/kg body weight capsaicin. However, rats treated with 3 mg/kg body weight capsaicin for 3 days showed a reduction of oxidative stress measured as malondialdehyde in the liver, lung, kidney and muscle. Liver glycogen was found to decrease after 3 days treatment with 3 mg/kg body weight capsaicin. From this study, it is hypothesized that capsaicin can be a potent antioxidant and aid in lowering LDL even when consumed for a short period.

Optimization of narirutin extraction during washing step of the pectin production from citrus peels

W.C. Kim, D.Y. Lee, C.H. Lee and C.W. Kim

J. Food Engineering, Vol. 63, 191-197. (2004)

Citrus peels can be a valuable source of pectin and narirutin. Narirutin can be extracted during the washing step of citrus peels in the pectin production process. In this study narirutin extraction conditions were optimized to maximize the narirutin extraction yield while minimized pectin loss. Washing temperature, time, and HCl concentration of the washing solution were chosen as independent variables of the central composite design. The results showed a good fit with the second-order polynomial equation, which was statistically acceptable at $P < 0:05$ level. Pectin loss was directly correlated with the increases in temperature, time, and HCl concentration during washing procedure. Consequently, the higher the temperature and longer the time, the yield of narirutin extracted was greater, although higher HCl concentration had a negative effect on narirutin extraction yield. The present study indicated that the combination of washing temperature (62oC), time (30 min), and the absence of HCl in the washing solution was found to be optimum conditions, yielding 0.6% of narirutin with a pectin loss of only 1.5% based on the dry citrus peels. The characterization of narirutin extracted from citrus peels was performed using HPLC and NMR.

Effects of Drying and Extraction Conditions on the Chemical Composition of Water Extract of *Lycium chinense* Miller

Peom-Joon Kim, Ju-Chan Lee, Kyung-Hee Ko and Cherl-Ho Lee

Food Engineering Progress, Vol. 8, No. 2, 105-110. (2004)

Lycium chinense fruits is known to have the function of healing eye disease, enforcing liver and kidney function, and anti-aging. It is one of the most common herbal medicines in China, and has believed to have similar effect to ginseng radix, Lycium fruit is normally dried for storage and distribution, and it is boiled in water to consume as tea or extract juice. In this study, the drying conditions of lycium fruit in hot-air drier and freeze drier were investigated and the rehydration characteristics and extraction rate of functional substances of the dried products were analyzed. The optimum drying condition was 50℃ hot-air drying for 48hrs. The rehydration value of dried Lycium varied widely with the drying method and the temperature of rehydration. Rehydration rate of freeze dried lycium was 93% of original fresh lycium at 90℃ for 28min, while it was only 37% for hot-air dried lycium at the same rehydration condition. The extraction rate of functional components of lycium, for example sugar, protein and betaine, also varied with the drying condition. The extraction rate of betaine was 0.74, 1.30, and 3.75 mg/g solid in 20, 50, and 90℃ water for hot-air dried sample, and 1.39, 2.18, and 4.85 mg/g solid in same temperatures of water for freeze dried sample. The extraction rates of betaine in boiling water for 28min were 6.00 mg/g solid for hot-air dried sample and 7.34 mg/g solid for freeze dried sample, which 1.5-1.6 times higher than those of infusion.

Dietary Risk Assessment for Polycyclic Aromatic Hydrocarbons in Foods

Hyo-Min Lee, Eun-Kyung Yoon, Kyung-Ah Park, Yun-Hee Kim, So-Young Jung, Ki-Sung Kwon, Myung-Chul Kim, In-Sang Song, Cherl-Ho Lee, Ji-Sun Yang and Ki-Hwa Yang

J. Fd. Hyg. Safety, Vol. 19, No. 1, 1-8. (2004)

This study was executed to determine the cumulative dietary risk of PAHs exposed by food ingestion. Food samples including barbecued beef, barbecued pork, grilled chicken, ham, bacon and vegetable oil which were collected from food markets. These samples were saponified, extracted and cleaned up to purify PAHs, and then the purified sample solutions were analyzed by HPLC-FL. Generally, the levels of total PAHs in barbecued beef (0.2 ppb), bacon (0.3 ppb), barbecued pork (0.7 ppb), ham (0.8 ppb), and vegetable oil (1.2 ppb) were low, whereas the level of total PAHs in grilled chicken (9.3 ppb) was significantly high. For the exposure assessment of PAHs due to food ingestion, PAHs levels converted into TEQBaP, the average body weight for 20-73 age group and consumed levels of food proposed from report on the National Health and Nutrition Survey were used. The estimated lifetime average daily intake of dietary PAHs was 4.32×10^{-4} μg-TEQ_{BaP}/kg/day as the mean value. The dietary risk adjusted to cancer potency of benzo(a)pyrene as 7.3 $(mg/kg/day)^{-1}$ was 3.44×10^{-6} based on current data.

Free Radicals Scavenging Activity of Bulro Kugi (*Lycium chinense* Mill) Fruit, Leaf and Root

Eun-Hae Kim, Hyeon-Wee Kim, Su-Dong Kim, Bo-Hee Lee, Cherl-Ho Lee and Kyung-Hee Koh

Korean J. Food Sci. Technol., Vol. 37, No. 1, 6-10. (2004)

Free radical-scavenging activities of Korean Bulro Kugi (*Lycium chinense* Mill) fruit, leaf, and root were evaluated. Total phenolic contents of fruit, leaf, and root were 1,078.4±61.0, 939.9±19.8, and 3,792±106.6mg/L, and their flavonoids were 396.7±15.2, 1,952.9±21.3, and 425.3±13.5 mg/L, respectively ($p<0.001$). HPLC revealed main polyphenolic compounds in fruit were p-coumaric and syringic acids in fruit, p-coumaric, syringic, and procatechuic acids in leaf, and p-coumaric, syringic, caffeic, and procatechuic acids in root. Highest radical-scavenging activities of superoxide anion and hydroxyl were found in leaf and root, respectively ($p<0.001$).

Hepatoprotective Effects of *Lycium chinense* Mill Fruit Extracts and Fresh Fruit Juice

Kyung-Il Kang, Jin-Young Jung, Kyung-Hee Koh and Cherl-Ho Lee

Korean J. Food Sci. Technol., Vol. 38, No. 1, 99-103. (2006)

Hepatoprotective effects of Bulro Kugi (*Lycium chinense* Mill) fruit extracts on CCl_4-administered rats were investigated in vivo. Administration of CCl_4 increased plasma glutamic oxalacetic transaminase (GOT), glutamic pyruvic transaminase (GPT), and lactate dehydrogenase (LDH) activities, induced lipid peroxidation as measured by malondialdehyde (MDA) content of rat liver, and significantly increased liver weight. Feeding of B. Kugi (*Lycium chinense* Mill) slightly increased body weight gain, although not significantly different from normal group. B. Kugi (*Lycium chinense* Mill) fruit extracts reduced blood cholesterol level and inhibited CCl4-induced increases of plasma GPT, GOT, and LDH activities, whereas increased contents of MDA and cytochrome P-450, and GST activity in liver tissue of CCl4-administered rats. Roasted B. Kugi (*Lycium chinense* Mill) fruit extract showed highest hepatoprotective effect among samples tested. These results suggest water extracts of B. Kugi (*Lycium chinense* Mill) fruit possess promising hepatoprotective activity against CCl_4-induced hepatic damage in rats.

NMR Application in Food Science

The Charge Properties of PETF Track Etched Membrane Pore Surface on the Cu^{2+} ESR Data

Hong Y-S, Cho C-H, Mitrofanova NV, Nechaev AN, Volkov VI, Mchedlishvili BV, Lee C-H

Magnetic Resonance Imaging, Vol. 19, No. 3, 588-588. (2001)

Track-etched membranes are the pore system possessing the regularly oriented pores with very narrow pore size distribution. It was proposed that polyethylene terephtalate (PETF) track-etched membranes contain the carboxylic groups. The carboxylic groups behaviors were investigated by the Cu^{2+} ESR, where Cu^{2+} ions were included in membrane as paramagnetic probes. The EPR spectra consist of anisotropic lines at 293 K as well as at 77 K, which is typical for the Cu^{2+} complexes possess the axial symmetry in disordered solid state. It was obtained two types of complexes characterized by the spin Hamiltonian parameters $g_\parallel = 2.32$, $A_\parallel = 170$ G, $g_\perp = 2.05$, $A_\perp = 25$ G (complex A) and $g_\parallel = 2.27$, $A_\parallel = 180$ G, $g_\perp = 2.06$ (complex B), respectively, where $g_\parallel$, $A_\parallel$ -g-factor and hyperfine coupling constant in parallel orientation; $g_\perp$, $A_\perp$ -g-factor and hyperfine constant in perpendicular orientation. It is possible to propose that complex A contains two carboxylic groups and two water molecules, $Cu(R\text{-}COO)_2(H_2O)_2$, but complex B contains four carboxylic groups and two water molecules, $Cu(R\text{-}COO)_4(H_2O)_2$. Keeping in mind the cylindrical shapes of pores, the area of pore walls per one carboxylic group, S_c, was calculated from maximum Cu^{2+} membrane concentration $[Cu^{2+}]$.

Cu^{2+} ESR Investigation in Acrylonitrile Sulfocation Exchange Membrane

Hong Y-S, Cho C-H, Dejardin P, Thomas M, Volkov VI, Mchedlishvili BV, Lee C-H

Magnetic Resonance Imaging, Vol. 19, No. 3, 588-588. (2001)

Using the ESR technique, we have investigated the behaviour of Cu^{2+} ions sorbed by sulfocation exchange films and fibres, AN 69 type, which are the copolymer of acrylonitrile and methallyl natrium sulfonate. The ESR spectra were recorded at 77 K and 293 K. At the room temperature the ESR spectra of membranes with maximum water content consist of two lines: anisotropic line as at the 77 K and isotropic symmetric line belongs to the fast rotating copper complexes. For the air dry samples, the spectrum is anisotropic broadened line, the shape of this line doesn't depend on the temperature. This spectrum belongs to the unmobile Cu^{2+} complexes which are close to each other in order Cu^{2+} unpaired electrons interact by means electronic dipole-dipole interaction. The spin-Hamiltonian parameters for anisotropic and isotropic lines are $G_\parallel = 2.409$; $A_\parallel = 130$ G; $g_\perp = 2.08$; $g_o = 2.19$; $g_{av} = 2.19$ where $g_\parallel$, $A_\parallel$ is hyperfine coupling constant in parallel orientation, $g_\perp$-g-factor in perpendicular orientation, go-isotropic g-factor, gav-the average g-factor calculated as $(2 g_\perp + g_\parallel)/3$. The Cu^{2+} ions exist in the sulfocation exchange membranes as aquacomplexes $[Cu(H_2O)_6]^{2+}$ even in the dry samples. The Cu^{2+} ions interact to the SO^{3-} groups by means of electrostatic interaction. For this reason the main part of aqua complexes is rotating very fast in the membrane with the maximum water content. The value of the complex rotation frequency is about 10^{11} Hz. Some Cu^{2+} complex as (about 10%) are undergone to the geometrical restriction and its rotation frequency less than 108 Hz. In the air dried membranes, the $[Cu(H_2O)_6]^{2+}$ complex motion is restricted for all complexes and its spectrum consist of the anisotropic line even at room temperature. For the maximum water content the sulfogroups are far from each other and Cu^{2+} ions spectrum shows the isolated behavior. During the drying the distance between the SO^{3-} groups become less because of magnetic dipole-dipole interaction between Cu^{2+} ions.

The Self-diffusion of Water and Membrane Structure in the New Type of Cation-exchange Polyamide-acid Membrane

S. A. Sokolova, O. V. Djakonova, V. V. Kotov, Y.-S. Hong, C.-H. Cho, V. I. Volkov and C.-H. Lee

Magnetic Resonance Imaging, Vol. 19, No. 3, 588-589. (2001)

It was supposed that high selectivity of polyamide acid membranes is determined by specific of water and ionic diffusion channels structure. Using IR-spectroscopy the particularities of water binding were understood. The self-diffusion processes were investigated by pulsed field gradient NMR. ESR Cu^{2+} was used in order to investigate the carboxylic groups distribution. Thin membranes (30-50 μm) were made after thermal treatment of line copolymer of 1,2,4,5-tetracarbonic acid with 4,4′-diaminediphenyloxide in the interval 383-448 K. From the IR spectroscopy data the water sorbed in membranes was divided into four parts; (1) water with the normal hydrogen bond network (3420 cm^{-1}); (2) water with damaged hydrogen bond network (3627, 3567 and 3467 cm^{-1}); (3) water bonded to imine groups (3328 cm^{-1}); water bonded to carbonyl and carboxyl groups (2667 cm^{-1}). For the membrane with the maximum water content, water self-diffusion was characterized by one self-diffusion coefficient. In this case the fast molecular exchange between water molecules in different channels is taking place and only the average self-diffusion coefficient could be measured. With the decreasing water content in membrane, the diffusion decay shape becomes two exponential. It shows two diffusion channels structure. It may be supposed that the first channel contains carboxylic groups, the self-diffusion coefficient in this channels is about $3*10^{-11}$ m^2/sec. The existence of ionogenic channels agrees with the Cu^{2+} ESR data for this membrane. It was shown that carboxylic groups are collected together and may organize clusters. Second channel may be some intermediated space between ionogenic channels. The water self-diffusion in this channel is about 10^{-9} m^2/sec. Proposed model of transport channels is discussed. It may be concluded that water transport is controlled by the translational diffusion motion in ionogenic channels.

Electron Spin Resonance Studies of Free Radicals in γ-Irradiated Soybean Paste

Eun-Joo Lee, Vitaly I. Volkov, and Cherl-Ho Lee

J. Agric. Food Chem. Vol 49, No. 7, 3457-3462. (2001)

Free radicals in γ-irradiated soybean paste were investigated by electron spin resonance (ESR) spectroscopy to determine the effect of temperature (77-296 K) and moisture content (1-54%) of samples irradiated at high dose (1-40 kGy). The samples were kept in liquid nitrogen (77 K) during irradiation and subsequent ESR measurements. The spectra shown at 77 K consisted of the hydrogen atom lines at low and high field and complicated symmetric spectrum. By increasing the microwave power, the line shape of ESR spectra altered, which indicated the detection of different paramagnetic centers at different microwave powers. In saturation curves, it was possible to select four types of spectra components which were different in their relaxation times. By the different irradiation doses, the change in free radical concentration showed a curvilinearly increasing relationship with irradiation dose in wet samples, whereas a proportional relationship was observed with dried samples. This might indicate that the indirect process of free radical formation was involved with the existence of free water radicals in the wet samples.

Detection of Free Radical in Gamma-irradiated Soybean Paste and Model System by Electron Spin Resonance Spectroscopy

Eun-Joo Lee, Vitaly I. Volkov, Myung-Woo Byun, Cherl-Ho Lee

Radiation Physics and Chemistry. Vol 64, No. 1, 61-66. (2002)

We have investigated ESR spectra of fermented soybean paste irradiated at 77K and compared with those of soybean protein isolate and soybean oil. The influences of irradiation dose, moisture content and heating after irradiation on the free radical concentration and species were examined. Four different carbon type free radicals, FR1-FR4, were identified as the product of amino acid decomposition. In the case of FR1, the doublet line arises from the hydrogen atom on the β-carbon adjacent to the carbonyl free radical. It disappeared at 150K. FR2 was most abundant and disappeared at 190K in wet soybean paste (WSP) and at 210K in dry soybean paste (DSP), respectively. The radical FR4 originated from decarboxylation and deamination of amino acids, which disappeared at 210K in both WSP and DSP. FR3 was assumed to be formed by the damage of amino acid side chains. The radical .OH was originated from water molecules, and was not observed in dry system. Sulfur radical was stable even at room temperature observed in both wet and dry systems. Aldehyde radical must be originated from the chemical reactions of enzymatic hydrolysates of soybean.

Water Self-diffusion Behavior in Yeast Cells Studied by Pulsed Field Gradient NMR

Suh, K.-J., Hong, Y.-S., Skirda, V.D., Volkov, V.I., C.-Y.J., and Lee, C.-H.

Biophysical Chemistry. Vol 104, No. 1, 121-130. (2004)

The water self-diffusion behavior in yeast cell water suspension was investigated by pulsed field gradient NMR techniques. Three types of water were detected, which differ according to the self-diffusion coefficients: bulk water, extracellular and intracellular water. Intracellular and extracellular water self-diffusion was restricted; the sizes of restriction regions were approximately 3 and 15-20 μm, respectively. The smallest restriction size was determined as inner cell size. This size and also cell permeability varied with the growth phase of yeast cell. Cell size increased, but permeability decreased with increasing growth time. The values of cell permeabilities P_1^d obtained from time dependence of water self-diffusion coefficient were in good agreement with the permeabilities obtained from the exchange rate constants P_1^{eff}. The values of P_1^{eff} were 7×10^{-6}, 1.2×10^{-6} and 1.6×10^{-6} m/s, and P_1^d were 6.3×10^{-6}, 8.4×10^{-7}, 1.5×10^{-6} m/s for yeast cells incubated for 9 h (exponential growth phase), 24 h (end of exponential growth phase), and 48 h (stationary growth phase), respectively.

Water Self-diffusion in *Chlorella* sp. Studied by Pulse Field Gradient NMR

Choong-Hun Cho, Young-Shick Hong, Ki-Rim Kang, Vitaly I. Volkov, Vladimir Skirda,
Chung-Yung J. Lee and Cherl-Ho Lee

Magnetic Resonance Imaging, Vol. 21, No. 9, 1009-1017. (2003)

The water self-diffusion behavior in *chlorella* water suspension was investigated by pulsed field gradient NMR technique. Three types of water was determined, which differs according to the self-diffusion coefficients; bulk water, extracellular and intracellular water. Intracellular and extracellular water self-diffusion were restricted, and the sizes of restriction regions were 3.4 μm and 17 μm, respectively. The water molecular exchange process between these three diffusion regions was investigated. The residence time and exchange rate constant for chlorella cells were obtained. The cell wall permeability determined from the rate constant as 3×10^{-6} m/s agreed with the permeability 10^{-6} m/s obtained from time dependence of intracellular water self-diffusion coefficient. The structural cluster model of chlorella cell is estimated to describe the extracellular water self-diffusion in chlorella water suspension.

Measurement of Water Movements in Food and Living Systems by Pulsed Field Gradient NMR

Young-Shick Hong and Cherl-Ho Lee

Food Engineering Progress Vol 8, No. 2, 63-76. (2004)

Pulsed-field gradient NMR (PEG-NMR) is being widely applied to probe living tissues and biological cells structure for measurement of thermodynamic binding constants, membrane permeability and rates of trans-membrane exchange processes. Water movements in biological systems and food matrices are important in the engineering aspect such as quality manipulation in food processing. The measurement of diffusion properties of water molecules in food systems is now possible using PFG-NMR, and the hydration properties and hydrodynamic properties can be accurately evaluated by this method. In this paper, we reviewed the theoretical basis and the applications of PFG-NMR spectroscopy in measurement of water movements in food systems.

Effect of Heat Treatment on Water Permeability of Yeast Cells as Measured by Pulsed Field Gradient (PEG) NMR Spectroscopy

Young-Shick Hong, Ki-Jeong Suh, Sung-Won Yoon, Vladimir Skirda, Vitaly Volkov and Cherl-Ho Lee

Food Sci. Biotechnol., Vol. 13, No. 5, 586-590. (2004)

The water self-diffusion behavior in yeast cell water suspension was investigated by pulsed field gradient (PEG) NMR techniques. The diffusional water permeability was estimated from the time dependence of the self-diffusion coefficient. Heating to 50-70℃ increased the water permeability of yeast cells from $6.7 \pm 0.7 \times 10^{-7}$ m/sec for fresh yeast to $2.4 \pm 0.3 \times 10^{-6}$ m/sec for heat-treated cells at 50℃ (CH50) with conventional heating in water bath. The exchange time decreased from 550±50 msec in fresh yeat to 430±40 msec in CH50. Ohmic heating (OH) was more effective on the permeability increase than conventional heating. This result coincided with our previous results on the leakage of cellular materials observed by heating in water bath and Ohmic heating.

Measurement of Water Movement in Food and Biomaterials By Pulsed Field Gradient (PEG)-NMR

Young-Shick Hong and Cherl-Ho Lee

Japan J. Food Engineering Vol 6, No. 1, 15-20. (2005)

Pulsed-field gradient NMR (PFG-NMR) is widely applied to probe living tissues and biological cells structure for measuring thermodynamic binding constants, membrane permeability and rates of transmembrane exchange processes. Water movements in biological systems and food matrices are important in the engineering aspect such as quality manipulation in food processing. The measurement of diffusion properties of water molecules in food molecules in food systems is now possible using PFG-NMR, and the hydration properties and hydrodynamic properties of food materials can be accurately evaluated by this method. In this paper, we measured the diffusion behaviour of water in protein matrix, Tofu, and the membrane permeability in biological cell such as *chlorella*, yeast and human red blood cell non-invasively by PFG-NMR.

Structural and Dynamic Properties of Polyoxyethylene Sorbitan Monooleate Micelle in Water Dispersion Studied by Pulsed Field Gradient NMR

Y.S. Hong, K.C. Kim, V.I. Volkov, V.D. Skirda, and C.-H. Lee

Appl. Magn. Reson., Vol 29, No. 2, 351-361. (2005)

The diffusion phenomenon of a nonionic surfactant, polyoxyethylene sorbitan monooleate (POE-SMO), micelle in aqueous solution was investigated by pulsed field gradient nuclear magnetic resonance (PEG NMR) with a high gradient strength of 17.4 T/m at the diffusion time t(d) varied from 3 to 300 ms. This high gradient strength allowed us to measure the slow self-diffusion coefficient of POE-SMO micelle, and the short diffusion time below 10 ms showed the restricted diffusion of the micelle. At the short t(d) the self-diffusion of the micelle was restricted and the restricted sizes were 1.8, 1.5, and 0.8 mμm for the POE-SMO concentration of 100, 200 and 300 mM, respectively, and 0.6 mμm for the POE-SMO only. The possible reason of this restriction was assumed to be the formation of a spatial network or a micellar clustering. Furthermore, a proton exchange between water molecule and surfactant OH group on the micelle surface was proposed. With respect to this proposal, the residence time of the proton at the micelle surface and the thickness of the surface were investigated from proton self-diffusion coefficients by PFG NMR.

Self-Diffusion Coefficient of Water in Tofu Determined by Pulsed Field Gradient Nuclear Magnetic Resonance

Young-Shick Hong and Cherl-Ho Lee

J. Agric. Food Chem., Vol 54, No. 1, 219-223. (2006)

The self-diffusion coefficient of water in soybean protein dispersion and tofu was measured by pulsed field gradient (PFG) NMR. A soy protein isolate (SPI) dispersion (6 and 12%, w/w) in water, calcium cross-linked precipitate, and tofu were used for comparison. The self-diffusion coefficient of water (D) in the SPI dispersion, 2.23×10^{-9} m^2/s, was estimated lower than that of free water, 2.6×10^{-9} m^2/s at 25 °C, and decreased as the SPI concentration increased. It further decreased by the addition of calcium chloride, reflecting the obstruction effect induced by the precipitates in addition to the hydration and hydrodynamic interaction in the protein dispersion. The two water regions in tofu were interpreted by the two-site Karger model: D_1 and D_2 of soft tofu were 2.26 $(\pm0.11)\times10^{-9}$ and 6.84 $(\pm0.34)\times10^{-11}$ m^2/s, respectively. The relative amount of proton (water) was $p_1 = 0.98$ and $p_2 = 0.02$ at 100 ms of diffusion time. The self-diffusion coefficients of water decreased in pressed tofu, and their relative amounts of water changed to $p_1 = 0.93$ and $p_2 = 0.07$. It was suggested that D_1 corresponded to obstructed water in the network structure and D_2 corresponded to hydrated water on the surface layer of pores formed in the protein network of tofu. The pore sizes estimated from the diffusion length of obstructed water were 21.3 μm in soft tofu and 20.8 μm in pressed tofu. The removal of fat from pressed tofu led to a decrease in D_2 from $6.26\ (\pm0.31)\times10^{-11}$ to $3.53\ (\pm0.18)\times10^{-11}\ m^2/s$, and the relative amount of hydrated water increased from 0.07 to 0.14, which indicated hydrophobic hydration.

New Approach for Characterization of Gelatin Biopolymer Films Using Proton Behavior Determined by Low Field 1H NMR Spectrometry

Young-Teck Kim, Young-Shick Hong, Robert M. Kimmel, Jeong-Hae Rho and Cherl-Ho Lee

J. Agric. Food Chem., Vol 55, No. 26, 10678-10684. (2007)

The behavior of protons in biopolymer films (BFs) formed with gelatin, water, and glycerol was investigated at various relative humidities (RHs) and concentrations of glycerol using a low field 1H NMR spectrometer. At a RH of approximately 0%, the distributed spin–spin relaxation times (T_2) of protons in BFs showed two components: a rapidly relaxing proton with the shortest T_2 derived from protons in the rigid backbone of the gelatin polymer such as CH_1– CH_2– and CH_3– and a slowly relaxing component with longer T_2 from protons of the functional groups in amino acid residues in gelatin such as –H, –OOH, and $–NH_3$. These two components are referred to as nonexchangeable (T_{2N}) and exchangeable protons (T_{2E}), respectively, indicating the different mobility of the protons. The T_{2E} increased as RH increased indicating the increase in relative mobility of protons due to the larger free volume in the BF matrix. Above a RH of 33%, the slowest relaxing component was found in all BFs and referred to as hydrationater protons (T_{2W}) with the highest relative mobility of all protons in the films. It suggests that the free volume in BFs can be formed above a RH of 33% in the absence of glycerol. The behaviors of T_{2N}, T_{2E}, and T_{2W} reveal the formation of free volume in the BF matrix associated with the presence of plasticizers (water and glycerol). The T_2 behavior in BFs is consistent with the behavior of spin–lattice relaxation (T_1). Our result is the first attempt to characterize using low field ^1H NMR technology how all protons in a film matrix behave and to develop correlations between proton mobility and free volume in protein-based BFs plasticized with water and glycerol.

Artifacts in the measurement of water distribution in soybeans using MR imaging

Young-Shick Hong, Jee-Hyun Cho, Na-Ri Kim, Chul-Hyun Lee, Chae-Joon Cheong,
Kwan-Soo Hong and Cherl-Ho Lee

Food Chemistry, Vol 112, No. 1, 267-272. (2009)

Significant artifacts occur from the overlapping signals of the water and lipids in relaxation time weighted magnetic resonance (MR) images and should be compensated, in order to determine a precise water distribution in the soybean seeds. The chemical shift selective T_1-, T_2-, and T_2-weighted MR images of water were compared to those with water or lipid suppression in soaked soybean seeds. In the absence of lipid suppression, the chemical shift artifacts were observed in the chemical shift selective T_1- and T_2- weighted MR images, due to the overlapping signals of the water and lipid protons. However, the MR images with lipid suppression had reduced artifacts. This study demonstrates that an appropriate MR imaging technique provides relatively uniform signal intensity and has importance in the investigation of true water distribution within food systems, such as to correlate a relationship between water distribution using MR imaging and water diffusion using pulsed field gradient (PFG) NMR.

MR imaging and diffusion studies of soaked rice

Young-Shick Hong, Kwan-Soo Hong, En-Soo Lee, Jee-Hyun Cho, Chul-Hyun Lee, Chae-Joon Cheong and Cherl-Ho Lee

Food Research International, Vol 42, No. 2, 237-245. (2009)

The effects of lipid on magnetic resonance (MR) images and diffusion data in soaked rice were investigated using MR imaging and pulsed field gradient (PFG)-NMR spectroscopy, as well as water diffusion within rice. Lipid contributed to proton density-weighted MR image and found to be diffused by diffusion-ordered spectroscopy (DOSY). During diffusion experiments, two components for the self-diffusion coefficient (D_{s1} and D_{s2}) of water and one component for lipid (D_{s3}) were observed in soaking rice. It suggests that D_{s2} of water self-diffusion corresponds to water diffusion within starch granules of rice, resulting in a restricted diffusion. Based on the restricted diffusion, the average size (a) of the starch granules was estimated to be 4.6 μm. The permeability of water (P) of starch granule was increased from 1.77×10^{-5} m/s to 2.49×10^{-5} m/s as the soaking time increased from 3 to 6. This study demonstrates that lipids play a role in MR images contrast and diffusion data, and that physicochemical properties of the starch granule can be characterized in soaked seeds by PFG-NMR.

A Literature Review on Traditional Korean Cookies, Hankwa

Cherl-Ho Lee and Young-Sun Maeng

Korean J. Dietary Culture, Vol 2, No. 1, 55-69. (1987)

A literature survey on Hankwa, traditional Korean cookies, was made in order to identify the state of scientific understanding on these products and the future study needs for the modernization of the products. The type of *Hankwa* varies with the raw materials used and the processing methods and is classified into 7 groups, i.e. Yumilkwa, Ganjung-Sanja, Dasik, Jeonkwa, Suksilkwa, Kwapyun and Yutgangjung. The recipe and processing characteristics of 7 types of Hankwa were discussed and the scientific finding on these products were reviewed.

A Literature Review on Korean Rice-cakes

Cherl-Ho Lee and Young-Sun Maeng

Korean J. Dietary Culture, Vol 2, No. 2, 117-132. (1987)

A literature survey on traditional Korean rice-cakes was made in order to identify the historical background and the state of scientific understanding on these products. Korean rice cakes can be classified into 5 groups depending on the processing methods; steamed (Jung-byung), pounded (Do-byung), shaped and steamed or boiled (Dan-ja), fried (Yu-Jeon-byung) and fermented and steamed (Yi-byung). They are further divided into varieties by the raw materials used, coating materials and shape. The recipe and processing characteristics of 5 groups of Korean rice-cake were discussed and the scientific findings on these products were reviewed.

Nutritional Evaluation of Korean Traditional Diet

Cherl-Ho Lee and Si-Saeng Ryu

Korean J. Dietary Culture, Vol 3, No. 3, 275-280. (1988)

The nutritional value of Korean traditional diet was estimated by using the 7-dish meal of Kim Ho Jik (1944) and the standard weekly menu of Bang Sin Young (1957), and compared to the current Recommended Daily Allowance of Korean. The Korean traditional diets were estimated to be able to supply 2,000~2,500 Kcal and 80~90 g of protein per day. The constitution of energy was made by 73~77%, carbohydrate, 15~18%, protein and 10~12% lipid. The content of animal protein was 20~30% of total protein. The Korean traditional diet could supply sufficient amounts of protein, minerals and vitamins for an adult male if the energy intake exceeds 2000 Kcal per day.

The Changes in the Dietary Pattern and Health and Nutritional status of Korean During the last one Century

Cherl-Ho Lee, Yong-Jae Joo, Kee-Ok Ahn and Si-Saeng Ryu

Korean J. Dietary Culture, Vol 3, No. 4, 397-406. (1988)

The changes in the dietary pattern of Koreans during the last one century and its consequences are summarized as follows;

1. Until the beginning of 20th century, Koreans used variety of cereals, vegetables and fruits for their staple food, but the variety has been largely reduced by the agricultural development and urbanized life style.
2. The well balanced traditional dietary pattern of Korean had been deeply deteriorated by the food shortage during the Japanese occupation and Korean war.
3. The deteriorated nutritional condition of Korean was not remedied by the restoration of traditional dietary pattern, but attempted to overcome it by the adoption of Western food habit.
4. The people were trained to eat milk and flour-meals during the starvation of Korean war, and it was continued after Korean war through the animal husbandry promotion policy.
5. The importation of food and feed cereals has been increased rapidly during the economic growth in 1970's and the food self-sufficiency dropped below 50%.
6. In 1970's, the food supply pattern of Korean was restored to the level of early 1900, but the consumption of lipid increased extraordinarily.
7. The overconsumption of animal food and lipid continues in 1980's, and it coincides with the rapid increase in the occurrence of food related degenerative diseases.
8. The establishment of Korean dietary goal which is based on the traditional dietary pattern is needed.

Literature Review on the Korean Traditional Non-alcoholic Beverages, I. Types and Processing Methods

Cherl-Ho Lee and Sun-Young Kim

Korean J. Dietary Culture, Vol 6, No. 1, 43-54. (1991)

The types and processing characteristics of traditional non-alcoholic beverage and their historical backgrounds were surveyed through the old literatures published from the 8th century to 1940. A total of over 70 different names of beverages were found in the literature. They were classified into 10 groups according to their processing methods and quality characteristics; Sunda (green tea), Yusada (tea analog with/without green tea), Tang (boiled herb extract), Jang (lactic acid fermented rice beverage), Suksu (rice tea), Mium (cereal gruel), Misik (roasted cereal powder), Sikhe (sweet rice beverage saccharified with malt), Sujonggwa (ginger-fruit drink) and Hwachai (fruits drink). In the old literatures, there was not exist clear distinction between Jang, Tang, Chong and Tea. Lactic acid fermented rice beverage seemed to be a common drink in Silla and Koryo periods (AD. 600-1400), but disappeared afterwards and completely forgotten today. Other beverages are maintained until today with almost identical methods of preparation as described in the literatures written in the 18th century.

Literature Review on The Korean Traditional Non-Alcoholic Beverages, II. Recent Status of Research and Developments

Cherl-Ho Lee and Sun-Young Kim

Korean J. Dietary Culture, Vol 6, No. 1, 55-69. (1991)

The scientific research results on the Korean traditional non-alcoholic beverages published in the literatures were reviewed. A total of 79 research papers were collected; 11 papers were on green tea,

38 on tea analog, 3 on rice tea, 4 on roasted cereal powder, 9 on malt saccharified rice beverage, 1 on ginger-fruit drink, 10 on fruits drink and 5 papers on others. Most of the researches were concerned to the chemical composition and processing conditions. More researches are needed on the quality requirements of the ingredients, the keeping quality of the products and the industrialization of the traditional processing methods.

Literature Review on Kimchi, Korean Fermented Vegetable Foods, I. History of Kimchi Making

Cherl-Ho Lee and Bo-Sun Ahn

Korean J. Dietary Culture, Vol 10, No. 4, 55-69. (1995)

The history of vegetable preservation technology by salting and fermentation in Korea was reviewed from the Three Nations Era to the end of Chosun Kingdom, and the development of present day's Kimchi processing technology was traced back by using the classic books as well as recent review papers published in Korea. Although the written record on salting and fermentation of vegetables first appears in 12th century literature (Dongkukisangkukjib, Gyu-Bo Lee 1168~1241), the use of salted/fermented vegetables could be dated back to the Three Nations Era (B.C. 37~A.D. 668) and even earlier period. The present type of *Kimchi* was gradually evolved after the introduction of red pepper into Korea in the 17th century. The descriptions on *Kimchi* fermentation appeared in the literatures written in the period of 16th~19th centuries in Korea, Sunjapbang (1500~), Domundaijak (1611), Sasichanyocho (1656), Eumsikdimibang (1670), Chubangmun (1600~), Saekgyung (1676), Yorok (1600~), Sanlimkynggje (1715), Cheungbosanlimkyungje (1766), Kyuhapchongsoe (1800~), Imwon-sipyukji (1827), Dongkuksesiki (1849) and Buinpylji (1855~) were reviewed.

A Survey on the Consumer Attitude Toward Health Food in Korea, (I) Consumer Perception on Health and Food Habit

Eun-Joo Lee, Seung-Ok Ro and Cherl-Ho Lee

Korean J. Dietary Culture, Vol 11, No. 4, 475-485. (1996)

The consumer perception on health and food habit, the experience of health food use and the discrimination between health food and drug of Korean consumer were surveyed by using a questionnaire containing 15 items in order to obtain the basic data for the assessment of the benefit and risk of health foods in Korea. A total of 1,000 people over 20 years of age living in Seoul and the vicinities were interviewed and asked to fill out the questionnaire during the period from the October 1995 to the February 1996. Among the 882 answers collected, 23 was incomplete data, and 859 answers were used for the statistical analysis by using SAS program. The perception of Korean consumer on health and food habit indicated that food habit was considered the most important factor for the maintenance of health, as appeared in 39.8% of the subjects, among which 93.9 % believed that food habit could cause disease, and 97.1% believed that disease could be cured by changing food habit. The most worried disease was cancer (30.6%), degenerative diseases (14.1%), diseases by accident (12.6%) and obesity (10.0%). The disease which likely to be caused by food habit was diabetes (35.6%), obesity (22.4%), high blood pressure (12.8%), constipation (12.7%) and cancer (7.9%). The disease which was believed to be cured by changing food habit was diabetes (40.1%), obesity (25.9%), constipation (16.5%), high blood pressure (7.4%) and cancer (3.3%). It appeared that the people had a perception that food habit was highly related with diabetes and obesity, but less with cancer which was mostly worried.

A Survey on the Consumer Attitude Toward Health Food in Korea, (II) Consumer Perception on Health Food

Eun-Joo Lee, Seung-Ok Ro and Cherl-Ho Lee

Korean J. Dietary Culture, Vol 11, No. 4, 487-495. (1996)

The consumer perception on health and food habit, the experience of health food use and the discrimination between health food and drug of Korean consumer were surveyed by using a questionnaire containing 20 items in order to obtain the basic data for the assessment of the benefit and risk of health foods in Korea. A total of 1,000 people over 20 years of age living in Seoul and the vicinities were interviewed and asked to fill out the questionnaire during the period from the October 1995 to the February 1996. Among the 882 answers collected 23 was incomplete data, and 859 answers were used for the statistical analysis by using SAS program. The survey revealed a strong interest of the consumer on health food by showing that more than a half of the subjects (58.8%) had the experience of actual use of health food, and 68.2% believed the effectiveness. What the consumer expect most from health food was to have beneficial effect to maintain overall health condition (59.8%), and the most negative aspect of health food was the overstatement on the effectiveness by the producers (52.1%). The most important source of information for the purchase of health food was the suggestion of friends and relatives (30.6%). Among the health foods registered and regulated by the food law, royal jelly (22.7%), squalene (16.0%), refined fish oil (15.1%), lactic acid bacteria (10.6%) and aloe (8.8%) were relatively well aware. Although 84% of the subjects perceived that health food is different from drug or traditional medicine, the largest percentage of the subject selected ginseng as the most well known type of health food (22.7%) as well as the most well known drug (or traditional medicine) (41.7%). Ginseng was also chosen as the most frequently used health food (17.0%), and vitamin tablets the third (13.0%). The vague definition of health food and unambiguous discrimination of it from medicine by the consumers were problematic for the correct use and reasonable purchasing behavior. The clear definition and proper regulation on the manufacture and distribution of health food, more strict control of labelling and advertisement, and a wide consumer education on health food were recommended

A Literature Review on Traditional Korean Fermented Soybean Products

Cherl-Ho Lee and Jun-Cheol Kim

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The line from South Manchuria to the Korean peninsular, where the most abundant varieties of wild soybeans are found, is considered to be the native home of soybean, This area was the territory of the Korean ancestors, who searched for a new plant protein source to substitute for meat protein and probably became the first people in history to use soybean as human food. The traces of soybean on the surface of a smooth earthen vessel of the Bronze Age was excavated from an old remains in Paldang, near Seoul, The story of soybean introduction into China says that it was brought from

Sanyung, South Manchuria, in early 7th century B.C. Korean were the first people to experiment with soybean fermentation, sparking the beginning of the soy sauce culture of the Orient. Their traditional technology was so advanced that they taught the techniques to neighboring countries. The History Book of Wei, the Chinese dynasty of the third century, praises the fermentation skill of the Korean people. The technique was transferred to Japan around that period, 2-3 century A.D., from Kokuryo. The early methods of soybean fermentation and their developments in Korean history and in neighboring countries were reviewed from the records in the old literatures. The cultural aspects related to the soybean fermentation were collected, and the recent scientific findings, such as microbiology, biochemical changes, taste components and physiological function of traditional fermented products were reviewed.

The Food Ways of Paleolithic Men in the Northeast Asia and Korean Peninsular

Cherl-Ho Lee

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The recent findings on paleolithic remains excavated in Korean peninsular and the neighboring Northeast Asian regions were reviewed and the food and dietary life of the paleolithic men, dictated by and adapted to the environment, were inferred. In this discussion the previous theory assuming that the inhabitants vanished from this area for a certain periods of times, for example glacial periods, due to the unsuitable environment and refilled again by new comers, was abandoned, because there were evidences indicating that this area was located in the peripheral edge of glacial region during the pleistocene, and the long land route from northern Siberia to southern Japanese islands through Korean Peninsular could provide enough time and space for the people to migrate and adapt to the changing environment. Therefor, the food ways of this region was considered as a developmental culture of continuity and succession. Interpretation of the lacking of archeological evidences for a certain periods of time as the vanishment of the inhabitants from the region is dangerous hasty conclusion, because the excavated archeological evidences we have are just a few drops in the long stream of the continuum of human history. The fauna and flora of six Early Paleolithic (700,000~ 300,000BP) remains, 12 Middle Plaeolithic(300,000~40,000BP) remains and 7 Late Plaleolithic (40,000~10,000BP) remains excavated in Korean Peninsular were analyzed, and compared to those of Northern China, Bohai Corridor, Liaodong Peninsular, Manchurian Basin and Maritime Province of Siberia. The early paleolithic inhabitants in Korean Peninsular lived mainly in the caves in the mountain as mobile hunter taking large animal. During the glacial periods, the sea level lowered down to 100m below of present level and the Yellow Sea basin between the central plain of China and Korean Peninsular were exposed and formed a huge steppes from the west end of Korean Peninsular to the east of Shandong Peninsular and Bohai Bay, supporting large herbivores such as auroch, bison, elk, water baffalo and Nauman's elephant. In the northern sub-alpine coniferous forests woolly mammoth, woolly rhinoceros, bear, boar, white bison, giant deer, horse were inhabited. Korean Peninsular was connected to Japanese Islands with land bridge. During the interglacial periods, the major hunting animals, deer and boar, moved to the north escaping from the humid and hot weather of the peninsular, and the people followed them. For the periodical movements, both for glacial/interglacial and seasonal migrations, the routs from the south of Japanese Islands to the

Manchurian Basin and Siberia through Korean Peninsular must be well known to the paleolithic men inhabited in the Northeast Asia. The Early and Middle paleolithic sites excavated today are mostly located on these routs starting from Jiri mountain in the south of Korean Peninsular through Baektu Mountain Range to Manchurian Basin or to Mongolian Plateau over Bohai Corridor and Taihang Mountains. The utilization of tree nuts and acorns, wild fruits, berries and grapes, grass seeds, roots and young buds of trees and ferns increased gradually by noticing that abundant plant materials were growing around the previously inhabited caves and dwellings. This might have resulted in the encoding of the homing instinct into human gene. The appearance of the pollen of grass, rice(Gramineae) and beans(Leguminosae, Papilionoideae) increased at the Late Paleolithic remains. By the increase of plant food in the diet, the dwelling sites gradually moved from the mountain to the plains near river. Since the people still feared of sudden flooding without knowing the method of water control, the dwellings were located on the hill side of river, where drinking water was closely available without having any vessels to carry and store the water. Tree leaves, wood pieces and flat stones, animal bones were used as the utensils for cooking and eating. Considering that most of the ritual vessels in this region have been made by wood, the use of wood vessels might precede the pottery culture of the Neolithic era. Animal skulls and horns were used as water vessels, which might have resulted in the conical bottom of the early pottery in the Neolithic era. Many of Early and Middle paleolithic sites in Korean Peninsular have the evidence of fire use, but raw meat, intestine and blood of animals appears to be the major source of nutrients, especially minerals and vitamins, for the paleolithic men. The technology of sun drying and smoked drying was gradually developed in the paleolithic era, and it contributed greatly to the survival and mobility of the people. Longer storage of food in cold weather was also recognized, and the length of settling in one dwelling site extended. It was also caused by the increase in population which started to confine them to a certain territory of movement. At the Late paleolithic era people became more familiar to live in the river side, where most of the Late paleolithic remains in this region were excavated, and started to enjoy freshwater shellfish, frog and mollusks at the foraging site without knowing to preserve the perishable animals.

The Primitive Pottery Age of Northeast Asia and Its Importance in Korean Food History

Cherl-Ho Lee

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The Northeast Asian Primitive Pottery Age(10,000-4,000 B.C.) existed between the Paleolithic Age and Neolithic Age was characterized and the development of earthenware technology and consequent food and dietary culture of the people were discussed. The technology of earthenware making and its use for cooking and storage of food appears to originate in the Korea Strait region including the southeastern coast of Korean Peninsular and northern part of Kyushu of Japanese Islands. The geographical and anthropological backgrounds of developing primitive pottery culture in this region were considered. The development of primitive earthenware technology as observed in the archeological studies on the excavates of the southern coast of Korea including *Sangnodaedo*, clearly shows the efforts of primitive men to improve the strength and waterproof property of earthenware suitable for cooking and storage of liquid food materials. The earthenware made before 6,000 B.C.

appears too soft and high water absorption to keep the original shape of the pieces, but the products after 6,000 B.C. are hard enough to keep the shape up to present time. A significant advancements of this technology are noticed in the products after 4,000 B.C., when the use of shell powder additives to the sandy clay and the high temperature kiln are appeared to start. The earthenware having different strengths and water absorption properties were intentionally made according to the purpose of use from this period. The use of earthenware of the littoral foragers made it possible to cook a mixture of different food ingredients such as, vegetables and roots, fish and shell fishes, seaweeds, and meats, in sea water(brine), and it opened the unique cooking technology of Korean, so called *Chigae* culture. The storage of wet grains, vegetables, shell-fish and fish and meats in earthenware allows the growth of microorganisms and results in spontaneous fermentation or putrefaction, and it must be the start of the long history of food fermentation in the Northeast Asia. In this view point, it was postulated that the cereal alcoholic fermentation, lactic acid fermentation of vegetables in brine(*kimchi* fermentation) started with the use of earthenware in the Primitive Pottery Age. This paper discusses the origin of Oriental food fermentation culture by using the archeological evidences of primitive earthenwares and the records in the classic literatures of Korea and China.

Functional Food of Interest to ASEAN: From Traditional Experience to Modern Production and Trading

Cherl-Ho Lee

Korean J. Food Sci. Biotechnol., Vol 13, No. 3, 390-395. (2004)

The countries in the East Asia have developed their own culture and identity through the history. Although they are commonly rice-eating people and historically influenced by Chinese culture, the climatic and geographic conditions made them to develop characteristic food habit and culture in each country. In the area of functional food, many similarities and also discrepancies are found among ASEAN countries. The similarities are basically come from the health concept of traditional Chinese medicine, such as the application of Yin and Yang and Five Phases theory. The health concept in Korean dietary culture is introduced as an example of East Asian thought of 'food as medicine'. The recent developments in functional food market of the world are reviewed, and the measures for cooperation and integration among ASEAN countries are suggested.

Key Public Health Issue Priorities in Asian Countries

Myeong-Ae Yu, Won-Taek Oh, and Cherl-Ho Lee

Korean J. Fd. Hyg. Safety, Vol 21, No. 3, 164-170. (2006)

Asian Branches of International Life Science Institute (ILSI), i.e. China, India, Japan, Korea and South East Asian Region, identified five key public health issue priorities of each region and compared the results. In case of China, India and South East Asian countries (Indonesia, Malaysia, Philippines, Thailand etc. ASEAN countries), communicable diseases were the first priority issue, while elderly issue and food safety were prime issues for Japan and Korea, respectively. Malnutrition was the second priority issue for India and ASEAN countries, whereas non-communicable disease like cancer and degenerative diseases was for Korea and China, and obesity for Japan. Typical issues were smoking for China, nutrition education for China and Japan, biotechnology aiming GMO for

India, and functional food causing health claim problem for Korea and Japan. Although the priority varied with the socioeconomic situation of each country, food and water safety recorded the highest priority of all the countries. The key public health issues of Korea were discussed in detail.

Harmonization of Eastern and Western Health Knowledge; Nutrigenetics and Sasang Typology

Cherl-Ho Lee

Food Science and Technology Research, Vol 13, No. 2, 89-95. (2007)

The completion of human genome project and the powerful tools of molecular biology together with bioinformatics technology give possibility to open the dialog between modern medicine and traditional remedies including Eastern medicine. Many of functional foods are originated from the traditional herbal medicine, and the scientific substantiation of the effectiveness of these products is required for the regulatory standards as well as for consumer protection. Needs for the reliable and efficient methods of scientific substantiation are increasing, and nutrigenomics may provide a short-cut way to scientific evaluation of many functional food ingredients and herbal medicine which have been used in the traditional societies for thousand years. Studies to apply nutrigenomic methodologies to the objective classification of Sasang body constitution types of Korean are reviewed. It is suggested that the empirical health food knowledge accumulated in the Eastern medicine may be explained scientifically by using the nutrigenomic methods, and it will contribute to open the custom-made nutrigenetic food age in the near future.

List of Publications

1. Lee, C.H., Studies on the Amino acid composition of Korean fermentation soybean Meju products and the evaluation of the protein quality, Korean J. Food Sci. Technol. 5(4):210-214. (1973)
2. Lee, C.H., The effect of Korean soysauce and soypaste making on soybean protein quality, Part I. Chemical changes during *Meju* making. Korean J. Food Sci. Technol. 8(1):12-18. (1976)
3. Lee, C.H, The effect of Korean soysauce and soypaste making on soybean protein quality, Part II. Chemical changes during *Meju*-brine ripening. Korean J. Food Sci. Technol. 8(1):19-32. (1976)
4. Lee, C.H., The effect of Korean soysauce and soypaste making on soybean protein quality, Part III. Changes in the lysine availability, Korean J. Food Sci. Technol. 8(2):63-69. (1976)
5. Lee, C.H, The effect of Korean soysauce and soypaste making on soybean protein quality, Part IV. Protein suppliment effect of soybean proteins to the rice diet, Korean J. Food Sci. Technol. 8(3):121-128. (1976)
6. Lee, C.H. and Rha, C.K., Thickening process of soy protein with calcium. J. Texture Studies, 7:441-449. (1977)
7. Sinskey, A.J., Boudrant, J., Lee, C.H., Deangelo, J., Miyasaki, Y., Rha, C.K. and Tenenbaum, S.R., Applications of temperature sensitive mutants for single cell protein products. Presented on US-USSR Joint Meeting on Single Cell Proteins in Moscow, June. (1977)
8. Lee, C.H. and Rha, C.K., Microstructure of soybean protein aggregates and its relation to the physical and textural properties of the curd. J. Food Sci., 43(1):79-84. (1978)
9. Tsintsadze, T.D., Lee, C.H. and Rha, C.K., Microstructure and mechanical properties of single cell protein curd. J. Food Sci., 43(2):625-635. (1978)
10. Lee, C.H., Imoto, M.E. and Rha, C.K., Evaluation of cheese texture. J. Food Sci., 43(5):1600-1605 (1978)
11. Tsang, S.K., Lee, C.H. and Rha, C.K., Cell wall disintegration and protein extraction from hydrocarbon grown yeast *Candida lipolitica*. J. Food Sci., 44(1):97-99. (1979)
12. Imoto, M.E., Lee, C.H. and Rha, C.K., Effect of compression ratio on mechanical properties of cheese. J. Food Sci., 44(2):343-345. (1979)
13. Lee, C.H., Tsang, S.K., Urakabe, R. and Rha, C.K., Disintegration of dried yeast cell and its effect on the protein extractability, sedimentation property and viscosity of cell suspension. Biotech. Bioeng., 21(1):1-17. (1979)
14. Lee, C.H. and Rha, C.K., Accelerated sedimentation test for the determination of the stability of protein dispersion. J. Food Sci., 44(2):419-424. (1979)
15. Lee, C.H. and Rha, C.K., Rheological properties of proteins in solution, In Food Texture and Rheology, ed. P. Sherman. Academic Press. New York, (1979)
16. Lee, C.H. and Rha, C.K., Application of scanning electron microscopy for the development of materials for food, In Scanning Electron Microscopy III, ed. R.P. Becker and O. Johari. SEM Inc., AMF O'Hare, II. U.S.A., 17-24. (1979)
17. Lee, C.H., Montiville, T.J. and Sinskey, A.J., Comparision of the efficacy os steam sterilization indicators. Appl. Environmental Microbiol., 37(6):1113-117. (1979)
18. Lee, C.H., Recent trend in food texture studies. Korean J. Food Sci. Technol., 11(4):314-320.

(1979)
19. Lee, C.H., Development and future prospect of soymilk processing technology. Food Industry, 52:29. (1979)(No English abstract)
20. Lee, C.H., Rheological properties of the food proteins. Korean J. Food Sci. Technol., 12(1):66-74. (1980)
21. Lee, C.H., Kim, Y.M., Lee, J.C. and Jung, P.K., The destruction of bacterial spores upon compressional pressure. Korean J. Food Sci. Technol., 12(4):272-277. (1980)
22. Lee, C.H., Functional properties of single-cell protein. Korean J. Applied Microbiol. Bioeng., 8(3):207-212. (1980)
23. Lee, C.H., Kim, Y.M. and Lee, J.C., Destruction rate of lactic acid bacteria upon tableting pressure, Korean J. Food Sci. Technol., 12(3):225. (1980)
24. Lee, C.H., Food industry and society - the benefit and risk, Food Science, 13(1):52-57. (1980)(No English abstract)
25. Lee, C.H., Park, C.R. and Chung, K.S., Changes in the chemical composition and flavor of yeast extract during the autolysis of bakers yeast. Korean J. Food Sci. Technol., 13(3):181-187. (1981)
26. Mheen, T.I., Kwon, T.W. and Lee, C.H., Studies on the nomenclature of Korean fermented foods. Korean J. Appl. Microbiol. Bioeng., 9(4):237-240. (1981)
27. Mheen, T.I., Kwon, T.W. and Lee, C.H., Traditional fermented products in Korea. Korean J. Appl. Microbiol. Bioeng., 9(4):253-261. (1981)
28. Lee, C.H., Lim, J.K. and Kim, D.H., Thermal energy efficiency of naturally convected solar drier supplemented with coal heater. Thesis Collection of Agricultures and Forestry, Korea University, 21(2):89-98. (1981)
29. Park, M.H., Sung, H.S. and Lee, C.H., Studies on the changes in the carbohydrates and color of ginseng extract during processing and storage. Korean Journal of Ginseng Science, 5(2):155-162. (1981)
30. Lee, S.J., Lee, K.S., Lee, C.H., Park, J.Y., Sung, H.S., Lee, M.W., Cho, Y.S., Park, K.J., Han, I.D., Wi, K.R. and Lee, S.J., Present status and problems in statistical quality control and product development, Food Science, 14(3):39-43. (1981)(No English abstract)
31. Lee, C.H., Processing and utilization of yeat extract. Food Industy, 60(8):73-76. (1981)(No English abstract)
32. Lee, C.H., Food processing technology for the 1980's, Nongkwang, No.11, 69-81. (1981)(No English abstract)
33. Lee, C.H., Food preservation and food processing industry, Nongkwang. No.5, 7-11. (1982)(No English abstract)
34. Lee, C.H. and Park, S.H., Studies on the texture describing terms of Korean. Korean J. Food Sci. Technol., 14(1):21-29. (1982)
35. Lee, C.H., Kim, H.R., Yang, H.C., Lee, M.W. and Bae, C.C., Effects of external conditions on the emulsifying property of proteins. Korean J. Food Sci. Technol., 14(1):49-56. (1982)
36. Lee, C.H., Lim. J.K., Kim. D.H. and Park, H.W., Effect of hot air recycling and humidistat

control on the thermal energy efficiency of solar drier supplemented with coal heater. Thesis Collection of Agricultures and Forestry, Korea University, 22:125-133. (1982)

37. Lee, C.H., Lupin seed. (Special lecture) Food Research, 23(1):3-9. (1982)(No English abstract)
38. Lee, C.H., Oh, S.H. and Kim, C.S., Studies on the fermentation of lupinseed, Part I. Determination of the growth rate of *Aspergillus oryzae* on beans. Korean J. Appl. Microbiol. Bioeng., 10(3):227-232. (1982)
39. Cho, H.O., Byun, M.W., Kwon, C.H., Yang, H.S. and Lee, C.H., Batch scale storage of sprouting foods by irradiation combined with natural low temperature, Part I. Storage of potatoes. Korean J. Food Sci. Technol., 14(4):355-363. (1982)
40. Byun, M.W., Lee, C.H., Cho, H.O., Kwon, J.H. and Yang, H.S., Batch scale storage of sprouting foods by irradiation combined with natural low temperature, Part II. Suitability for potato chip processing of irradiated potatoes after storage. Korean J. Food Sci. Technol., 14(4):364-369. (1982)
41. Lee, C.H., Technical aspects of food quality control, Food Science, 15(2):27-32. (1982)(No English abstract)
42. Lee, C.H., Development and function of US Food, Drug and Cosmetics Law, Food Science, 15(4):71-76. (1982)(No English abstract)
43. Lee, C.H., Basic principles and potential of food fabrication, Food Science, 15(3):4-11. (1982)(No English abstract)
44. Lee, C.H., Kim, C.S. and Yang, H.C., Microstructure and hydrodynamic properties of soybean protein bodies in solutions. J. Food Sci., 48(3):695-702. (1983)
45. Lee, C.H. and Kim, C.W., Studies on the rheological properties of Korean noodles, I. Viscoelastic behavior of wheat flour noodles and wheat-sweet potato starch noodle. Korean J. Food Sci. Technol., 15(2):183-188. (1983)
46. Lee, C.H. and Kim, C.W., Studies on the rheological properties of Korean noodles, II. Mechanical model parameters of cooked and stored noodles. Korean J. Food Sci. Technol., 15(3):295-301. (1983)
47. Lee, C.H. and Kim, C.W., Studies on the rheological properties of Korean noodles, III. Correlation between Mechanical parameters and sensory quality of noodles. Korean J. Food Sci. Technol., 15(3):302-306. (1983)
48. Oh, S.H., Lee, C.H., Studies on the fermentation of lupin seed (II), Preparation of traditional Korean fermented been sauce and paste. Kor. J. Appl. Microciol. Bioeng., 11(3):241-248. (1983)
49. Lee, C.H. and Kim, D.H., Hot-air drying characteristics of oyster mushroom, *Pleurotus ostreatus*. Thesis Collection of Agricultures and Forestry, Korea University, 23:137-147. (1983)
50. Lee, C.H., Lim, J.K., Kim, J.D. and Lee, M.H., Construction of single-screw extruder and its mechanical properties and product characteristics for corn grits extrusion-cooking. Korean J. Food Sci. Technol., 15(4):392-398. (1983)
51. Lee, C.H., Cho, T.S., Lim, M.W., Kang, J.H. and Yang, H.C., Studies on the Sik-hae fermentation made by flat-fish. Kor. J. Appl. Microbiol. Bioeng., 11(1):53-58. (1983)

52. Lee, C.H., Food texture and its chemistry. Progress in Chemistry and Chemical Industry, 23(12): 854-865. (1983)(No English abstract)
53. Lee, C.H. and Kwon, Y.K., Food R&D evaluation and quality analysis, Food Science, 16(3):33-41. (1983)(No English abstract)
54. Lee, C.H. and Kwon, O.H., Effect of addition of starch, salt and soda ash on the mechanical properties of *Naengmyon*. J. Food Sci. Technol., 16(2):175-178. (1984)
55. Lee, C.H., Kim, C.S. and Lee, S.P., Studies on the enzymatic partial hydrolysis of the soybean protein isolates, Korean J. Food Sci. Technol., 16(2):228-234. (1984)
56. Lee, C.H. and Lee, S.W., Peeling operation of root vegetables: potato, sweet potato and carrot, Korean J. Food Sci. Technol., 16(3):329-335. (1984)
57. Lee, C.H. and Kim, S.K., Studies on measurement of protein hydrophobicity: Hydrophobic gel column chromatography. Korean Biochem. J., 17(4):373-380. (1984)
58. Lee, C.H., Lee, H.D. and Kwon, O.H., Milling properties of Australian wheats and physicochemical properties of the flours. J. Korean Agricultural Chemical Society, 27(1):21-28. (1984)
59. Lee C.H., Protein hydrophobicity and its relation to the structure and functional properties of food proteins, Proceeding of the 9th Science and Technology Symposium, Seoul. The Federation of Science and Technology Societies, Korea:251. (1984)
60. Lee, C.H., Present status and development of lactic acid fermented foods in the Republic of Korea, UNIDO Symposium on the Importance of Lactic Acid Fermentation in the Food Industry, November 27-29, Mexico City, Mexico. (1984)
61. Lee, C.H., Kim, S.K. and Lee, S.P., Studies on the measurement of protein hydrophobicity: Fluorometry and hydrophobic partition, Korean Biochem. J., 18(2):129-135. (1985)
62. Lee, C.H. and Lee, H.D., The quality of Korean dried noodle made from Australian wheats. Korean J. Food Sci. Technol., 17(3):163-169. (1985)
63. Lim, J.K., Wakamiya S., Noguchi A. and Lee, C.H., Effect of reverse screw elements on the residence time distribution in twin-screw extruder. Korean J. Food Sci. Technol., 17(3):208-212. (1985)
64. Lee, C.H., Han, O., Tae, W.T., Kim. Y.W. and Lee, J.K., Lactic acid fermentation of lupin seed milk. Kor. J. Appl. Microbiol. Bioeng., 13(3):191-198. (1985)
65. Lee, C.H. and Son, H.S., The textural properties of imitation cheese by response surface analysis. Korean J. Food Sci. Technol., 17(5):361-370. (1985)
66. Lee, C.H. and Kim, J.K., Microstructure of lupin seed: a comparative study with soybean. Korean J. Food Sci. Technol. 17(6):454-459. (1985)
67. Lee, C.H., Kim, C.S. and Oh, S.H.. The soaking and cooking properties of soybean and lupinseed. Thesis Collection of Agricultures and Forestry, Korea University, 25:179-188. (1985)
68. Kim, Y.U., Lee, C.H., Han, O., Tae, W.K. and Lee, J.K., Lactic acid fermentation of lupinseed milk, J. of Korean Soybean Research Society, 2(2):52-53. (1985)
69. Lee, C.H., Lee, E.H., Lim, M.H., Kim, S.H., Chae, S.K., Lee, K.W. and Koh, K.H., Characteristics of Korean fish fermentation technology. Korean J. Dietary Culture, 1(3):267-378. (1986)

70. Lee, C.H., Kimchi: Korean fermented vegetable foods. Korean J. Dietary Culture, 1(4):395-492. (1986)
71. Lee, C.H., Lupin seed for human consumption. Korean J. Food Sci. Technol., 18(5):398-405. (1986)
72. Lee, C.H., Lee, H.D., Yoo, B.S. and Hong, S.H., Effect of wheat variety, protein content and extraction rate of flour on the color preference of Korean dried noodle. Thesis Collection of Agricultures and Forestry, Korea University, 26: 119-131. (1986)
73. Lee, C.H., Traditional food technologies and their recent developments in Korea, in Traditional Foods and Some Products and Technologies, CFTRI, India. (1986)
74. Lee, C.H., *Kimchi*: Korean fermented vegetable foods. Traditional Foods and their processing in Asia, NODAI Research Institute Tokyo University of Agriculture. 201-209. (1987)
75. Yoo, B.S. and Lee, C.H., Development of shear extrusion test for the texture evaluation of cooked noodle. Korean J. Food Sci. Technol., 19(2):171-175. (1987)
76. Kim, J.K., Tokuji Watanabe and Lee, C.H., Microstructure and textural properties of cell mass from cooked kidney bean and soybean. Korean J. Food Sci. Technol., 19(2):164-170. (1987)
77. Lee, C.H. and Maeng, Y.S., A literature review on traditional Korean cookies, Hankwa, Korean J. Dietary Culture, 2(1):55-69. (1987)
78. Lee, C.H., Maeng, Y.S. and Ahn, H.S., Studies on the sensory characteristics of traditional Korean cookies, *Hankwa*. Korean J. Dietry Culture, 2(1):71-79. (1987)
79. Lee, S.P. and Lee, C.H., Partition coefficient of proteins of different surface hydrophobicity in poly(ethylene glycol)-dextran aqueous two phase system. Korean J. Food Sci. Technol., 19(2): 140-145. (1987)
80. Lee, S.P. and Lee, C.H., Effect of salts on the partition of proteins in poly(ethylene glycol)-dextran aqueous two phase system. Korean J. Food Sci. Technol., 19(2):146-150. (1987)
81. Lee, S.P., Kim, Y.M. and Lee, C.H., Purification of intracellular β-galactosidase from *Lactobacillus sporogenes* in an aqueous poly(ethylene glycol)-potassium phosphate two-phase system. Kor. J. Appl. Microbiol. Bioeng., 15(2):84-88. (1987)
82. Lee, B.Y. and Lee, C.H., Factors affecting foam separation of proteins. Korean J. Food Sci. Technol., 19(3):220-224. (1987)
83. Lee, B.Y. and Lee, C.H., Foam separation of bovine serum protein fractions. Korean J. Food Sci. Technol., 19(3):225-230. (1987)
84. Souane, M., Kim, Y.B. and Lee, C.H., Microbial characteristics of Gajami Sik-hae fermentation. Kor. J. Appl. Microbiol. Bioeng., 15(3):150-157. (1987)
85. Lee, S.P. and Lee, C.H., Protein partition in an aqueous poly(ethylene glycol)-salt two phase system. Korean J. Food Sci. Technol., 19(4):285-289. (1987)
86. Lee, C.H. and Kim, S.K., Effects of protein hydrophobicity on the surfactant properties of food proteins. Food Hydrocolloids, 1(4):283-289. (1987)
87. Kim, Y.W. and Lee, C.H., Functional properties of lupinseed protein concentration, Korean J. Food Sci. Technol., 19(6):499-505. (1987)

88. Lee, C.H. and Maeng, Y.S., A literature review on Korean rice-cakes. Korean J. Dietary Culture, 2(2):117-132. (1987)
89. Lee, C.H., Hong, S.H., Hwang, S.U. and Shin, A.J., Studies on the sensory characteristics of Korean tea and related products. Korean J. Dietry Culture, 2(2):133-147. (1987)
90. Lee, K.J., Lee, C.H. and Lee, H.S., Changes in the chemical composition and textural properties of Korean cabbages during salting. J. Korean Society of Food Science, 3(1):64-70. (1987)
91. Lee, C.H., Gore, P.J., Lee, H.D., Yoo, B.S. and Hong, S.H., Utilization of Australian wheat for Korean style dried noodle making. J. Cereal Science, 6:283-297. (1987)
92. Kim, Y.T. and Lee, C.H., Quality evaluation of different types of salt-fermented shrimp product. Thesis Collection of Agricultures and Forestry, Korean University, 27:151-154. (1987)
93. Lee, C.H., Food processing by Korean rural families: Techno-Economic Analysis of Rural Drying Technology, 120-133. (1987)
94. Han, O. and Lee, C.H., Structure and function of food extruder, Food Science, 20(2):44-52. (1987)(No English abstract)
95. Lee, C.H., Pulses. Food Science, 21(2):12-15. (1988)(No English abstract)
96. Lee, C.H., Extrusion technology for the production and processing of Korean traditional foods. Korean J. Dietry Culture, 3(1):95-99. (1988)
97. Kang, I.J. and Lee, C.H., Changes in hydrophobicity of proteins during thermal aggregation. Korean Biochem. J., 21(1):88-93. (1988)
98. Hong, S.H. and Lee, C.H., Measurement of viscoelastic properties of heat denatured gluten network. Korean J. Food Sci. Technol., 20(2):148-156. (1988)
99. Ryu, G.H. and Lee, C.H., The effects of the type of cereal powder and extruder operation conditions on the barrel temperature distributions. Korean J. Food Sci. Technol., 20(3):303-309. (1988)
100. Ryu, G.H. and Lee, C.H., Effects of moisture content and particle size of rice flour on the physical properties of the extrudate. Korean J. Food Sci. Technol., 20(4):463-469. (1988)
101. Lee, C.H., Souane, M. and Ryu, G.H., Effects of prefermentation and extrusion cooking on the lactic fermentation of rice-soybean based beverage. Korean J. Food Sci. Technol., 20(5): 666-673. (1988)
102. Lee, C.H., Kim. J.Y. and Shin, D.H., The effect of extrusion cooking of flour on the yield and the quality of *Takju*. Thesis Collection of Agricultures and Forestry, Korea University, 28:183-192. (1988)
103. Lee, C.H., Hwang, I.J. and Kim, J.K., Macro- and microstructure of Chinese cabbage leaves and their texture measurements. Korean J. Food Sci. Technol., 20(6):742-748. (1988)
104. Lee. C.H. and Hwang, I.J., Comparision of cutting and compression tests for the texture measurement of Chinese cabbage leaves, Korean J. Food Sci. Technol., 20(6):749-754. (1988)
105. Hwang, I.J., Yoon, E.J., Hwang, S.Y. and Lee, C.H., Effects of K-sorbate, salt-fermented fish and $CaCl_2$, addition on the texture changes of Chinese cabbage during Kimchi fermentation. Korean J. Dietry Culture, 3(3):309-317. (1988)
106. Lee, C.H. and Ryu, S.S., Nutritional evaluation of Korean traditional diet. Korean J. Dietry

Culture, 3(3):275-280. (1988)
107. Lee, H.J., Lee, Y.K., Koo, S.J., Hong, S.H. and Lee, C.H., Effects of processing method and storage temperature and time on the texture of Yaksik (cooked and seasoned glutinous rice). Korean J. Dietry Culture, 3(4):391-396. (1988)
108. Lee, C.H., Joo, Y.J., Ahn, K.O. and Ryu, S.S., The changes in the dietry pattern and health and nutritional status of Korean during the last one century. Korean J. Dietry Culture, 3(4):397-406. (1988)
109. Lee, C.H., Kim. J.K. and Doo, B.D., Studies on the microstructure and texture of kidney bean mash and soybean mash. J. Korean Soybean Research Society, 5(1):41-44. (1988)
110. Kim, Y.O. and Lee, C.H., Food fuctional property of lupinseed protein concentrate(LPC). J. Korean Soybean Research Society, 5(1):44-. (1988)
111. Lee, C.H., Development of low-cost food dehydration systems using solar energy and coal for the village level food preservation in Korea, in Technology for Rural Development, ed. S. Radhakrishna, M. Mohinder Singh and C.K. John, World Scientific, Singapore, 512-522. (1988)
112. Lee, C.H., Wheat characters necessary for optimum Korean noodle production, 38th Australian Cereal Chemistry Conference, 25-30, September, Sydney, Australia. (1988)
113. Lee, C.H. and Han, J.H., Partition of Bacillus subtilis neutral protease in aqueous two-phase systems. I. Counter-current distribution using PEG/PPB aqueous two-phase systems, Korean Biochem. J., 22(4):373-378. (1989)
114. Lee, C.H. and Han, J.H., Partition of Bacillus subtilis neutral protease in aqueous two-phase systems, II. The measurement of isoelectric points by the cross partition using PEG/Dextran aqueous two-phase systems. Thesis Collection of Agriculture and Forestry, Korea University, 29:181-185. (1989)
115. Lee, C.H., Fish Fermentation Technology. Korean J. Appl. Microbiol. Bioeng., 17(6):645-654. (1989)
116. Lee, C.H., Lee, H.D., Kim, J.Y. and Kim, K.M., Sensory quality attributes of *Takju* and their changes during pasteurization. Korean J. Dietry Culture, 4(4):405-410. (1989)
117. Han, O., Lee, S.H., Lee, H.Y., Oh, S.L. and Lee, C.H., The effects of screw speeds and moisture contents on soy protein under texturization using a single-screw extruder. Kor. J. Food Sci. Technol., 21(6):772-779. (1989)
118. Lee, B.I., Yoon, S.W. and Lee, C.H., Determination of the degree of gelatinization of cooked rice and its effect on the enzyme activity of the Korean *Gokja* grown with *Aspergillus oryzae*. Food Sci. Biotechnol., 8(3):162-167. (1989)
119. Lee, C.H., Ryu, K. H., and Souane, M., Effect of prefermentation and extrusion cooking on the lactic acid fermentation of rice-soybean flour mixture dispersion. J. Korean Soybean Research Society, 6(1):43- . (1989)
120. Lee, C.H., Lee, B.Y. and Lee, C.H., Effect of pH on the separation and purification of model protein using counter current distribution. Korean J. Food Sci. Technol., 22(1):56-60. (1990)
121. Lee, C.H., Lee, B.Y. and Lee, C.H., Effect of potassium chloride on the separation and puri-

fication of model proteins using counter current distribution. Korean J. Food Sci. Technol., 22(2):177-182. (1990)

122. Lee, B.Y., Lee, Ch.H. and Lee, C.H., Effects of ammonium sulfate on the separation and purification of model proteins using counter current distribution. Thesis Collection of Agriculture and Forestry, Korea University, 30:149-157. (1990)
123. Lee, C.H., Present state of food rheology researches in Korea. The Korean Journal of Rheology, 2(1):1-17. (1990)
124. Lee, C.H. and Yoon, E.J., Changes in the force-distance curve of Chinese cabbage leaf-stalk by the type of puncture and cutting probes and their relations to the textural parameters. The Korean Journal of Rheology, 2(1):46-52. (1990)
125. Lee, C.H., Park, C.S., Han, B.J., Kim, B.C. and Jang, J.H., Studies on the rheological properties of sugar derivative sweeteners. Korean J. Food Sci. Technol., 22(7):852-857 (1990)
126. Lee, C.H., Souane, M., Lee, H.D. and Kim, S.Y., Studies on the functional properties of sugar derivative sweeteners. Korean J. Dietry Culture, 5(4):431-436. (1990)
127. Lee, C.H., Min, K.C., Souane, M., and Chung, M.J., Selection of microbial strains for the lactic acid fermentation of cereals. Thesis Collection of Agriculture and Forestry, Korea University, 30:130-147. (1990)
128. Lee, C.H., Lee, H.D. and Hong, H.K., Studies on the taste describing terms of monosodium glutamate and the interactions between MSG and other basic taste substances. Korean J. Dietry Culture, 5(4):425-430. (1990)
129. Yang, S.Y., Kim, Y.H., Kim, C.J., Lee, M.H. and Lee. C.H., Manufacture of pork rind snack by extrusion cooking progress. Korean J. Food Sci. Technol. 22(4):451-455. (1990)
130. Yang, S.Y., Kim, Y.H., Kim, C.J., Lee, M.H. and Lee. C.H., Manufacture of pork thigh and chicken meat snack by extrusion cooking progress. Korean J. Food Sci. Technol. 22(4):456-460. (1990)
131. Lee, C.H., Selection of microorganism for the production of lactic acid beverage from cereals, 5th European Congress on Biotechnology, 8-14 July, Copenhagen, Denmark. (1990)
132. Lee, C.H., The fate of bitter peptides in an enzymatic hydrolyzate of soymilk during lactic acid fermentation, 5th European Congress on Biotechnology, 8-14 July, Copenhagen, Denmark. (1990)
133. Lee, C.H., Mechanism of sensory recognition and its measurements. Food Science and Industry, 24(2):79-83. (1991)(No English abstract)
134. Lee, C.H., Lee, H.D., Hong, H.K. and Hong, S.K., Effect of monosodium glutamate on the taste response of chorda tympany nerve of cat. Korean J. Food Sci. Technol., 23(1):37-43. (1991)
135. Lee, C.H., Tae, W.T., Kim, G.M. and Lee, H.D., Studies on the pasteurization conditions of *Takju*. Korean J. Food Sci. Technol., 23(1):44-51. (1991)
136. Lee, C.H., Han, B.J., Kim, N.Y., J.K. and Kim, B.C., Studies on the browning reaction of sugar derivative sweeteners. Korean J. Food Sci. Technol., 23(1): 52-56. (1991)
137. Lee, C.H. and Kim, S.Y., Literature review on the Korean traditional non-alcoholic beverages, I.

Types and processing methods. Korean J. Dietary Culture, 6(1):43-54. (1991)
138. Lee, C.H. and Kim, S.Y., Literature review on the Korean traditional non-alcoholic beverages, II. Recent status of research and developments, Korean J. Dietary Culture, 6(1):55-69. (1991)
139. Lee, C.H., Processing methods and quality characteristics of traditional noodles. Korean J. Dietary Culture, 6(1):105-122. (1991)
140. Lee, C.H., Kim, G.M., Kim, J.Y. and Lim, J.G., Effect of extrusion-cooking on the molecular structure and alcohol yield of wheat starch. Korean J. Food Sci. Technol., 23(6):683-688. (1991)
141. Kim, S.Y., Souane, M., Kim, G.E. and Lee, C.H., Microbial characterization of *Jangsu*. Korean J. Food Sci. Technol., 23(6):680-694. (1991)
142. Oh, S.H. and Lee, C.H., Research trends on the rheological properties of mycelial broths. The Korean Journal of Rheology, 3(2):93101. (1991)
143. Rhee, S.H. and Lee, C.H., Properties of dextransucrase from *Leuconostoc mesenteroides* isolated from *Sikhae*. J. of Microbiol. Biotechnol., 1(3):176-181. (1991)
144. Kim, H., Kim, J.Y., Choi, Y.G. and Lee, C.H., Development of wheat germ nut processing by using extrusion cooking method. Thesis Collection of Agriculture and Forestry, Korea University, 31:151-158. (1991)
145. Lee, C.H., Application of Biotechnology to Food Processing in Africa, Industrialization of lactic acid fermentation technology of cereals and its dissemination to developing countries, pp. 76-83. (1991)
146. Lee, C.H., New frontiers in biopolymer production and processing. First International Symposium on the Development of Natural Resources and Environmental Preservation, October 13-18, Korea University, Seoul, Korea. pp 91-103. (1992)
147. Park, C.S. and Lee, C.H., Effect of reaction time on the rheological properties of dextran formed solution produced by crude dextransucrase from *Leuconostoc mesenteroides Sikhae*. Kor. J. Appl. Microbiol. Biotechnol., 20(3):316-323. (1992)
148. Lee, H.D. and Lee, C.H., Studies on the quality evaluation of Korean red pepper by color measurement. Kor. J. Dietry Culture, 7(2):105-112. (1992)
149. Lee, H.D., Kim, M.H. and Lee, C.H., Relationships between the taste components and sensory preference of Korean red peppers. Kor. J. Food Sci. Technol., 24(3):266-271. (1992)
150. Lee, C.H., Lee, S.J., Souane, M. and Koh, K.H., Debittering effect of lactic acid fermentation on the partial hydrolysate of soymilk. Foods and Biotechnology, 1(1):40-45. (1992)
151. Cho, J.S., Han, J.J. and Lee, C.H., Physical properties of chitosan film made from crab shell, Korean J. Food Sci. Technol., 24(6), 574-580. (1992)
152. Kim, C.H., Kim, M.R. and Lee, C.H., Effect of type of enzyme on bitterness of partial hydrolyzates of soybean proteins. Food and Biotechnology, 1(2):79-84. (1992)
153. Lee, C.H., Min, K.C., Souane M., Chung, M.J., Mathiasen, T.E. and Adler-Nissen, J., Fermentation of prefermented and extruded rice flour by the lactic acid bacteria from Sikhae. Food Biotechnology, 6(3):239-255. (1992)
154. Lee, C.H., Application of extrusion cooking to traditional Korean foods, in Food Extrusion

Science and Technology, ed. J.F.Kokini, C.-T. Ho and M.V. Karwe, Marcel Dekker INC., USA, pp. 711-724. (1992)
155. Yi, D.Y., Kim, G.M., Lee, K.Y. and Lee, C.H., Organic acid composition and flavor characteristics of lactic acid fermented cereal beverages. J. Microbiol. Biotechnol., 3(2):129-133. (1993)
156. Oh, S.H., Kim, J.I., O,P.S. and Lee, C.H., Morphological measurements of submerged culture of *Aspergillus niger* by fully automatic image analysis. J. Microbiol. Biotechnol., 3(3):204-208. (1993)
157. Oh. S.H., O,P.S. and Lee, C.H., Rheological properties of mycelial broth in submerged culture of *Aspergillus niger* No.PFST-38. J. Microbiol. Biotechnol., 3(3):209-213. (1993)
158. Oh, S.H., O,P.S. and Lee, C.H., Effect of aeration and agitation conditions on the production of glucoamylase with *Aspergillus niger* No.PFST-38. J. Microbiol. Biotechmol., 3(4):292-297. (1993)
159. Lee, B.Y., Mok, C.K. and Lee, C.H., Comparision of the degree of gelatinization as determined by DSC endothermic peak and enzymatic amalysis. Korean J. Food Sci. Technology, 25(4):400-403. (1993)
160. Kim, Y.B., Kim, J.Y., and Lee, C.H., Effect of extrusion cooking and simple heating on the molecular structure of rice starch. Korean J. Food Sci. Technology, 25(6):703-709. (1993)
161. Lee, C.H., Pysical properties and function of biopolymers. J. Korean Society of Food Science, 9(4):333-348. (1993)(No English abstract)
162. Lee, C.H., Industrialization and standardization of traditional foods. Inje Food Science Forum, 1:155-187 (1993)(No English abstract)
163. Kim, Y.K., Lee, K.Y., Lee, C.H., Lee, Y.I., Lee, K.H. and Lee, M.K., Application of thermotolerant yeast, *Candida rugosa* for the production of yeast protein from rye stillages. Korean J. Appl. Microbiol. Bioeng., 21(3):281-287. (1993)
164. Lee, C.H. and Kim, K.M., Literature review on the processing technology of Korean rice wine, Bioindustry, 6(4), 6-23. (1993)(No English abstract)
165. Lee, C.H., The history of Korean rice wine, Bioindustry, 6(4), 58-61. (1993)
166. Lee, C.H., Importance of lactic acid bacteria in Non-dairy food fermentation, UNIDO Symposium on Food Fermentation Technology, 13-16 December, 1993, Dakar, Senegal. (1993)
167. Ryu, G.H., Woler, C.E. and Lee, C.H., Prediction of wheat flour extrudate properties by using NIR analysis. Food and Biotechnology, 3(1):1-5. (1994)
168. Lee, C.H., Ota, Y. and Chen, R.H., A terminological study of trilingual (Chinese-Korean-Japanese) presentation on food texture. Korean J. Dietary Culture, 9(2):171-177. (1994)
169. Imm, B.Y. and Lee, C.H., Kinetic study of acid hydrolysate of dextran. Food and Biotechnology, 3(3):198-200. (1994)
170. Imm, B.Y. and Lee, C.H., Single point viscosity measurement for estimating intrinsic viscosity of dextran. Food and Biotechnology, 3(3):201-204. (1994)
171. Lee, C.H., Studies on the production and processing of dextran, 7th Thesis Collection, Sudang Foundation, pp. 43-103. (1994)

172. Lee, C.H., Cho, J.H., and Kim, J.Y., Development of rice-based weaning food by using extrusion cooking technology. Dae San Non Chohg,, 2:57-64. (1994)
173. Lee, G.G., Kim, J.Y. and Lee, C.H., Studies on the effects of amylase addition to rice extrusion on the rheological properties of the extrudate for weaning food base. Korean J. Food Sci. Technol., 26(6):670-678. (1994)
174. Lee, C.H., Importance of lactic acid bacteria in non-dairy food fermentation, in Lactic Acid Fermentation of Non-dairy Food and Beverages, ed. Lee, C.H., Adler-Nissen, J. and Barwald, G., Harn Lim Won, Seoul, 8-25. (1994)
175. Lee, C.H., The changes in the dietary pattern and health and nutritional status of Korean during the last one century, Asian-Pacific Symposium on Health Food, Nutrition Food and Gourmet Food, August 22-26, Beijing, China. (1994)
176. Lee, C.H., An introduction to Korean food culture. Korean and Korean American Studies Bulletin, 6(1):6-10. (1995)
177. Lee, B.Y., Lee, Ch.H. and Lee, C.H., Gelatinization properties of starch dough with moisture content, heating temperature and heating time. Korean J. Food Sci. Technol., 27(3):428-438. (1995)
178. Lee, C.H. and Kim, G.M., Determination of the shelf-life of pasteurized Korean rice wine, *Yakju*, in aseptic packaging. Korean J. Food Sci. Technol., 27(2) : 156-163. (1995)
179. Shin, Y.S., Lee, K.S., Lee, J.S. and Lee, C.H., Preparation of yogurt added with *Aloe vera* and its quality characteristics. J. Korean Soc. Food Nutr., 24(2) : 254-260. (1995)
180. Lee, C.H., Changes in the dietary patterns, health, and nutritional status of Koreans during the last century. Korean and Korean American Studies Bulletin, 6(1):32-47. (1995)
181. Lee, C.H. and Ahn, B.S., Literature review on *Kimchi*, Korean fermented vegetable foods, I. History of *Kimchi* making. Korean J. Dietary Culture, 10(4):311-319. (1995)
182. Lee, B.Y., Lee, Ch.H. and Lee, C.H., Effect of moisture content on viscosity of starch dough. Korean J. Food Sci. Technol., 27(4):582-592. (1995)
183. Lee, B.Y., Lee, Ch.H. and Lee, C.H., Effect of heating temperature on viscosity of starch dough, Korean J. Food Sci. Technol., 27(4):593-597. (1995)
184. Kim, U.S., Lee, C.H., Lee, S.J., Lee, J.D., Moon, K.H. and Baek, S.H., Effect of the *Aloe araborescens* added-diet on the cadmium toxicity in rat. Korean J. Food Sci. Technol., 27(4): 555-563. (1995)
185. Lee, C.H., Korea, the country of soybean fermentation. Korea AgraFood, 1(3):8-14. (1995)
186. Lee, C.H., *Chungkukjang*; a fermented soybean product as instant military food of old days. Korea AgraFood, 1(3):8-9. (1995)
188. Lee, C.H., *Hankwa*: Traditional Korean cookies. Korea AgraFood. 1(4):10-12. (1995)
189. Lee, C.H., Product development and shelf-life determination by using sensory evaluation techniques, Proceedings on The 1st Seminar of the Center for Advanced Food Science and Technology of Korea University on the Recent Progress in the Food Sensory Evaluation Technology, October 31, Korea University, Seoul, pp. 30-37. (1995)

190. Um, M.N. and Lee, C.H., Isolation and Identification of *Staphylococcus* sp. from Korean fermented fish products. J. Microbiol. Biotechnol., 6(5):340-346. (1996)
191. Kim, H.Y. and Lee, C.H., Studies on the physicochemical factors influencing the optimum amount of added water for cooking in the preparation of Korean cooked rice, Bab. J. Korean Food Sci. Technol., 28(4):644-649. (1996)
192. Lee, H.D. and Lee, C.H., Changes of soluable solid content in red pepper by different extraction conditions. Korean J. Dietary Culture, 11(3):385-392. (1996)
193. Lee, E.J., Noh, S.O. and Lee, C.H., A Survey on the consumer attitude toward health food in Korea, (1) Consumer perception on the health and food habit. Korean J. Dietary Culture, 11(4):475-485. (1996)
194. Lee, E.J., Noh, S.O. and Lee, C.H., A Survay on the consumer attitude toward health food in Korea, (2) Consumer perception on the health and food habit. Korean J. Dietary Culture, 11(4): 487-495. (1996)
195. Lee, C.H., Lactic acid fermennted foods and their benefits in Asia. Food and Biotechnol., 5(3):187-197. (1996)
196. Lee, C.H. and Shin, D.W., Functional properties and stability of soybean sauce, Research Institute for Fermented Soybean Products, Youngnam University, pp. 55-68. (1996)
197. Lee, C.H., Health concepts in traditional Korean diet, Proceedings of IUFoST '96 Regional Symposium on Non-Nutritive Health Factors for Future Foods, Oct. 10-11, Seoul, p.47-56. (1996)
198. Lee, C.H., Present status of bioindustry and biotechnology R&D in Korea, UNIDO Expert Group Meeting on the The Contribution of Biotechnology to Industrial Development, June 3-5, UNIDO Headquaters, Vienna, Austria. (1996)
199. Lee, C.H., Isolation of *Staphylococcus* sp. from Korean fermented fish products, First Swiss-Korean Symposium on Pharmaceutical Sciences and Food Research, July 29-30, Swiss Federal Institute of Technology(ETH), Zurich, Switzerland. (1996)
200. Lee, C.H., Production mechanism and physiological effect of MCPD and DCP in acid hydrolized soybean sauce, Japan-Korea Symposium, pp. 1-12. (1996)(No English abstract)
201. Kim, K.M. and Lee, C.H., Shelf-life extension technology of traditional rice wine. Bio Industry, (1997)(No English abstract)
202. Han, J.H. and Lee, C.H., Efeects of salts and poly(ethylene glycol)-palmitate on the partitioning of proteins and *Bacillus subtilis* neutral protease in aqueous two-phase systems. Colloids and Surfaces B: Bioinerfaces, 9:109-116. (1997)
203. Choi, S.J., Yoon, S.W. and Lee, C.H., Ohmic heating characteristics of foods having different chemical composition and microstructure. Food Engineering Progress, 1(1):5-10. (1997)
204. Lee, B.Y. and Lee, C.H., The principles, apparatus and application of Countercurrent Chromatography. Food Science and Industry, 30(1):77-88. (1997)(No English abstract)
205. Lee, C.H., Characteristic of food rheology and the research trends in Korea. The Korean Journal of Rheology, 9(2):47-52. (1997)

206. Han, J.H. and Lee, C.H., Determining isoelectric points of model proteins and *Bacillus subtilis* neutral protease by the cross partitioning using poly(ethylene glycol)/Dextran aqueous two-phase system. Colloids and Surfaces B: Biointerfaces, 9:131-137. (1997)
207. Kim, C.H., Kim, M.R. and Lee, C.H., The Bitterness of the enzymatic hydrolysate of soybean proteins and the amino acid composition of the UF filtrate. Food Science and Biotechnology, 6(4):244-249. (1997)
208. Byun, S.H. and Lee, C.H., Studies on physicochemical properties of Erythritol, substitute sugar. Korean J. Food Sci. Technol., 29(6):1089-1093. (1997)
209. Lee, C.H., Lactic acid fermented foods and their benefits in Asia. Food Control, 9(5/6):259-269. (1997)
210. Lee, C.H., Electroencephalogram(EEG) measurement evoked by taste substances with human subjects, Food Science and Industry, 31(3):47-55. (1997)(No English abstract)
211. Lee, C.H., Food irradiation for the 21st Century's nuclear energy utilization, Food Science and Industry, 30(4):4-5. (1997)(No English abstract)
212. Lee, C.H., Lee, B.Y., Lee, H.Y. and Lee. C.H., Effects of pH and potassium chloride in solvent system of high-speed countercurrent chromatography, Korean J. Food Sci. Technol., 29(6): 1222-1227. (1997)
213. Lee, H.D. and Lee, C.H., Changes of sensory characteristics in red pepper by different extraction conditions. Korean J. Food Sci. Technol., 30(3):535-541. (1998)
214. Kim, J.Y. and Lee, C.H., Formation of enzyme resistant starch by extrusion cooking of high amylose corn starch. Korean J. Food Sci. Technol., 3(5):1128-1133. (1998)
215. Choi, W.S. and Lee, C.H., Effect of compression test conditions on the texture parameters of imitation crab-leg product. Korean J. Food Sci. Technol. 30(5):1077-1084. (1998)
216. Choi, W.S. and Lee C.H., Determination of rheological properties of surimi gels and imitation crab-leg products by stress-relaxation test. Korean J. Food Sci. Technol., 30(5):1085-1091. (1998)
217. Choi, W.S. and Lee, C.H., Changes in the gelation mechanism and the rheological behavior of surimi on the different heating methods. Food Engineering Progress, 2(2):108-116, (1998)
218. Byun, S.H. and Lee, C.H., Dental caries suppression effect and other physiological properties of Erythritol. Korean J. Food Sci. Technol., 30(2):446-449. (1998)
219. Lee, K.S., Shin, Y.S., and Lee, C.H., Acid tolerance of *Lactobacillus brevis* isolated from *Kimchi*. Korean J. Food Sci. Technol., 30(6):1399-1403. (1998)
220. Kwon, S.H., Lee, C.H. and Hong, E.H., The feasibility study on the establishment of a world soybean center. Dae San Non Chohg,, 6:287-314, (1998)(No English abstract)
221. Kim, J.Y. and Lee, C.H., Crystalline structure of the extrudate of high amylose corn starch . Korean J. Food Sci. Technol., 30(5):1024-1028. (1998)
222. Lee, C.H., Health concept in the traditional Korean diet, Therapeutic use of foods in East Asia, Korean and Korean American Studies Bulletin, 9(1/2): 8-18 (1998)
223. Lee, C.H., Literature review on traditional Korean fermented soybean products. Korea Jang

Cooperative Vol 61, 3-18. (1998)
224. Lee, C.H., Safety and prospect of irradiated food, Food Science and Industry Special Issue, 2-3 (1998)(No English abstract)
225. Lee, C.H., Safety and benefit of pseudo-oestrogen substances in foods, Food Science and Industry, 31(4):68-74. (1998)(No English abstracts)
226. Choi, W.S. and Lee, C.H., Effects of temperature on viscoelastic properties and activation energies of surimi gels with heating methods, Food Engineering Progress, 2(3):227-234. (1998)
227. Hong, Y.S., Lee, C.H. and Lee, G.Y., Effect of weak acid pretreatment on the enzymic hydrolysis against wheat gluten of high concentration. J. Korean Soc., Food Sci. Nutr., 27(6):1110-1116. (1998)
228. Lee, C.H., Lee, C.H. and Lee, B.Y., The separation of flavonoglycosides from *Ginco biloba* L. leaves by high-speed counter current chromatography. Food Science and Biotechnology, 8(3), 182-192. (1999)
229. Lee, C.H., Traditional food - its concept and modern interpretation, Nongchon Saenghwal Kwahak, 20(3):42-46. (1999)(No English abstract)
230. Byun, M.W., Lee, W.J., Yuk, H.S., Lee, K.H., Kim, K.P. and Lee, C.H., Consensus rule on international trade of irradiated foods in Asia-Pacific region. Food Science and Industry, 32(1):82-87. (1999)(No English abstract)
231. Lee, C.H., Health concepts in traditional Korean diet. Bulletin of the Research Institute for Food Science, Kyoto University, 62:1-17. (1999)
232. Lee, B.I., Yoon, S.W. and Lee, C.H., Determination of the degree of gelatinization of cooked rice and its effect on the enzyme activity of the Korean *Gokja* grown with *Aspergillus oryzae*. Food Science and Biotechnol., 8(3):162-167. (1999)
233. Lee, C.H., Lactic acid fermentation in traditional Korean foods. Bulletin of the Research Institute for food Science, Kyoto University, 62:18-39. (1999)
234. Lee, C.H., The Food Ways of Paleolithic Men in the Northeast Asia and Korean Peninsular. Korea Cultural Studies, Vol 31, 418-458. (1998)
235. Lee, C.H., The Primitive Pottery Age of Northeast Asia and Its Importance in Korean Food History. Korea Cultural Studies, Vol 32, 325-357. (1999)
236. Lee, C.H., Impact of trade liberalization on food security situation in Korea. Food Science and Industry, 32(2):70-79. (1999)
237. Lee, J.H., Kim, N.K., Lee, D.H. and Lee, C.H., Protective effect of selected amino acids and food extracts on ethanol toxicity decrement in rat liver. Korean J. Food Sci.Technol., 31(3):802-808. (1999)
238. Kim, M.R., Choi, S.Y., Kim, C.S., Kim, C.W., Shigeru, Utsumi and Lee, C.H., Amino acid sequence analysis of bitter peptides from a soybean proglycinin subunit synthesized in *Escherichia coli*. Biosci. Biotechnol. Biochem., 63(12):2069-2074. (1999)
239. Kim, M.R., Choi, S. and Lee, L.H., Molecular characterization and bitter taste formation of tryptic hydrolysis of 11S glycinin. J. Microbiol. Biotechnol., 29(4):509-513. (1999)

240. Chung, S.W., Choi, W.S., Son, H.S. and Lee, C.H., Effects of cryoprotectants on the textural changes of whole-coagulated soybean curd (Tofu) during frozen storage. Korean J. Food Sci. Technol., 31(4):957-963. (1999)
241. Cho, Y.R., Kim, S.D., Chang, H.I., Sung, H.C., Lee, C.H. and Kim, C.W., A method for the separation of mouse pancreatic islets using discontinuous percoll gradient centrifugation. J. Mictobiol. Biotechnol., 9(4):522-524. (1999)
242. Cho, S.J., Kim, C.H., Yim, M.H. and Lee, C.H., Large-scale purification of protease produced by *Bacillus* sp. from *Meju* by consecutive polyethylene glycol/potassium phosphate buffer aqueous two-phase system. J. Microbiol. Biotechnol., 9(4):498-503. (1999)
243. Choi, H.D., Park, Y.G., Jang, E.H., Seoh, H.M. and Lee, C.H., Rheological properties of β-glucans isolated from non-waxy and waxy barley. Korean J. Food Sci. Technol., 32(3):590-597. (2000)
244. Lee, K.Y., Ahn, H.J., Lee, C.H., Kim, J.G., Shin, M.G. and Byun, M.W., Effects of gamma irradiation on quality in the processing of low salted and fermented shrimp. J. Korean Soc. Food Sci. Nutr. 29(3):430-436. (2000)
245. Lee, C.H., Korean culture of fermentation, BESETO Fermentation, Samkukmunhwa Jungboji, Vol.80, pp. 10-17. (2000)(No English abstract)
246. Ahn, H.J., Lee, C.H., Lee, K.H., Kim, J.H., Cha, B.S. and Byun, M.W., Processing of low salted and fermented shrimp using gamma irradiation before optimum fermentation. Korean J. Food Sci. Technol., 32(5):1107-1113. (2000)
247. Ahn, H.J., Lee, K.H., Lee, C.H., Cha, B.S. and Byun, M.W., Effects of gamma- irradiation on changes of chemical compositions in the processing of fermented shrimp with low salt. Korean J. Food Sci. Technol., 29(4):629-634. (2000)
248. Lee, K.H., Ahn, H.J., Lee, C.H., Kim, Y.J. and Byun, M.W., Changes of chemical properties in processing of low salted and fermented shrimp using gamma irradiation immediately before optimum fermentation. Korean J. Food Sci. Technol., 32(5):1051-1057. (2000)
249. Kim, S.B., Kwak, N.S., Shin, H.S., Lee, C.H., Lee, H.J., Son, D.W., Cho, T.H. and Choi, D.R., International status and development of health foods. Food Science and Industry, 33(3):72-76. (2000)(No English abstract)
250. Lee, C.H., Present status of health foods. Kwanggosimeui, 1(1):16-18. (2001)(No English abstract)
251. Lee, J.Y., Lee, H.D. and Lee, C.H., Characterization of hydrolysates produced by mild-acid treatment and enzymatic hydrolysis of defatted soybean flour. Food Research International, 34:217-222. (2001)
252. Hong, Y.S., Cho, C.H., Mitrofanova, N.V., Nechaev, A.N., Volkov, V.I., Mchedti Shvili, B.V. and Lee, C.H., The charge properties of PETF track etched membrane pore surfaces on the Cu^{2+} ESR data. Magnetic Resonance Imaging, 19(3-4):588. (2001)
253. Hong, Y.S., Cho, C.H., Dejardin, P., Thomas, M., Volkov, V.I., Mchedlishvili, B.V. and Lee, C.H., Cu^{2+} ESR investigation in acrylonitrile sulfocation exchange membranes. Magnetic Resonance

Imaging, 19(3-4):588. (2001)
254. Sokolova, S.A., Djakonova, O.V., Kotov, V.V., Hong, Y.S., Cho, C.H., Volkov, V.I. and Lee, C.H., The self-diffusion of water and membrane structure in the new type of cation-exchange polyamide-acid membranes. Magnetic Resonance Imaging, 19(3-4):588-589. (2001)
255. Lee, C.H., Structure and characteristics of bitter peptides in soybean protein hydrolysate. The 32nd Symposium of Korea Life Science Society on Physiological Function of Soybean, Suncheon University, pp 3-41. (2001)(No English abstract)
256. Lee, E.J., Vitaly, I., Volkov, V.I. and Lee, C.H., Electric spin resonance studies of free radical in gamma-irradiation soybean paste. J. Agri. Food Chem, 49(7):3457-3462. (2001)
257. Hong, Y.S., Lee, K.Y. and Lee, C.H., Molecular weight distribution of protein hydrolysate by the enzymic hydrolysis of weakly acid-treated wheat gluten. Food Sci. and Technology Research, 7(2):126-130. (2001)
258. Lee, E.J. and Lee, C.H., Effective components of commercial enzyme food products and their HACCP scheme. Korea J. Sci. Technol., 33(4):461-468. (2001)
259. Lee, E.J., Cho. Y.J., Park, S.Y. and Lee, C.H., Quality assessment of commercial chlorophyll products in Korea. Food Engineering Progress, 5(2):96-102. (2001)
260. Cho, Y.J., Park, S.Y., Lee, E.J. and Lee, C.H., Effective components of commercial fermented plant extracts and their HACCP scheme. Food Engineering Progress, 5(3):165-174. (2001)
261. Lee, E.J., Vitaly, I., Volkov, V.I., Byun, M.W. and Lee, C.H., Detection of free radicals in gamma-irradiated soybean paste and model system by electron spin resonance spectroscopy. Radiation Physics and Chemistry, 64(1):61-66. (2002)
262. Yoon, S.W., Lee, C.Y., Kim, K.M. and Lee, C.H., Leakage of cellular materials from *Sacharomyces cerevisiae* by Ohmic heating. J. Microbiol. Biotechnol., 12(2), 183-188. (2002)
263. Ahn, H.J., Yook, H.S., Rhee, M.S., Lee, C.H., Cho, Y.J. and Byun, M.W., Application of gamma irradiation on breakdown of hazardous volatile N-nitrosoamines. J. Food Sci., 67(2):596-599. (2002)
264. Lee, C.H. and Lee, S.S., Cereal Fermentation by Fungi. Applied Mycology and Biotechnology, 2:151-170. (2002)
265. Ahn, H.J., Jo, C.R., Kim, J.H., Chung, Y.J., Lee, C.H. and Byun, M.W., Monitoring of nitrite and N-nitrosamines levels in irradiated pork sausage. J. Food Protection, 65(9):1493-1497. (2002)
266. Ahn, H.J., Kim, J.H., Lee, C.H. and Byun, M.W., Reduction of carcinogenic N-nitrosamines and residual nitrite in model system sausage by irradiation. J. Food Science, 67(4):1370-1373. (2002)
267. Ahn, H.J., Kim. J.H., Yook, H.S., Lee, C.H. and Byun, M.W., Irradiation effects on kinetics and nitrosation of volatile N-nitrosamine in different solvent systems. Food Sci. Biotechnol., 11(1):62-65. (2002)
268. Park, W.M., Rhee, S.J., Lee, C.H. and Yoon, K.E., Suitability of domestic grape, Cultivar Campbell's Early, for production of red wine. Korean J. Sci. Technol., 34(4):590-596. (2002)
269. Kang, K.L., Lee, C.Y.J. and Lee, C.H., Comparison of rheological properties of powder *Chlorella*

sp. cultivated in fermentor and pond. J. Microbiol. Biotechnol., 12(5):740-745. (2002)

270. Lee, C.H., Hong, Y.S., Cho, J.H., Suh, K.J., Vitaly I. Volkov, Utilization of Pulsed field gradient NMR for food biotechnology. Proceedings of the 69th Conference of Korean Society of Food Science and Technology, Muju Resort, pp. 42-50. (2002)(No English abstract)
271. Lee, C.Y.J., Kim, M.S., Yoon, S.W. and Lee, C.H., Short-term Control of Capsaicine on Blood and Oxidative Stress of Rats *In Vivo*. Phytother. Res., 17:454-458. (2003)
272. Suh, K.J., Hong, Y.S., Skirda, V.D., Volkov, V.I., Lee, C.Y.J. and Lee, C.H., Water self-diffusion behavior in yeast cells studied by pulsed field gradient NMR. Biophysical Chemistry, 104(1):131-140. (2003)
273. Lee, G.G., Lee, H.D. and Lee, C.H., Changes in sensory characteristics during salt aging of *Doenjang*(*Fermented Soybean Paste*) made by different starters. Food Engineering Progress, 7(1):13-19. (2003)
274. Lee, G.G. and Lee, C.H., Changes in flavor components during salt aging of *Doenjang* (*Fermented Soybean Paste*) made by different starters. Food Engineering Progress, 7(1):20-30. (2003)
275. Ahn, B.S and Lee, C.H., Changes in microbial and chemical composition and sensory characteristics of fermented soybean paste, *Chungkukjang*, by high dose gamma irradiation (10~ 20 kGy). Korean J. Food Sci. Technol., 35(2):166-172.(2003)
276. Rhee, S.J., Lee, C.Y.J., Kim, K.K and Lee, C.H., Composition of the Traditional (*Samhaeju*) and Industrial (*Chongju*) Rice Wine Brewing in Korea. Food Sci. Biotechnol., 12(3):242-247. (2003)
277. Choi, H.D., Seog, H.M., Kim, Y.S. and Lee, C.H., Effect of barley β-Glycan on dynamic viscoelasticity of barley starch, Korean J. Food Sci. Technol., 35(6):1022-1027. (2003)
278. Ko, K.H., Kim, H.W., Han, S.H., Park, Y.H., Lee, C.H. Polyphenolic compounds and superoxide radical scavenging activity of *Moru-ju*. Food Sci. Biotechnol., 12(3):290-297. (2003)
279. Cho, S.J., Oh, S.H., Pridmore. R.D., Juillerat, M.A. and Lee, C.H., Purification and Characterization of Proteases from *Bacillus amyloliquefaciens* isolated from Traditional Soybean Fermentation Satater. J. Agri. Food Chem., 51:7664-7670. (2003)
280. Choi, H.D., Seog, H.M., Kim, S.R., Park, Y.G. and Lee, C.H., Effect of barley β-Glycan on gelatinization of barley starch, Korean J. Food Sci. Technol., 35(4): 545-550. (2003)
281. Kim, M.R., Kawmura Y. and Lee, C.H., Isolation and identification of bitter peptides of tryptic hydrolysate of soybean 11S Glycinin by Reverse-phase High Performance Liquid Chromatography. J. Food Sci. 68(8):2416-2422. (2003)
282. Cho, C.H., Hong, Y.S., Kang, K.R., Vitaly I. Volkov, Vladimir Skirda, Lee, C.Y.J. and Lee, C.H., Water self-diffusion in Chlorella sp. studied by pulse field gradient NMR. Magn. Reson. Imaging 21:1009-1017. (2003)
283. Lee, C.H. and Lee, C.Y., Pradigm shift: Harmonization of Eastern and Western food system, in Bioprocesses and Biotechnology for Functional Foods and Nutraceuticals, Marcel Dekker, New York, 415-425 (2003)
284. Lee, C.H., Hong, Y.S., Volkova, V.D. and Volkov, V.I., Determination of water self-diffusion

behavior in microorgani는 by using PFG-NMR, in Magnetic Resonance in Food Science, ed. by P.S. Belton, A.M. Gil, G.A. Webb and D. Rutledge, The Royal Society of Chemistry, Cambridge, UK, 199-208 (2003)
285. Lee, C.H., An analysis of food hygiene incidences and future development of food safety risk management system, GongjeonYunku,, 1(1):90-93. (2004)
286. Hong, Y.S. and Lee, C.H., Measurement of moisture transfer in food and biomaterials by using PFG-NMR, Food Engineering Progress, 8(2):63-76. (2004)
287. Kim, P.J., Lee, J.C., Ko, K.H. and Lee, C.H., Effects of drying and extraction conditions on the chemical composition of water extract of *Lycium chinense* Miller, Food Engineering Progress 8(2):105-110. (2004)
288. Kim, W.C., Lee, D.Y., Lee, C.H. and Kim, C.W., Optimization of narirutin extraction during washing step of the pectin production from citrus peels. J. Food Eng., 63:191-197. (2004)
289. Lee, C.H., Functional food of interest to ASEAN : from Traditional Experience to Modern Production and Trading. Food Sci. Biotechnol., 13(3):390-395 (2004)
290. Ahn, H.J., Lee, C.H., Kim, J.H., Han, S.B., Jo C., Kim, S. and Byun, M.W., Identification of radiolytic products from N-nitrosodimethylamine and N-nitrosopyrrolidine by gas chromatography and mass spectrometry. Radiat. Phys. Chem., 69:99-102. (2004)
291. Lee, C.Y.J., Kim, K.C., Park, H.W., Song, J.H. and Lee, C.H., Rheological properties of erythrocytes from male hypercholesterolemia. Microvasc. Res., 67:133-138. (2004)
292. Park, H.R., Ahn, H.J., Kim, J.H., Yook, H.S., Kim, S., Lee, C.H. and Byun, M.W., Effects of irradiated phytic acid on antioxidation and color stability in meat models. J. Agr Food Chem, 52(9):2572-2576. (2004)
293. Lee, C.H. Creative fermentation technology for th future. Concise reviews in Food Science. J. Food Sci. 69(2):R31-36. (2004)
294. Lee, C.H. The role of biotechnology in modern food production. J. Food Sci. 69(3):R92-95. (2004)
295. Rhee, S.J., Lee. C.Y.J., Kim, M.R., Lee, C.H. Potential antioxidant peptides in rice wine. J. Microbiol. Biotechnol. 14(4):715-721. (2004)
296. Hong. Y.S., Suh, K.J., Woon. S.W., Skirda V., Volkov V., Lee, C.H. Effect of heat treatment on water permeability of yeast cells as measured by pulsed field gradient(PFG) NMR spectroscopy. Food Sci, Biotechnol. 13(5):586-590. (2004)
297. Kim, P.J., Lee, J.C., Ko, K.H. and Lee, C.H. Effects of Drying and Extraction Conditions on the Chemical Composition of Water Extract of Lycium chinense Miller Food Engineering Progress 8(2):105-110. (2004)
298. Lee, H.M., Yoon, E.K., Park, K.A., Kim, Y.H., Jung, S.Y., Kwon, K.S., Kim, M.C., Song, I.S., Lee, C.H., Yang, J.S. and Yang, K.H. Dietary risk assessment for polycyclic aromatic hydrocarbons in foods, J. Food Hyg. Safety 19(1):1-8. (2004)
299. Kim, E.H., Kim, H.W., Kim, S.D., Lee, B.H., Lee, C.H. and Koh, K.H., Free radical scarvenging activity of Burlro Kugi(*Lycium chinense* Mill) fruit, leaf and root, Korean J. Food. Sci. Technol.,

37(1), 6-10. (2005)
300. Hong, Y.S, and Lee, C.H., Measurement of water movement in food and biomaterials by Pulsed Field Gradient(PFG)-NMR. Japan Journal of Food Engineering, 6(1):15-20. (2005)
301. Kim, J.I., Lee, C.J., Jin, M.S., Lee, C.H., Paik, S.G., Lee H.Y. and Lee, J.O., Crystal sstructure of CD14 and its implications for lipopolysaccharide signaling, J. Biol. Chem. 280(12):11347-11351. (2005)
302. Hong, Y.S., Kim, K.C,. Volkov, V.I., Skirda, V.D. and Lee C.H., Structural and dynamic properties of polyoxyethylene sorbitan monooleate micelle in water dispersion studied by pulsed field gradient NMR, Appl. Magn. Reson. 29(2):351-361. (2005)
303. Hong, Y.S., Ro, S.O., Lee, H.K., Volkov, V.I., Lee, C.H., Determination of the apparent diffusion coefficient of water in red blood cells by High-field PFG-NMR using various pulse sequences, in Magnetic Resonance in Food Science, ed. by S.B. Engelsen, P.S. Belton and H.J. Jakobson, The Royal Society of Chemistry, Cambridge, UK, 186-194, (2005)
304. Lee, C.H. and Kwon, T.W., History of soybean utilization, in Soybean ed. by Soy-world Museum Construction Committee, Korea University Press, Seoul, 3-44 (2005)
305. Hong, Y.S. and Lee C.H., Self-diffusion coefficient of water in tofu determined by Pulsed Field Gradient Nuclear Magnetic Resonance, J. Agric. Food Chem., 54(1):219-223. (2006)
306. Yu, M.A., Oh, W.T. and Lee, C.H., Key public health issue priorities in Asian countries, Korean J. Food Hyg. Safety 21(3):164-170. (2006)
307. Kang, K.I., Jung, J.Y., Koh, K.H. and Lee, C.H., Hepatoprotective effects of *Lycium chinense Mill* fruit extracts and fresh fruit juice, Korean J. Food Sci Technol. 38(1):99-103. (2006)
308. Choi, W.S. and Lee, C.H. Large and small deformation studies of Ohmic and water-bath heated surimi gel by TPA and creep test, Food Sci. Biotechnol. 15(3):409-412. (2006)
309. Kim, Y.T., Hong, Y.S., Kimmel, R.M., Rho, J.H. and Lee, C.H., New approach for characterization of gelatin biopolymer films using proton behavior determined by Low Field 1H NMR Spectrometry, J. Agric. Food Chem. 55(26):10678-10684. (2007)
310. Seo, M.Y., Kim, S.H., Lee, C.H. and Cha, S.K. Fibrinolytic, immunostimulating, and cytotoxic activities of microbial strains isolated from Kochujang, Korean J. Food Sci. Technol. 39(3): 315-322. (2007)
311. Lee, C.H., Harmonization of Eastern and Western health knowledge; Nutrigenetics and Sasang Typology, Food Science and Technology Research 13(2):89-95. (2007)
312. Song, H.P., Byun, M.Y., Jo, C., Lee, C.H., Kim K.S. and Kim, D.H. Effects of gamma irradiation on the microbiological, nutritional, and sensory properties of fresh vegetable juice, Food Control 18(1):5-10. (2007)
313. Cho, S.J., Juillerat, M.A. and Lee, C.H. Cholesterol lowering mechanism of soybean protein hydrolysate, J. Agric. Food Chem. 55(26):10599-10604. (2007)
314. Son, H.S., Kim, K.M. Van Den Berg, F., Hwang, G.S., Park, W.M., Lee, C.H. and Hong Y.S., 1H Nuclear Magnetic Resonance-based metabolomic characterization of wines by grape varieties and production areas, J. Agric. Food Chem. 56(17):8007-8016. (2008)

315. Cho, S.J., Juillerat, M.A. and Lee, C.H., Identification of LDL-receptor transcription stimulating peptides from soybean hydrolysate in human hepatocytes, J. Agric. Food Chem. 56(12):4372-4376. (2008)
316. Kim, M.R., Yukio, K., Kim, K.M. and Lee, C.H., Tastes and structures of bitter peptide, Asparagine-Alanine-Leucine-Proline-Glutamate, and its synthetic analogues, J. Agric. Food Chem. 56(14):5852-5858. (2008)
317. Hong, Y.S., Cho, J.H., Kim, N.R., Lee, C.H., Cheong, C.J., Hong, K.S. and Lee. C.H., Artifacts in the measurement of water distribution in soybeans using MR imaging, Food Chemistry 112(1):267-272. (2009)
318. Hong, Y.S., Hong, K.S., Lee, E.S., Cho, J.H., Lee, C.H., Cheong. C.J. and Lee, C.H., MR imaging and diffusion studies of soaked rice, Food Research International 42(2):237-245. (2009)
319. Son, H.S., Hwang, G.S., Kim, K.M., Kim E.Y., Van Den Berg, F., Park, W.M., Lee, C.H. and Hong Y.S., 1H NMR-based metabolomic approach for understanding the fermentation behaviors of wine yeast strains, Anal. Chem. 81(3):1137-1145. (2009)
320. Ko, B.K., Ahn, H.J., van den Berg, F., Lee, C.H. and Hong, Y.S. Metabolomic insight into soy sauce through 1H NMR spectroscopy, J. Agric. Food Chem. 57(15):6862-6870. (2009)
321. Son, H.S., Hwang, G.S., Park, W.M., Hong Y.S. and Lee, C.H., Metabolomic characterization of malolactic fermentation and fermentative behaviors of wine yeasts in grape wine, J. Agric. Food Chem. 57(11):4801-4809. (2009)
322. Lee, J.E., Hong, Y.S. and Lee, C.H., Characterization of fermentative behaviors of lactic acid bacteria in grape wines through 1H NMR- and GC-based metabolic profiling, J. Agric. Food Chem. 57(11):4810-4817. (2009)
323. Lee, J.E., Hwang, G.S., Van Den Berg, F., Lee, C.H. and Hong, Y.S., Evidence of vintage effects on grape wines using ^{1}H NMR-based metabolomic study, Analytica Chimica Acta 648(1):71-76. (2009)
324. Son, H.S., Hwang, G.S., Ahn, H.J., Park, W.M., Lee, C.H. and Hong Y.S., Characterization of wines from grape varieties through multivariate statistical analysis of ^{1}H NMR spectroscopic data, Food Research International 42(10):1483-1491. (2009)
325. Son, H.S., Hong, Y.S., Park, W.M. Yu, M.A. and Lee C.H., A novel approach for estimating sugar and alcohol concentrations in wines using refractometer and hydrometer, J. Food Sci. 74(2):106-111. (2009)
326. Son, H.S., Hwang, G.S., Kim, K.M., Ahn, H.J., Park, W.M., Van Den Berg, F., Hong Y.S. and Lee, C.H., Metabolomic studies on geographical grapes and their wines using 1H NMR analysis coupled with multivariate statistics, J. Agric. Food Chem. 57(4):1481-1490. (2009)
327. Cherl-Ho Lee, Food biotechnology, in Food Science and Technology, Ed. by Geoffrey Campbell-Platt, Wiley-Blackwell, West Sussex, UK, 85-113, (2009)
328. Lee, C.H., Lee, H.M., Park, Y.H., Bahk, K.J., Kim, H.J., Kwon, J.H., Michael Doyle, Robert Buchanan, Ann Yaktine, Robert Brackett and Sanford Miller, Risk Assessment of Foods, KAST Press, Seoul, 1-24 (2010)

◐ Patents

1 Cherl-Ho Lee and Jang-Ryul Park; A method of yeast extract making, Korean Patent # A23L, 1/28 (1982)
2. Cherl-Ho Lee and Chan-Shik Kim; A process of lupine seed protein concentrate making, Korean Patent # 64-5020 (1986)
3. Cherl-Ho Lee and Hie-Don Choi; A method of separating rice starch from broken rice debris, Korean Patent # 32383 (1990)
4. Cherl-Ho Lee, Gi-Wook Sung, Ji-Yong Kim and Dong-Hun Shin; A method of rice beer (Takju) brewing using wheat flour, Korean Patent # 046627 (1991)
5. Cherl-Ho Lee, Moussa Suoane and Kyung-Chan Min; A method of processing vegetable lactic acid fermented beverages using a microorganism, Korean Patent # 052980 (1992)
6. Cherl-Ho Lee and Chang-Su Kim; A method of making Kimchi stuffing material keepable in room temperature, Korean Patent # 091712 (1995)
7. Gil-Sang Chun and Cherl-Ho Lee; Broiler smoking method using rubber net packing, Korean Patent 12064 (1996)
8. Cherl-Ho Lee and Won-Suk Choi; An extruder design for surumi texturization and the products, Korean Patent # 26823 (1997)
9. Ki-Young Lee, Sang-Bae Son, Cherl-Ho Lee and Young-Shick Hong; A method making high-concentrate protein hydrolysate by using hydrochloric acid and enzyme, Korean Patent # 0339836 (2002)
10. Boo-Yong Lee, Chang-Ho Lee, Sung-Jun Cho and Cherl-Ho Lee; A method of isolation and purification of Meju Bacillus protease in an aqueous two phase system, Korean Patwent # 0327617 (2002)
11. Cherl-Ho Lee, Bo-Sun Ahn and Sung-Won Yoon, Rapid soybean paste making by using multiple fermentation principle, Korean Patent # 0369218 (2002)
12. Cherl-Ho Lee and Sook-Jong Rhee, Antioxidative pertides from rice-wine ‘Samhaeju’ and their isolation methods, Korean Patent # 10-0509798 (2005)

Christmas Annual Reports (1983-2009)

Y1(Hardness)
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Y4(Melting)
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This beautiful computer graphic was made by the program sent from
Mr. Nak-Kyung Kim studying at Georgia Univ., U.S.A.
X 400
X 100
Intact starch granules in potato cell and gelatinised surface cells
after alkali peeling. (From S.W. Lee's MS thesis)


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Review of Achivements of the Food Materials
Science & Engineering Laboratory in 1983

Closing the year 1983, a review of our activity during this year may have significant meaning to us as well as to others.
Presently, this lab has 1 in Ph.D. course, 10 in MS course and 2 undergraduate students under Prof. Cherl-Ho Lee's supervising.

New Comers in 1983

Miss H.S. Son., J.S. Lee, joined to our lab from March for their MS course.

Graduates(MS)

Mr. J.G. Lim,(Thermal energy efficiency of vinyl house type solar drier supplemented with coal heater).

Mr. S.W. Hyun,(Studies on the chicory-coffee processing and the sensory evaluation of the products).

Mr. J.D. Kim,(Studies on the mechanical properties and product characteristics of corn grits extrusion cooking with single-screw food extruder).

Miss J.K. Kim,(Texture softening kinetics and structural changes of legumes and cereals).

Research Paper Presentations

* 43rd IFT Annual Meeting in New Orleans, USA.(June, 22)
  C.H. Lee - Soaking and cooking properties of beans
* MIT Seminar, Boston, USA.(June, 24)
  C.H. Lee - On protein hydrophobicity
* The Grain Pool of Western Australia, Board of Directors Meeting, Perth, Australia.(Jan. 17)
* New Zealand Dairy Research Institute Seminar, Palmerston North, N.Z. (Jan. 31)
  C.H. Lee - Hydrodynamic properties of soybean protein body
* UNU Workshop on traditional Food Technologies, Mysore, India.(July,18)
  C.H. Lee - Traditional Food Technologies in Korea
* 21st Annual Meeting of Korean Society for Applied Microbiology. (Apr. 25)
  Mr. S.H. Oh,(Fermentation of Lupinseed)
* 30th annual meeting of Korean Society of Food Science & Technology. (May, 28)
  Mr. S.K. Kim,(Proftein hydrophobicity), Mr. J.K. Lim,(Extrusion process), Mr. D.H. Kim,(Drying of mushroom) and Miss J.K. Kim, (Cooking kinetics of red bean & pea).

* 43rd Annual Meeting of Korean Society of Agricultural Chemistry. (July, 9)
  Ms. H.D. Lee,(Dough preperty of 6 different varieties of flour)
* 31th annual meeting of Korean Society of Food Science & Technology. (Nov. 5)
  Mr. C.S. Kim,(LPI & LPC preparation), Mr. S.W. Lee,(Mechanical peeling process), Mr. O.H. Kwon,(Mechanical property of noodle)

Visitors

Prof. T. Watanabe, Kyoritsu Woman's Univ., Tokyo, Japan.(May, 30)

Dr. W. Muhlbauer, Inst. of Agri. Engineering, Hohenheim University, West Germany. (Sep. 29)

Mr. Roy Ford and Mr. John J. Lussick, The Grain Pool of Western Australia. (Oct. 21)

Ms. Winnie Tauber, Denmark. (Oct. 31)

Dr. K, Saio, National Food Research Institute of Japan, (Nov. 3)

Mr. Kevin Swan, Mr. Ron Hessford and Mr. R.G. Smith, The Grain Pool of Western Australia. (Nov. 11)

Study Abroad

Mr. J.K. Lim and Ms. J.K. Kim got UNU fellowship for one year rescarch at the National Food Research Institute of Japan, Starting from Dec. 10.

Marriage and Birth

4 members got eternal mates.

Mr. D.H. Kim,(Feb. 24)

Mr. S.W. Hyun,(Apr. 10)

Mr. J.K. Lim,(Aug. 21)

Mr. H.W. Park,(Nov. 5)

Mr. Han, E., became a father on Oct. 9(daughter).

Moving

Professor Lee moved to a new house. The new address is 122-297 Mukdong, Dongdaemoonku, Seoul.

New Job

Mr. H.R. Kim got a position at the Korean Ginseng & Tabacco Research Institute, starting from March.

Review of Achivements of the Food Materials Science & Engineering Laboratory in 1984

Closing the year 1984, a review of our activity during this year may have significant meaning to us as well as to others.
Presently, this lab has 2 in Ph.D. course, 10 in MS course and 2 undergraduate students under Prof. Cherl-Ho Lee's supervising.

New Comers in 1984

Mr. B.S. Yoo., S.P. Lee., J.B. Lim., Y.T. Tae, joined to our laboratory from March for their MS course.

Graduates(MS)

Miss H.D. Lee,(Physicochemical properties of the flours of Australian wheat varieties and their noodle quality)

Mr. S.K. Kim,(Effective protein hydrophobicity and its relationship to the food functionality)

Mr. H.W. Pack,(Studies on the preparation of rice germ oil)

Mr. O.H. Kwon,(Studies on the mechanical properties of various noodles and its relation to the sensory quality)

Mr. S.H. Oh,(Studies on the fermentation of lupinseed for traditional Korean bean sauce and paste making)

Mr. D.H. Kim,(Studies on the drying characteristics of Pleurotus ostreatus)

Research Paper Presentations

* 84 Science and Technology Symposium, Seoul.(July, 13)
  Prof. C.H. Lee - Protein hydrophobicity and food functional properties.

* Seminar at the National Food Research Institute, Tsukuba, Japan. (Aug. 15)
  Prof. C.H. Lee - Protein hydrophobicity

* UNIDO Symposium on Lactic Acid Fermentation, Mexico City, Mexico. (Nov. 26-29)
  Prof. C.H. Lee - Lactic acid fermented foods in Korea

* 32th Annual Meeting of Korean Society of Food Science & Technology. (May, 26)
  Miss J.S. Lee ,(Viscometric determination of protein hydrophobicity)
  Mr. C.S. Kim,(Enzyme application for lupinseed milk)
  Miss H.S. Son,(Texture of imitation cheese by RSM)
  Miss H.D. Lee,(Physical properties of Australian wheat flours)

* 33th Annual Meeting of Korean Society of Food Science & Technology. (Nov. 17)
  Miss J.S. Lee,(Viscometric measurement of milk protein hydrophobicity)
  Miss H.D. Lee,(Rice starch making from broken rice by-products)

Visitors

Dr. N.S. Scrimshaw, MIT, USA.(April 15)

Mr. R. Ford and Mr. R. Coffey, The Grain Pool of Western Australia, Perth, Australia.(May, 15)

Dr. P. Veeraju, CFTRI, Mysore, India.(May, 21)

Prof. K. Poulsen, DTH, Lyngby, Denmark.(July, 7)

Mr. G.A. Holland and Mr. G.J. Spiel, Australian wheat Board, Melbourne, Australia.(Sep. 20)

Study Abroad

Mr. C.S. Kim got UNU fellowship for one year research at CFTRI, Mysore, India and NFRI, Japan starting from Oct. 15.

Mr. S.K. Kim left for USA to continue his study on protein hydrophobicity at MIT, starting from Nov. 1.

Prof. C.H. Lee will stay at Bread Research Institute of Australia in Sidney from Dec. 9, 1984 to end of January, 1985 for the cooperative research on noolde processing by Australian wheat varieties.

Marriage and Birth

2 members got eternal mates.

Mr. S.K. Kim,(Oct. 15) with Miss J.H. Joo

Mr. J.H. Hwang,(Oct. 28) with Miss W.S. Yoo

New Job

Mr. D.H. Kim got a position at the Miwon Research Institute, starting from September 1.

Military Service

Mr. S.H. Oh and O.H. Kwon went for military service.

Welcome

We expect Mr. J.K. Lim and Miss J.K. Kim to return home in December, after finishing 1 year UNU fellowship at the National Food Research Institute and Kyoritsu Womens University of Japan.

Review of Achievements of the Food Materials
Science & Engineering Laboratory in 1985

Closing the year 1985, a review of our activity during this year may have significant meaning to us as well as to others. Presently, this lab. has 2 in Ph. D. course, 9 in MS course and 1 undergraduate student under prof. Cherl-Ho Lee's supervising.

New Comers in 1985

Mr. B.Y. Lee, Y.W. Kim, S.H. Hong, C.S. Kim and Miss. J.K. Lee joined to our laboratory from March and Mr. K.K. Lee from September for their MS course.

Graduates(MS)

Mr. O. Han (Studies on the lactic acid fermentation of vegetable milk made by lupinseed protein concentrate)
Mrs. H.S. Son (Studies on the textural properties of imitation cheese by response surface analysis)
Miss. J.S. Lee (Studies on the measurement of hydrophobicity by viscometric method)

Research Paper Presentations

* The 45th Annual IFT Meeting, Atlanta, USA, June 9-12.
  Lee, C.H., Kim, S.K. (Studies on the effect of protein hydrophobicity on the functional properties of food proteins)
  Lee, C.H., Son, H.S. (Studies on the textural properties of imitation cheese by response surface methodology)
* Wheat Quality Seminar, AWB, Seoul, May 1985
  Lee, C.H. : Australian research on Korean dried noodles.
* Asia Tech'85 Conference, Kuala Lumper, Malaysia Dec. 4-7
  Lee, C.H. : Development of low-cost food dehydration system using solar-energy and coal for the village level food preservation in Korea.
* The 34th Annual Meeting of Korean Society of Food Science and Technology. (May, 29)
  Yoo, B.S. (Evaluation of the texture of Korean dried noodle made from Australian wheats.)
  Lee, H.D. (Appearance and overall acceptability of Korean dry noodle made from Australian wheats.)
  Han. O. (Studies on the acid fermentation of vegetable milk made by lupinseed protein concentrate(LPC).)
  Lim, J.K. (Effect of reverse screw elements on the residence time distribution in twin-screw extruder.)
  Kim, J.K. (Microstructure and textural properties of cooked cell mass from kidney bean and soybean.)

* 35th Annual Meeting of Korean Society of Food Science & Technology (Nov., 30)

Lee, S.B. (Studies on the protein separation using two-phase system.)
Yoo, B.S. (Effect of extraction rate on eating quality of dried noodle.)
Lee, B.Y. (Studies on factors in foam separation of protein.)

Visitors

March 6 : Dr. A. Noguchi, NFRI, Japan.
March 18 : Mr. V. Alisauskas and Dr. G. McMaster, AWB, Australia.
May 3 : Mr. R. Coffee, Grain Pool of WA Australia.
May 3 : Mr. J. Wisher and Dr. G. McMaster, AWB, Australia.
Aug. 12 : Mr. Y. Ohta; Ajinomoto Co., Japan., Mrs. S. Musumi, UNU.
Sep. 19 : Mr. M. Moss; AWB, Australia.
Oct. 28 : Dr. K. Nishinari, NFRI, Japan.
Nov. 23 : Dr. N.S. Scrimshaw, MIT, USA

Study Abroad

Mr. J.K. Lim left for Japan to continue his Ph. D. degree study on Food Extrusion at Kyushu University.

Mr. S.K. Kim and Mr. J.B. Lim continue their studies as visiting scientist at MIT.

Mrs. H.S. Son, with her husband, left for Cansas Univ. of USA to continue her study.

Mr. C.S. Kim continue his study on legume protein technology at NFRI of Japan.

Marriage and Birth

2 members got eternal mates.

Mr. C.S. Kim (Jan., 27) with Miss. Y.J. Kim
Mrs. H.S. Son(July, 27) with Mr. S.T. Lim

New Job

Mr. H.O. Park got a position in Food Research Institute/AFDC

Miss. J.S. Lee got employment at Bo Won Food Co., LTD

Military Service

Mr. S.H. Oh and O.H. Kwon are still in military service.

* Prof. Cherl-Ho Lee and Mrs. Lee stayed in Australia from Dec. 15,'84 to Feb. 3,'85 for a collaborative research with Bread Research Institute of Australia in Sydney.

  The year of 1985 was busy year for Prof. Lee. He has been appointed as Director of Food Research Center of Korea Univ. In March, elected as President of Korean Society of Food Extrusion Research in July and General Secretary of the Korean Society of Food Culture in Nov.. He travels to Malaysia and Thailand for site visit as an UNU project co-ordinator on fish fermentation technology.

* Miss. Yeong Suk Kim joined to this lab. as secretary of Prof. Lee.

Review of Achievements of the Food Materials

Science & Engineering Laboratory in 1986

Closing the year 1986, a review of our activity during the year may have significant meaning to us as well as to others. Presently, this lab has 2 in Ph.D. course and 14 in MS course under Prof. Cherl-Ho Lee's supervising.

New Comers in 1986

Mr. H.D. Choi, Mr. N.K. Kim joined to our laboratory from March and Mr. I.J. Kang, J. Kim, G.H. Ryu from September for their MS course. Mr. Moussa Souane from Senegal joined to our lab for his Ph.D. course.

Graduates(MS)

Mr. S.P. Lee(Studies on the protein separation using liquid-liquid system)
Mr. B.S. Yoo(Development of shear extrusion test for texture evaluation of cooked noodle)

UNU Fellow

Mr. Moussa Souane from Institute de Technologie Alimentaire, Senegal (Microbial aspects of Shikhae fermentation)
Miss. Srimaung Maleehual from Institute of Food Research and Products Development, Kasetsart Univ., Thailand (Biochemical changes during salt curing of mackerel)
Mr. Alioune Samb from Institute de Technologie Alimentaire, Senegal (Extrusion cooking of fish products)

Research Paper Presentation

* The 4th International Lupin Conference, Geraldton, Western Australia (Aug. 15-22)

  Lee, C.H. (Lupin seed for human consumption)

* Seminar on Traditional Foods and the Processing in Asia, Tokyo Univ. of Agriculture, Tokyo, Japan,(Nov. 13-15)

  Lee, C.H. (Kimchi; Korean fermented vegetable foods)

* 36th Annual Meeting of Korean Society of Food Science & Technology, (June, 7)

  Mr. S.P. Lee (Studies on the separarion of β-galactosidase using two-phase system)
  Mr. B.Y. Lee (Studies on factors in foam separation of bovine serum protein)
  Mr. Y.W. Kim (Studies on functional properties of lupin seed protein concentrates)

  Miss.J.K. Lee (Studies on the physico-chemical properties of corn extrudate having various moisture contents and particle size)
  Mr. K.K Lee (Studies on heat generation rate of corn-grits extrusion cooking)

* 28th Annual Meeting of Korean Society for Applied Microbiology & Bioengineering

  Mr. Moussa Souane (Influence of garlic and red pepper on the Microflora of Kajami shik-hae)

* 37th Annual Meeting of Korean Society of Food Science & Technology, (Oct. 18)

Mr. S.H. Hong (Studies on rheological properties of heat denatured gluten by stress relaxation test)

Mr. S.H. Hong (The relationships between the mechanical properties of heat denatured gluten and eating quality of Korean dried noodle)

Mr. H.D. Choi (Studies on starch isolation using the broken rice obtained by rice-oil production)

Visitors

July 8-15 : Mr. Derek Miller, Australian Wheat Board
July 10-15 : Mr. I. Middleton, Baker Perkins, Australia
Oct. 24-28 : Prof. Orapin Bhumibhamon, Kasetsart Univ., Thailand
Nov. 20 : Mr. J. Wischer, Australian Wheat Board

Study Abroad

Mr. C.S. Kim left for Japan to continue his Ph.D. degree course at Kyoto University

Mr. N.K. Kim left for U.S.A. to continue his MS degree course at the State University of Georgia

Marriage and Birth

Mr. N.K. Kim married Miss H.S. Kim (Aug. 16)

New Job

Mr. O. Han : the Food Research Institute of Agriculture & Fishery Development Corporation, Korea

Mr. S.H. Oh : the Pacific Chemical Research Institute, Suwon

Mr. Y.W. Kim : the Miwon Research Institute, Seoul

Military Service

Mr. S.H. Oh and O.H. Kwon finished their military service

Mr. W.T. Tae went for military service (Nov. 21)

Travels

Prof. Lee took UNU site visit to Burma and Sri Lanka from Feb. 9-20. He visited 7 institutions and interviewed 13 UNU fellowship candidates. Prof. Lee visited Australia from Aug. 14-30. He attended to the 4th International Lupin Conference and visited Australian Wheat Board in Melbourne, Bread Research Institute and Univ. of NSW in Sydney. Prof. Lee visited United Nations University in Tokyo at Nov. 12.

Mr. S.H. Hong took four-weeks course on baking technology at Bread Research Institute of Australia, Sydney, Australia (April 11-May 10)

Summer Course

This year our laboratory opened two new courses ;

one-week course for food extrusion research (June 23-27, 28 participants) and two-day course for rapid dough baking (July 12-15, 88 participants)

Review of Achievements of the Food Materials Science & Engineering Laboratory in 1987

Closing the year 1987, a review of our activity during the year may have significant meaning to us as well as to others. Presently, this lab has 4 in Ph.D. course and 8 in MS course under Prof. Cherl-Ho Lee's supervising.

New Comers in 1987

Mr. Boo-Young Lee and Mr. Sung-Hie Hong for Ph.D. course

Mr. Junghoon Han, Mr. Chang-Ho Lee, Mr. Ji-Young Kim and Miss Hye-Gyung Hong for MS course

Graduates (MS)

Mr. Young-Wook Kim (Studies on the functional properties of lupinseed protein concentrates)

Mr. Bco-Young Lee (Studies on factors affecting foam separation of protein)

Mr. Sung-Hie Hong(Studies on rheological properties of heat denatured gluten by stress relaxation test)

Study Abroad

Mr. Sam-Pin Lee left for U.S.A. to carry out UNIDO project at M.I.T. in Boston

Mr. Byung-Seung Yoo left for U.S.A. to continue his Ph.D. degree course at University of Rhode Island

Mr. Hak-Ryang Kim left for Sweden for his Ph.D. study at SIK, Goteborg

Visitors

Feb. 9: Mr. W. Kamel, Chief, Technology Programme Promotion Unit, UNIDO, Vienna

Aug. 4: Mr. R. Coffey, The Grain Pool of Western Australia, Perth, Australia

Oct. 12: Dr. J.M. Hesser, President, Hesser and Associates Inc.

UNU Workshop

The UN University workshop on Fish Fermentation Technology was organized by Prof. Cherl-Ho Lee and held at Korea University, June 22-26. Eleven overseas delegates, 6 Korean delegates and one overseas observer were participated. They were Dr. T.W. Kwon (Korea), Dr. A. Besrat (UNU), Dr. S.W. Lee (Korea), Dr. K.H. Steinkraus (USA), Dr. H.C. Chen (Rep. of China), Dr. C.H. Lee (Korea), Dr. R.D. Cooke (United Kingdom), Dr. R.C. Mabesa (Philippines), Dr. M.I.A. Karim (Malaysia), Dr. S. Putro (Indonesia), Dr. Myo Thant Tyn (Burma), Mr. M. Souane (Senegal), Dr. W.A. Scheffers (Netherland), Dr. T.I. Mheen (Korea), Dr. Y.B. Kim (Korea), Dr. E.H. Lee (Korea), MS. S. Knochel (Denmark) and MS. E.I. Dizon (Philippines)

Publications

1987 was rather fruitful year for our laboratory. Two books, Fermented Fish Products in Korea and Food Extrusion Technology (in Korean), written by Prof. Cherl-Ho Lee and other co-authors, were published by Yulim Moon Hwa Sa Inc.. A total of 13 research papers from our laboratory were appeared in both domestic and international journals.

Travels

July 19-26: Prof. Lee took a study tour to Japan with 13 members of the Korea Society of Food Extrusion Research. He visited Prof. E. Doi's Lab. of Kyoto University, Dr. A. Noguchi's Lab. of NFRI and 5 extruder manufacturers; Kurimoto (Osaka), Mitsubish H.I. (Nagoya), Taiyo Chem. Co. (Yokkaichi) and Toshiba (Numazu). Mr. Jae-Gak Lim and Mr. Chan-Shic Kim guided the group in Japan.

Aug. 5-14: Prof. Lee visited Dr. A. Sinskey of M.I.T., Center for Advanced Food Technology of Rutgus Univ., U.S.A., Mr. A. Reilly of TDRI, U.K., Dr. R. Kloepzig of UNIDO, Vienna, Prof. M. Jul and Prof. L. Bogh-Sorensen of KVL, Denmark, Mr. J. Hojmark Jensen of NFAD, Denmark, MS. S. Knochel and Prof. A. Nielsen of DTH, Denmark, Dr. J.M. Flink of Alfred Jorgen's Lab., Denmark, Prof. A.M. Hermansson of SIK Sweden, Prof. K.R. Norum of Oslo Univ., Norway and Dr. A. Besrat of UNU, Japan. During this trip, he met many graduates from our lab., Dr. Chan-Hwa Kim, Mr. Sung-Koo Kim, Mr. Sam-Pin Lee and Mr. Jung-Bae Lim at MIT, Boston, and Mr. Hak-Ryang Kim at SIK in Goteborg, Sweden. Moreover, he met his Danish Family, Mr. Kristen Larsen's at Gylling and his old friends in Denmark after 12 years of his leave from the country.

Nov. 9-15: Mr. Ouk Han of Food Research Institute of AFDC and Mr. Dae-Hwan Kim of Knorr Korea Inc. attended to the Symposium on the Application of Twin Screw Extrusion-cooking held in Tokyo. Afterwards, they visited three extruder manufacturers and Mr. Jae-Gak Lim's home in Kyushu.

Research Paper Presentation

* 38th Annual Meeting of Korean Society of Food Science & Technology (May 30, Woo-Suk Univ., Jeonju)

Hong, S.H. (Sensory characteristics of Korean traditional tea)

Kang, I.J. (Hydrophobicity of heat denatured proteins)

Ryu, G.H. (Physico-chemical properties of rice extrudates)

Hwang, I.J. (Texture measurements of Kimchi cabbages)

Kim, D.C. (Measurements of the gelatinization of corn extrudates)

* 39th Annual Meeting of Korean Society of Food Science & Technology (Nov. 7, Konkook Univ., Seoul)

Ryu, G.H. (Extruder operation conditions and barrel temp. distribution)

Kim, J. (Sensory evaluation of Korean dried noodle)

Souane, M. (Prefermentation and extrusion cooking for rice-soybean lactic fermentation)

Marriage

Mr. Byung-Seung Yoo married with Miss Hwa-Choon Yu

New Job

Mr. Young-Wook Kim: Research and Development Center, Miwon Co. Ltd., Seoul

Military Service

Mr. Boo-Young Lee and Mr. Sung-Hie Hong went for military service

Review of achievements of the Food Materials
Science & Engineering Laboratory in 1988

Closing the year 1988, a review of our activity during this year may have significance to us as well as to others. Presently, in our group, there are 4 in Ph.D. course and 10 in M.S. course under the direction of Prof. Cherl-Ho Lee.

New Comers in 1988

Dong Hoon Shin, Ms. Eui Jeong Yoon joined to our laboratory from March and Ki Myoung Kim, Suck Hyoung Rhee, Ms. Na Young Kim from September for their M.S. course. Ouk Han, Ms. Hyun Duck Lee joined to our group for their Ph.D. course.

Graduates (M.S.)

Kim, Jeong (Studies on the quality characteristics of Australian Standard Whites for Korean noodle making and sensory evaluation of dry noodle)

Kang, Il Jun (The effects of heating and salt addition on the hydrophobicity and surface property of proteins)

Ryu, Gi Hyung (Effects of the type of feed material and operational conditions on the heat generation pattern in single-screw extruder and product characteristics of rice extrudates)

Choi, Hee Don (Physicochemical and rheological properties of rice starch phosphates and rice starch extrudates)

Research Paper Presentation

* 2nd International Food Convention, Invited lecture(Feb.18-23, Mysore,India)

  Lee, Cherl-Ho (Extrusion technology for the production and processing of traditional foods)

* 40th Meeting of Korean Soc. of Food Sci. & Technol. (May,28,Cheon Nam Univ.)

  Moussa Souane (Effect of extrusion temperature on microbial survival in rice-soybean blended flours)

  Han, Jung Hoon (Optimization for purification of protease produced from B. subtilis in PEG-PPB aqueous two-phase system)

  Kang, Il Jun (The effects of heating and salt addition on the hydrophobicity and surface property of proteins)

* 38th Australian Cereal Chemistry Conference, Invited lecture (Sept. 25-30, Bronte Inn, Sydney, Australia)

  Lee, Cherl-Ho (Wheat characters necessary for optimum Korean noodle production)

* 41th Meeting of Korean Soc. of Food Sci. & Technol. (Oct. 28)

  Han, Jung Hoon (Determination of the pI value of various proteins with aqueous two-phase system)

  Han, Jung Hoon (Purification of protease produced from B. subtilis by counter-current distribution method)

  Lee, Chang Ho (Studies on the instant Korean tea production with spray-dryer)

  Kim, Ji Yong (Studies on the improvement of Takju, korean traditional alcohol beverage, by using extrusion cooking)

Publications

This year was also productive year for our group. We published 9 research papers and one book "Food Extrusion Technology (II)".

Summer Course

The International Workshop for Food Extrusion Technology (June 27-July 1) was held at Korea University, attracting 49 participants from Korean food industries and research institutes. Dr. Akinori Noguchi, Mr. Seiichiro Isobe of NFRI, Japan, Prof. Isao Hayakawa, Mr. Lim Jae-Kak of Kyushu Univ., Japan and Mr. Christian Millauer of Buhler Brothers, Switzerland were invited as special lecturers.

Visitors

Oct. 21 - Nov. 10 : Dr. C.W. Kim, MIT, The School of Science
Oct. 31 - Nov. 7 : Prof. C.K. Rha, MIT, The School of Science
Nov. 13 - 17 : Prof. A.J. Sinskey, MIT, Dept. of Biology
Nov. 13 - 21 : Mr. R.Kloepzig, UNIDO, Vienna, Austria

Home Coming

Oct. 25, Sam-Pin Lee returned from MIT after his 1.5 year study for UNIDO project.

Study Abroad

Mr. Il Jun Kang left for Japan to continue his Ph.D. degree at Kyoto University.

Marriage and Birth

Mr. G.H. Ryu married Ms. M.K. Kim. (Aug. 20)

New Job

Mr. G.H. Ryu : Korea Advanced Institute of Science & Technol., Seoul.

Military Service

Mr. H.D. Choi went for military service. (Aug. 29)

Picnic

Our group annual picnic was held in Oct. 30 at the University farm in Dukso. More than 40 alumni and students joined to the picnic. In the valleyball game OB won over YB.

Travels

Prof. Lee received Japanese Award to stay at NFRI, Japan, for 3 weeks (Jan. 20 - Feb. 10) for a lecture and extrusion study with Dr. A.Noguchi. Prof. Lee visited MIT, Boston, for the 2nd Review Meeting (Aug. 6-10) for UNIDO project and then visited UNIDO office in Vienna, Austria. He also visited Buhler Brothers Ltd. in Uzwil, Switzerland, Dr. O.Hassan of UNTAD in Geneva and Dr. Abraham Besrat of UNU in Tokyo. (Aug. 11-18)

Prof. Lee will stay in Denmark during his school winter vacation (Dec. 10, 88 - Feb. 25, 89). He will conduct pilot plant scale cereal lactic fermentation trials with the research group of Prof. Jens Adler-Nissen of DTH. His address in Denmark is : Centre for Food and Process Biotechnology, The Technical University of Denmark, DK 2800 Lyngby, Denmark, Tel. 02884066, Fax 02882239

Review of achievements of the Food Materials Science & Engineering Laboratory in 1989

Closing the year 1989, a review of our activity during this year may have significance to us as well as to others. Presently in our group, there are 7 in Ph.D. course and 11 in M.S. course under the direction of Prof. Cherl-Ho Lee.

New Comers in 1989

Dr. Lim, Jae-Kag completed his Ph.D. degree study at Kyushu University, and joined our group as Post-doctorate Research Associate.

Ph.D. course: Kim, Young Wook (Spring), Kim, Ji Yong (Fall)

Ms course: Song, Yoon Seok and Kim, Chang Hyun (Spring), Rhee, Sook Jong (Fall)

Graduation (M.S.)

Kim, Ji-Yong	(Effect of extrusion-cooking of flour on the alcohol yield and quality of Takju)
Lee, Chang Ho	(Separation and purification of model proteins using countercurrent distribution)
Jeong, Young Gil	(Lactic acid fermentation of soymilk supplemented with rice extrudate Gamju)
Hwang, Seung Hoon	(Effects of protein content of weak flour on the dough property and the physical properties of the extrudates)
Han, Jeong Hoon	(Partition of Bacillus subtilis neutral protease in aqueous two-phase systems)
Kim, Man Young	(Effects of storage conditions and storage temperature on the textural changes of rice cake)
Choi, Jin Tae	(Baking properties of the flours from Dark Nothern Spring and Canadian Western Red Spring)
Kim, Young Seong	(Effects of extrusion-cooking of starch materials on the quality of fermented hot-bean paste)
Lee, Seung Woo	(Pasteurization and manufacturing process of arrowroot juice)

*Research Paper Presentation

○ 43th Meeting of Korean Soc. of Food Sci. & Technol. (June 3. Kyung Buk Univ.)

Lim, Jae Kag	(Characteristics of thermo-treated wheat starch and wheat gluten under pressure)
Lee, Chang Ho	(Effects of potassium chloride on the separation and purification of model proteins using countercurrent distribution)
Lee, Boo Yong	(Effects of ammonium sulfate on the separation and purification of model proteins using countercurrent distribution)
Shin, Dong Hoon	(Factors influencing the residence time of flour in single-screw extruder)
Kim, Gi Myong	(Thermal resistance of microorganisms in Takju, Korean traditional alcohol beverage)
Yoon, Eui Jeong	(Texture measurement of cabbage leaf-stalk)
Hong, Hae Kyung	(Sensory recognition mechanism and expression of the taste of MSG)

○ 10th Meeting of Korean Society of Dietary Culture (June 10, Seoul)

Lee, Hyun-Duk	(Sensory quality attributes of Takju)
Kim, Ji Yong	(Effect of extrusion-cooking of flour on the alcohol yield and quality of Takju)

○ 43th Meeting of Korean Soc. of Food Sci. & Technol. (Nov. 4)

Shin, Dong Hoon	(Residence time of single-screw extruder with varing screw tips and die structures)
Tae, Won Taek	(Effects of heating conditions on the quality of pasteurized Takju)
Lim, Jae Gak	(Rheological properties of oligcsaccharides)
Lee, Seung Woo	(Pasteurization and manufacturing process on arrowroot juice)

Kim, Young Seong	(Effects of extrusion-cooking of starch materials on the quality of fermented hot-bean paste)
Han, Oak	(Effects of temperature on soy-protein texturization using single-screw extruder)
Hwang, Seung Hoon	(Effects of protein content of weak flour on the dough property and the physical properties of the extrudates)

○ 34th Meeting of Korean Society for Applied Microbiology (Oct. 28, Yon-Sei Univ., Seoul)

Souane, Moussa	(Selection of microorganisms for cereal lactic fermentation)

○ IFS Workshop on Post-harvest Technology, preservation and Quality of Fish in S.E. Asia, 12-17 November, Bangkok, Thailand.

Lee, Cherl-Ho	(Fish fermentation technology-a review)
Souane, Moussa	(Microbiological characterization of Gajami sikhae fermentation)

* Publications

The book "Fish Fermentation Technology" edited by Cherl-Ho Lee, Keith H. Steinkraus and P.J.A. Railley will be published by the end of this year, after two years of painful editorial work.

* Visitors

○ Prof. A.J. Sinskey, MIT, USA (June. 26)
○ Mr. R.A.I. Williamson, APV Far East Ltd., Hong Kong (Oct. 28)
○ Mr. H. Sasaki, Kobe Steel Co., Japan (Oct. 28)

* Study Abroad

○ Ryu, Gi Hyung left for U.S.A. to continue his Ph.D. degree study at Kansas Univ.

* Marriage

Kim, Young Wook (May. 7)	Kang, Il Jun (Sep. 2)
Hong, Hae Kyung (Nov. 7)	Kim, Chan Sik (Spring)
Kwon, Oh Hoon (Spring)	

* Birth; Kim, Yong Wook got his first daughter. (Sep. 22)

*New Job

○ Lee, Boo Yong: Korea Food Research Institute
○ Lee, Chang Ho: Korea Food Research Institute
○ Kim, Ji Yong: Korea Food Research Institute (Temporary)

* Military Service

○ Han, Jeong Hoon went for military service.

* Home Coming Day

The First Home-Coming Day of our group was held in May at Science Library. Around fifty alumni were gathered and Dr. Lee, Gi Young and Dr. Lim, Jae Kag presented their Ph.D. thesis studies.

* Picnic

Our group annual picnic was held at the University Farm in Dukso.
More than 20 alumi and students joined to the picnic.

* Travels

Prof. Lee spend two months from June at the Department of Biotechnology, the Technical University of Denmark, for the cooperative research on the development of high protein content lactic beverages from cereals. His mother died July 12, and he returned back to Korea July 5, and after the furneral he left again to Denmark with his family.

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Picture of Aspergillus Oryzae grown on Cooked Rice
Merry Christmas and Happy New Year 1998!


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Merry Christmas and Happy New Year 1998!

Report of Food Materials Science and Engineering Laboratory 1991.

The annual review of achievements of our lab has been made for several years, becoming a meaningful records for us. Presently we have 5 in Ph.D. course and 10 in M.S. under the direction of Professor Cherl-Ho Lee.
Kim Mi Ryung, Lee Do Yon, Lee Kang Kwon, Han Jung Jun, Kim Yong Bum, Kim Min Su (March) and Lim Bu Yong (Sept.) entered as MS student and Kim Ki Myung (March) for Ph.D. course.

Moussa Souane completed his Ph.D. study after 5 years of hard life in Korea and returned to his home country, Senegal. His doctoral thesis was " Development of cereal lactic fermentation process for the production of high-protein content beverage" We had three M.S. graduates this year;
Kim Sun Yong (Microbial characterization of Jangsu; An ancient lactic acid fermented cereal beverage), Lee Suk Chong (Studies on the control of bitterness from soymilk hydrolysate) and Kim Mi Hee (Studies on the taste components in Korean red pepper)

Research Paper Presentation

* UNIDO Expert Group Meeting, (Dec. 16-20, IITA, Nigeria)
  Lee, Cherl-Ho (Industrialization of lactic acid fermentation of cereals and its dissemination to the developing countries)
* 46th Meeting of Korean Soc. Food Sci. Technol. (25 May, Chungbuk Univ.)
  Park Chun Sang (Rheological properties of crude dextran solution made from dextransucrase of Leuconostoc mesenteroides)
  Kim Hun (Wheat germ nut processing by using a twin-screw extruder)
* 47th Meeting of Korean Soc. Food Sci. Technol. (2 Nov.,Dongkuk Univ.)
  Kim Gi Myung (Sensory optimization of organic acid composition in lactic acid fermented beverage of rice-soymilk mixture)
  Kim Chang Hyun (Comparision of bitterness level of soyprotein hydrolysate treated with different types of enzymes)
  Han Jung Jun (Rheological properties of chitosan isolated from crab residue

Publication

This year we have published 9 research papers.

Summer Course

The ·91 Food Extrusion Technology Summer Course was held at Korea University from July 2 to 5, attracting 50 participants from Korean food industries and research institutes

International Course

The UNIDO International Course for Food Fermentation Technology was started from 1 October for its 10 months training. The participants are T.O.Nashiru(Nigeria),H.Elsoufi(Sudan),L.S.Collado(Philippines),M.F.Moheedin (Sri Lanka), K.Vachanavinich(Thailand),N.V.Viet(Vietnam),M.Balaraman(India) and M.A.Abdel-Naby(Egypt). Professor Lee, as director of UNIDO project, devoted much of his time for the preparation of the course. Kim Gi Myung assisted him as project manager.

Visitors

Professor Jens Adler-Nissen of DTH, Denmark, stayed with us for one month in June-July, as UNIDO Consultant on the project for industrialization of lactic acid fermentation technology of cereals and its dissemination to developing countries. Dr. K. Venkataraman of UNIDO, Vienna, visited us in July. Short term home-coming visits were made by Kang Il Jun (Kyoto Univ.,Japan) in June, Kim Sung Koo (MIT,USA) and Kim Hack Ryang (Lund Univ.,Sweden) in December.

Marriage and Birth

Rhee Suk Hyung married with Rhee Sook Jong (October). Lee Bu Yong married with Park Hyung Jin (July) and got a son. Hong Sung Hie and Yoon Eui Jeong in Australia and Lee Sam Pin in USA got a son each. Kim Chang Soo married with Kim Mee Rhan and had a daughter. Kim Mi Hee married in June and left to Mexico. Song Yoon Seok married in USA.

New Jobs

Kim Chan Shick became Assistant Professor of Dept. of Agricultural Chemistry, Cheju University. Han Jung Hun jointed to Nuri Communication, Choi Hee Don to Haitai Co., Shin Dong Hoon to Kolon Co., Lee Suk Hyung to Dusan Resear. Inst., and Kim Chi Yong Assistant Professor of Kijeon Junior College, Park Choon Sang joined to Nong Shim Co.Ltd., Kim Hun to Miwon Co.Ltd. and Cho Jung Sook to Samsung Electronics.

Picnic

Our group picnic was held in 18 April at the University Farm. More than 40 alumni and students enjoyed mountain climbing in Dukso.

Professor Lee has been very much occupied this year with the preparation of UNIDO International Course. In addition he built a small laboratory in Kalmaedong, located at a 30 min driving distance from school. Due to his overloading work, he was hospitalized twice this year to operate cataract(July) and thyroid(September). Professor and Mrs. Lee traveled to Nigeria during December 12-26 to attend the UNIDO Expert Group Meeting at IITA.

Report of Food Materials Science and Engineering Laboratory 1992.

It is the season to summarize the annual review of achievement of our laboratory. Presently we have 5 in Ph.D.course and 6 in MS. under the direction of Prof. Cherl-Ho Lee.

Han Ouk completed his Ph. D. study last winter after three and a half years of pains-taking research work with extruder. His doctoral thesis was entitled to "Texturization of rice and soybean protein mixtures by extrusion cooking". Lee Hyun-Duck finished her Ph. D. study last summer after four years of hard work on Korean red pepper. Her thesis was "Studies on the taste components of Korean red peppers (*Capsicum annuum*)". The laboratory produced 6 M.S. graduates this year; Park Chun Sang (Studies on the rheological properties of dextran formed solution), Kim Hun (Development of wheat germ nut processing by using extrusion cooking method), and Cho Jeong-Suk (Physical properties of chitosan film made from crab shell) in February, and Kim Chang Hyun (Studies on the bitterness of soybean protein hydrolysate obtained by different proteases), Kim Yeong Keun (Application of thermo tolerant yeast, *Candida rugosa*, for the reduction of COD and the production of yeast from naked barley stillages) and Kim Min Soo (Retention of flavor components added to rice flour upon extrusion) in August.

Dr. Moussa Souane of Senegal revisited Korea last June and stayed for three months as visiting scientist in our lab. Dr.Mohamed A. Abdel-Naby stays in our lab as a post- doctorate fellow after completion of UNIDO International Course at Korea Univ.

Research Paper Presentation

*UNIDO International Workshop on Lactic Acid Fermentation of Non-Dairy Food and Beverages, June 25-27, Korea Food Research Institute, Songnam, Korea

Lee Cherl-Ho (Importance of lactic acid bacteria in non-dairy food fermentation)

*9th International Biotechnology Symposium, August 16-21, Crystal City, Virginia, USA

Lee Cherl-Ho (Control of organic acid composition and flavor characteristics of rice-soymilk beverage by fermentation with Leuconostoc mesenteroides Sikhae)

Lee Cherl-Ho (Effects of type of enzyme on the bitterness of protein hydrolysate)

*The 1st International Symposium on the Development of Natural Resources and Environmental Preservation, Korea University, October 13-18, Seoul

Lee Cherl-Ho (New frontiers in biopolymer production and processing)

*48th Annual Meeting of Korean Soc. of Food Sci. and Technol., May 30, Kyung Nam Univ.

Lee Cherl-Ho (Plenary lecture - Protein Processing Technology)

Kim Min Soo (Efects of estrusion-cooking on the retention of added flavor compounds)

Lee Do Yeon (Effects of sugar addition on the flavor formation in lactic acid fermentation of rice-soymilk mixture)

Lee Hyun-Duck (Studies on the kinetics of water extracts of Korean red peppers)

Kim Mi Ryung (Effects of types of protein and enzyme on the bitterness formation in acid soluble soybean protein hydrolysate)

Kim Yong Bum (Changes in the molecular size of rice starch by extrusion-cooking)

*Annual Meeting of Korea Soc. of Food Extrusion Res., Oct. 27, Korea Univ., Seoul

Lee Cherl-Ho (Wheat food extrusion and flour quality)

Kim Ji-Yong (Extruded snack products made from wheat)

*Annual Meeting of Korean Soc. for Applied Microbiology, Oct.30-31, Kyung Buk Univ.

Kim Yeong Keun (Production of protein by thermo-tolerant yeast *Candida rugosa* from naked barley stillage)

Mohamed A. Abdel-Naby (Optimization of some fermentation parameters for maximal productivity of lactic acid bacteria by Ca-alginate immobilized *L.lactis*)

*49th Meeting of Korean Soc. of Food Sci. & Technol., Nov.6-7, Seoul Education Centre

Han Jung Joon (Rheological properties of chitosan complex isolated from *Asp. niger*)

Kim Yong Bum (Effects of extrision-cooking and simple heating on the molecular structure of rice starch)

Lee Kang Kwon (Effects of amylase addition on the extrusion-cooking of rice flour)

*We have published 10 research papers and a Korean patent in this year.

International Course

The UNIDO International Course for Food Fermentation Technology was successfully completed in

August. A total of 8 textbooks in the subjects of Traditional fermentation technology, Cereal Lactic fermentation technology, Biotechnology and genetic engineering , Korean language, Extrusion cooking technology, Starter culture technology, Enzyme process technology and Korean dietary culture were written in English by 16 professors and lecturers participated to the teaching.

International Workshop

International Workshop on Lactic Acid Fermentation of Non-Dairy Food and Beverages was held as a UNIDO project activity in 25-27 June at Korea Food Research Institute, Songnam. Prof.Jens Adler-Nissen of Denmark, Prof.Gunter Barwald,Germany, Dr. Moussa Souane,Senegal, Dr.George Tzotzos of UNIDO,Vienna and Mrs.Satoko Musumi of Japan came to the workshop.

The Annual Meeting of Korea Society of Food Extrusion Research,held in Oct.27 at Korea Univ.,invited Dr.Akinory Noguchi of the National Food Research Institute of Japan. He came with Mrs.Noguchi and presented a lecture on Food Processing Under Special Conditions.

News from the Graduates

Dr.Kim Young Man of Ildong Pharmaceutical Co. was appointed as professor of Ansung Agr. Junior College. Park Chang Real of Choheung Chemical Co. became the Deputy Director of the company's Research Institute.

Kim Young Sung of Sampyo Food Co. became prof. of Shin Heung Junor College,and Kim Young Wook of Miwon Co. move to its LA office in May.

Kim Sung-Koo completed his Ph.D. study at MIT, USA, with the thesis "Modulation of the porosity of bi-polymer membrane in encapsulation", and continues postdoctorate research at MIT. Kim Hak Ryang received D.Sc. degree at Univ.of Lund,Sweden,with the dissertation "Physicochemical properties of hydroxypropyl potato starch",and stays there as a postdoctorate fellow.

Yoo Byoung Seung finished his PH.D.study at Rhode Island Univ.,USA,with the research on the physical properties of fish paste,and continues his postdoctoral research at Cornell Univ. Ryu Gi Hyung completed his Ph.D. study at Kansas State Univ. with the thesis "Extrusion-cooking of wheat flour: effect of extrusion conditions,some baking ingredients and emulsifiers",and continues postdoctorate research at Cornell U. Kang Il Jun completed his Ph.D. study at Kyoto Univ.,Japan, with the thesis "Studies on evaluation and control of textural properties of soy protein gels", and stays there as a postdoc.

Hong Sung Hie completed his Ph.D. study at the Univ.of New South Wales, Australia, with the thesis "The effects of genotype and environment on factors governing the quality of white dry salted noodle", and returned home with Yoon Ewi Jung and their son to take a position at Korea Food Reseach Institute. Kim Nak Kyung returned home from Georgia Univ.,USA, to take the military compulsory job at Miwon Techn. Research Institute.

Han Jung Hoon married in May and left to USA to commence his PH.D. study at Purdue Univ. Dr.Moussa Souane married with Kim Sun-Young in September,and Sun-Young resigned the position of TongYang Magic Co. in order to go to Senegal in December. Happy weddings were also made by Park Chun Sang in May and Shin Dong Hoon in November.

Picnic: This year alumni meeting was held in June 6 at Korea Food Research Institute, near NamSeoul Golf Resort,participated over 40 people including spouses and children. Kim Dong Chul, Han Ouk, Yang Seung Yong, Lee Boo Yong and Lee Chang Ho of KFRI made an excellent arragement for the picnic.

News from Professor Lee's Family

Prof. Lee attended the 8th Biorheology Congress in Yokohama,Japan, in August, and met Dr.Tokuji Watanabe at Tokyo Metropolitan Food Tech. Res. Center, Mrs.Satoko Musumi of UNU Fund, Dr.Akinori Noguchi at National Food Res.Inst. of Japan,and Prof.Yasuhiro Otha of Bunkyo Univ. He attended the 9th International Biotechnology Symposium in Crystal City, Virginia,in August, and met there Prof. ChoKyun Rha, Prof.A.J.Sinskey and Dr.Kim Sung-Koo. He also visited Mr.R. McDonald of Wenger Int.Inc. and Dr.J.M. Hesser of HRA in Kansas City.

Mrs.Lee(Ro) has been busy with her teaching at Ehwa Womens Univ. and DuckSung Womens Univ. in the subject of Family Nursing, in which 300-400 students enrolled each semester.

Jung-Sil is in the 2nd year of high-school and already devoting most of her time for the preparation of university entrance exam. Moon-Sil is in the last year of middle-school and facing to the high-school entrance exam this winter. Han-Sil was lucky to pass the first entrance exam in her life for Sunhwa Art Middle-school in piano major, and she is practicing piano 3-4 hours a day.

Report of Food Matereals Science and Engineering Laboratory 1993

It is the season to review the activities of our laboratory in 1993. Presently we have 7 in Ph. D. course and 5 in Ms course under the guidance of Prof. Cherl-Ho Lee. New faces are Chung Kyung Hoon of Cheil Sugar Co. and Choi Won Suk for Ph. D., Cho Jin Ho and Kim Tae Hoon for MS course. Lee Do Yon and Kim Mi Ryung continue their Ph. D. study after graduation of MS course and Kang Bo Sik returned from military service for his MS study.

We produced two Ph. D. this year, Oh Sung Hoon with a thesis "Rheological properties of mycelial broths of glucoamylase producing Aspergillus niger" and Lee Bu Yong with "Studies on the measurement of rheological properties of starch dough using extrusion capillary viscometer and its gelatinization kinetics". Seven MS studies were completed, Lee Do Yon (studies on the control of organic acid composition and flavor of rice-soymilk beverage by Leuconostoc mesenteroides Sikhae), Kim Mi Ryung (studies on the bitterness and hydrophobicity of the acid soluble protein hydrolysates obtained by different type of proteins and proteases), Han Jung Joon (studies on the rheological properties of chitosan isolated from portunus trituberclatus and Aspergillus niger mycelium), Lee Kang Kwon (studies on the effects of amylase addition to rice extrusion on the rheological properties of the extrudate for weaning food base), Kim Yong Bum (a study on the changes in molecular weight distribution and enzyme susceptibility of rice starch by extrusion-cooking and simple heat tretment of rice flour), Lee Taik Dong (studies on the storage stability of Deep-fried instant noodle made from hydrogenated soybean oil), and Imm Bue Young (kinetics of acid hydrolysis of dextran and molecular characterization of the dextran hydrolysates).

Research paper presentation

* 3rd symposium on Chinese Dietary Culture, Sept. 10-11, Taipei, Taiwan
  Lee, Cherl-Ho (A terminological study of trilingual (Chinese-Korean-Japanese) presentation on food texture.)
* 42nd Annual Meeting of Korean Soc. for Applied Microbiology, Oct. 23, Korea Univ., Seoul
  Lee Cherl-Ho (The types and technology of traditional alcoholic beverages in Korean old literatures)
* 93' Annual Meeting of Korean Society of Food Science, Nov. 6, Yonsei Univ., Seoul
  Lee Cherl-Ho (Plenary lecture-Physical properties and funtion of biopolymers)
* UNIDO Symposium on Food Fermentation Technology, December 13-16, Dakar, Senegal
  Lee Cherl-Ho (Importance of lactic acid bacteria in non-dairy food fermentation)
* 41st Meeting of Korean Soc. for Applied Microbiology, May, 1, KOEX, Seoul
  Oh Sung Hoon (Effects of aeration and agitation conditions on production of glucoamylase with Aspegillus niger No. PFST-38)
* Annual Meeting of Korean Soc. of Rheology Sep. 24, Kyung Buk Univ., Taeku
  Imm Bue Young (Rheological properties of dextran produced by Leuconostoc mesenteroides sikhae)
* 42nd Meeting of Korean Soc. for Applied Microbiology, Oct. 23, Korea Univ., Seoul
  Oh Sung Hoon (Morphological measurment and rheological properties of mycelial broths of glucoamylase producing Aspergillus niger)

* 51th Meeting of Korean Soc. of Food Sci. and Technol. Oct. 30, Korea Food Res. Ins., Songnam, Korea

Lee Bu Yong	(Studies on the measurement of rheological properties of starch dough using extrusion capillary viscometer)
Kim Won Jung	(Studies on the physical preoperties of cellulose isolated from natural pulp)

Summer course

This year the Korea Society for Food Extrusion Reseach organized a workshop in collaboration with the Food Engineering Section of the Korean Society of Food Science and Technology. The workshop title was "Physical Properties of Food and Extrusion Technology". Prof. Chong Min Lee of Univ. of Rhode Island, USA, participated to the workshop as a special lecturer covering half of the workshop.

News from the graduates

Dr. Jae Kak Lim left to Japan to take his position at the Japan office of Cheil Sugar Co. Dr. Kim Hak-Ryang moved to the Univ. of Manitoba, Canada, as a research fellow. Lee Sam-Pin finished his Ph.D. study at Cornell Univ. with the thesis "Enhancing the functional properties of bovine β-lactoglobulin A by genetic modification." and returned to MIT for his postdoctorate research with Prof. A.J.Sinskey. Kim Nak Kyung stayed in Georgia Univ.,USA, for six months to cmplete his Ph.D. thesis and returned back home to Miwon Central Research Institute. Choi Hee Don moved from HaiTai Confectionary Co. to Korea Food Research Institute. Kim Dae Hwan opened his own business in food ingredients trade in Hanamdong. Lee Kwang Kyu established a food processing factory in Kyunggido.

New jobs were taken by Kim Mi Ryung (Bingrae), Kim Young Bum (SamYang Food Co.) Lee Kang Kwon (NongShim) Imm Bue Young (Lucky Food Res. Inst.).

Happy weddings were made by Kim Won Jung in October and Choi Hee Don in Oct.

News from Professor Lee

This year Prof. Lee devoted most of his time for the Korean Society of Applied Microbiology as the Chairman of Execute Committee. He was suceessful in fund raising for the events of the 20th Anniversary of the Society . The 20th Annivesary Symposium "Microbial Industry and National Development" was held completed. A book "20-year history of Korean Society of Applied Microbiology" was published by him as chief editor.

He also organized the first exibition and quality evalustion of Korean tradition alcoholic beverage,participating over 50 kinds of rice wines and brandys from all of the country. A Symposium a grand Discussion for the restoration of Korean wine were also organized and drew special concern of the people. He is presently travelling Africa to participate UNIDO Symposium on food Fermentaion Technology in Dakar,Senegal. He will meet Dr. Moussa Souane and Kim Sun Young there.

Report of Food Materials Science and Engineering Laboratory 1994

It is the season to review the activities of our laboratory in 1994. Presently we have 8 in Ph.D. course and 6 in Ms course under the guidance of Prof. Cherl-Ho Lee. Choi Hee-Don of KFRI and Lee Kang-Kwon of NongShim entered to Ph.D. course this year, and Ahn Bo Sun joined our group as Ph.D. student. New faces in Ms. course are Captain Kim Ho-Young, Choi Sung-Jin and Byun Sang-Hee. Seven Ms studies were completed: Kim Young-Sun (Partition of sprayed thiophanate-methyl to the milling fractions of wheat), Kim Won-Joong (Studies on the physical properties of carboxymethyl-cellulose film made from pulp), Bae Min-Jeong (Studies on the composition and physical properties of isolated-glucan from Saccharomyces cerevisiae cell wall residue), Park Kyung-Hee (Effect of coagulants on the shelf-life and sensory quality of packaged tofu (soybean curd)), Kim Un-Sung (Effect of Aloe arborescens added diets on the cadmium toxicity in rat), Lee Man-Sul (A comparative study on the analytical methods for chlorophyll content in spirulina), and Jung Tae-Won (Studies on dehydration of concentrated coffee extract by using disk type centrifugal separator)

Research paper presentation

* Asian-Pacific Symposium on Health Food, Nutrition Food and Gourmet Food, August 22-26, Beijing, China
  - Lee, Cherl-Ho (The changes in the dietary pattern and health and nutritional status of Korean during the last one century)
* First Symposium on The Science of Kimchi, November 4, Intercontinental Hotel, Seoul
  - Lee, Cherl-Ho (Changes in the texture of Korean cabbage during Kimchi making and their measurements)
* 52th. Meeting of Korean Soc. of Food Sci. and Technol., May 28, Nat. Fisheries U. of Pusan
  - Kim Ji Yong, Cho Jin Ho (Studies on rheological properties of rice flour for weaning food base made by single- and twin-screw extruders)
  - Kim Gi Myung, (Studies on shelf-life of pasteurized Yakju- Korean traditional alcoholic beverage)
  - Choi Won Suk (Rheological properties and texture of commercial crab meat analogs made from surimi)
  - Kang Bo Sick (Studies on the molecular weight distribution of dextrans produced by various concentrations of dextransucrase)
  - Lee Do Yon (Effect of freeze-concentration on the flavor of Korean rice wine, Yakju)
  - Kim Tae Hoon (Measurement of rheological properties of wheat dough by extrusion capillary viscometer)
  - Bae Min Jung (Measurements of yield and purity of yeast cell wall β-glucan produced by various extraction methods)
* 53th Meeting of Korean Soc. of Food Sci. and Technol., Nov. 11, Yonsei Univ. Seoul
  - Kim Gi Myung, Lee Do Yon (Studies on the pasteurization conditions of canned Takju)
  - Kim Tae Hoon, Kim Ho Young (Determination of optimun water addition for rice cooking for Korean)
  - Lee Eun Joo (Studies on the physico-chemical methods for the measurement of eating quality of cooked rice)

News from the graduates

Dr. Sung-Ku Kim returned home from MIT and became assistant professor of the Department of Biotechnology of National Fisheries University of Pusan. Dr. Byung-Seung Yoo returned home from Cornell to take his position at the Food Research Institute, Seoul. Dr. Gi-Hyung Ryu returned home from Cornell and became assistant professor of the Department of Food Sience & Technology of Kongju National University. Dr. Sung-Hie Hong was appointed as senior researcher of the Institute of Agricultural Food Technology. Dr. Hyun-Duk Lee left to USA to take her postdoctorate research at UCLA Davis last year and continues her work there this year. Dr. Kyung-Hee Koh became professor of the Department of Food and Nutrition of Sungsim Womens University.

News from Professor Lee

Prof. Lee took Sabbatical leave in the Spring Term, and was appointed as the reseach fellow of the Smithsonian Institution in Washington D.C., USA, from March to August. He stayed there in March-April and in July-August to work with Dr. G.T. Sharrer on the project of "Food in the making of modern Korea". He visited the National Food Research Institute of Japan in Tsukuba for two weeks in June-July to work with Dr. Akinori Noguchi on the Ohmic heating, high pressure cooking and food extrusion. He met Dr. Tokuji Watanabe, Mrs. Satoko Musumi, Dr. Kyoko Saio and Dr. Jae-Kak Lim in Tokyo, and visited Sophia University and Tsukuba University.

All members of his family went to USA during his 2nd stay in Washington D.C., and visited Boston to meet many old friends,Dr. ChoKyun Rha and Dr. A.J. Sinskey of MIT, Mr. and Mrs. Shi-Bal Ryu, Dr. Se-Kyung Oh, Dr. Chan-Hwa Kim and Dr. Sam-Pin Lee. On the way to Boston he visited Westreco in Milford, Connecticut, and met Dr. Soon-Young Kwon and Dr. Hesung Chun Koh, Director of East Rock Institute. Prof. and Mrs. Lee visited Beijing in August to participate to the Asian-Pacific Symposium on Health Food, and met many Chinese friends, Prof. Shen Zai-Chun and his family of Beijing Agricultural Engineering University, and Prof. Dang Yi of Beijing University of Traditional Chinese Medicine. They enjoyed sightseeing of Beijing and the Great Wall. In September Prof. Lee participated to the International Symposium on the Role of University in the Global Society of the 21st Century, held at Tsukuba University, Japan.

Professor Lee was active in the Korean Society of Food Science and Technology as the Gereral Secretary of the Excutive Committee this year. He published an essay book "Food Orchestra", and acted as a Tuesday morning science column speaker of KBS radio program from May to December. In the Fall Term he is devoting most of his time for the University Development Planning Committee and University Evaluation Research Committee of Korea University.

Mrs. Lee has been busy with lecturing at Duksung University and Sungeui College. She is also acting as special lecturer for Becton Dickinson Korea, Inc. Jung-Sil entered HongIk University in the Science of Art major. She went to Japan with her father and stayed at the homes of Ms. Shizuo Iyama, Mr. Akira Kojima and Mr. Kazuo Imai. She also stayed in Washinton D.C. for two weeks to see the museums of the Smithsonian Institution. Moon-Sil is now 2nd year of highshcool and busy with her class leader business. Han-Sil passed the entrance examination for SunHwa Art Highschool in piano major.

Report of Food and Biomaterials Science and Engineering Laboratory 1996

There was a great organizational change in Korea University this year, and our laboratory belongs to the Graduate School of Biotechnology, a special research oriented insitute which will be supported ca. US$ 10 million every year by both the Government and the School Foundation. The goal of this institute is to achieve academic excellency to compete with world's leading academic groups and to become the national center of advanced research and teaching in the field of biotechnology.

Presently we have 11 members in our laboratory, 4 Ph.D. course and 7 Ms. course under the guidance of Prof. Cherl-Ho Lee. Jin-Yeol Lee, Byeung-Il Lee, Hye-Joo Jeon, Sun-Hwa Chung and Im-Sook Lee joined our group for Ms. course. In the spring, 3 members completed their Ms. course, Ho-Young Kim (Physicochemical factors influencing the optimum amount of added water for cooking in the preparation of Korean cooked rice, Bab), Seong-Jin Choi (Effect of ohmic heating on the permeability of *saccharomyces cerevesiae* cell wall), and Sae-In Jang (Flavor components of a fermented meat by a starter Staphylococcus xylosus isolated from Korean fermented fish product). In the autumn, Sang-Hee Byun (Functional properties of erythritol as a substitute for sucrose), Ja-Yeun Lee (Protective effect of food extract on ethanol toxicity in rat liver), Heung-Suk Park (Graft, polymerization of vinyl sulfonic acid sodium salt onto chitosan and food application), Ho Shin (Rheological changes of redbean jam during storage) and Hak-Cherl Kim (Fermentation of fish-soysauce using anchovy and koji and characterization of its taste compounds) completed their Ms. degree studies.

Dr. Yong-Seo Shin, the graduate of Wonkwang University, joined our lab this september as post-doctorate researcher supported by the Ministry of Education Fellowship.

Research paper presentation

* Korea-Japan Symposium on Safety of MCPD & DCP in Soysauce, April 6, Sejong Cultural Center, Seoul, Korea - A GREAT PUBLIC HEARING AND DEBATE
  Cherl-Ho Lee (Mechanism of MCPD & DCP formation in HVP and its influence to human)
* First International Symposium on Functional and Physiological Activities of Korean Traditional Soybean Fermented Foods. May 30, Konkuk University, Seoul
  Cherl-Ho Lee (The safety and food functionality of soysauce products)
* UNIDO Expert Group Meeting The Contribution of Biotechnology to Industrial Development, June 3-5, UNIDO Headquarters, Vienna, Austria
  Cherl-Ho Lee (Present status of bioindustry and biotechnology R&D in Korea)
* First Swiss-Korean Symposium on Pharmaceutical Sciences and Food Research, July 29-30, Swiss Federal Institute of Technology (ETH), Zurich, Switzerland
  Cherl-Ho Lee (Isolation of Staphylococcus from Korean fermented fish products)
* Korea Food Extrusion Research Society Workshop, August 21-22, Korea University, Seoul
  Cherl-Ho Lee (Processing and quality characteristics of traditional Korean noodles)
* IUFoST 96 Regional Symposium on Non-nutritive Health Factors for Future Foods, Oct. 10-11, Seoul Education and Culture Center, Seoul
  Cherl-Ho Lee (Health concepts in traditional Korean diet)
  Eun-Joo Lee (A Survey on the consumer attitude toward health food in Korea-Consumer perception on health foods)
* Symp. on Sci. & Technol. of Soysauce Industry, Nov. 1, YoungNam Univ., Taeku, Korea
  Cherl-Ho Lee (The functionality and Safety of soysauce products)
* Foundation Symp. for Korean Soc. of Industrial Food Eng., Nov. 22, Seoul Nat. Univ., Seoul
  Cherl-Ho Lee (Application of extrusion technology to food industry and its future prospect)
* 1996 Annual Meeting of Korean Society of Rheology, Nov. 22, Seoul National Univ., Seoul
  Cherl-Ho Lee (Characteristics of food rheology and the research trends in Korea)
  Won-Suk Choi (Rheological properties of surimi gel under ohmic heating conditions)
* 56th Meeting of Korean Soc. of Food Sci. Technol., June 1, Chon-Buk Univ., Chon-Joo
  Ki-Myung Kim (Heat resistance of yeasts in Takju at different pHs and alcohol conc.)
  Sung-Won Yoon (Effects of ohmic heating on permeability of cell wall of S. cerevisiae)
  Won-Suk Choi (Rheological properties of crab flavored sticks with stress-relaxation test)
  Young-Shick Hong (Kinetic studies for partial enzymatic hydrolysis of various proteins)
  Sang-Hee Byun (Sweetness of Erythritol solutions added with different NaCl conc.)

Do-Youn Yee (Changes in chemical composition of Takju by heating)

Mee-Ryung Kim (Isolation and characterization of bitter peptide hydrolysate of soybean protein synthesized in E. coli.)

Eun-Joo Lee (A Survey on the consumer attitude toward health food in Korea-Consumer perception on health and food habit)

* 10th Annual Meeting of Korea Food Extrusion Research Society, Nov. 21, Korea University

Byung-Il Lee (Studies on the dehydration of soybean residue using Twin-screw extruder)

Center for Advanced Food Science and Technology (CAFST)

In june 20, CAFST had its 2nd Seminar on the Application of Genetic Engineering in Food Technology, Prof. Joeng-Sheop Shin (Korea Univ.), Prof. Chan-Shick Kim (Cheju Univ.) and Dr. George Tzotzos (UNIDO, Vienna) were the invited lecturers, Prof. Kwan-Hwa Park (Seoul Nat. Univ.), Dr. Bun-Sam Lim (Miwon Ltd.) and Prof. Tai-Wan Kwon (Inje Univ.) were the chairmen, and Prof. Kyung-Hee Baek (KU) and Prof. Sang-Yun Choi (KU) were the debaters. In the following panel discussion presided by Prof. Cherl-Ho Lee, Dr. George Tzotzos (UNIDO), Dr. Moon Hi Han (Korea Res. Inst. of Biosci. & Bioeng). Dr. Jong-Sei Park (Korea FDA), Dr. Yong-Ha Park (Korea Inst. Envir. Prot. Technol.), Dr. Bu-Young Lee (Inst. Agri. Sci. Technol.), Mr. Christopher Pestalozzi (Nestle Korea Ltd.) and Prof. Se-Yong Lee (KU) were participated. The contents were published on Food Science and Industry, Vol. 29, No. 3.

CAFST organized two invited lectures given by Dr. Jung-Hoon Han (Purdue Univ., U.S.A) on "Modeling on the material transmission of antibiotics in food packing material" in March 2, and by Dr. Yoon-Seok Song (FDA, U.S.A) on "Recent study on the packing safety at F.D.A in U.S.A" in April 13. The CAFST Workshop in Therapeutic Foods of Traditional Chinese Medicine was held in Sept. 16-Oct. 2.

CAFST has five member companies, sponsoring the center with annual membership fee, they are Crown Confectionary. Haema Food Co., Edong Takju Brewery, Ohyang Food Co., and Tae Kyung Nong San Co.

News from the graduates

Dr. Ouk Han left position at Korea Food Research Institute and became professor of the Department of Food Nutrition of Hoseo University, Asan. Dr. Jae-Gak Lim of Cheil Jedang Corp. returned home from his five years service at Tokyo Office. Dr. Jung-Hoon Han finished his Ph.D. study at Purdue University and started post-doctorate research at UCLA from May, Dr. Yoon-Seok Song finished his Ph.D study at Rutgers University and got position at U.S. FDA in Chicago. Miss Do-Youn Yee will be married in December 22.

Visitors

Prof. Dang Yi of Beijing University of Traditional Chinese Medicine stayed with us for one month as a visiting professor in Sept-Oct. She gave 20 hours lecture on Therapeutic Foods in Traditional Chinese Medicine to our graduate course as well as to a CAFST workshop.

Prof. Kab-Sang Lee of Wonkwang University is visiting professor of our lab for one year started from this september.

News from Prof. Lee and the family

On the way to Swiss meeting Prof. Lee and Mrs. Lee visited Denmark in August. It was Mr. Kristen Larsen's 60-year birthday in Gylling, and their visiting from Korea was a big surprise to everybody in the party. In Copenhagen they visited Mr. Moon-Wook Yoon and Prof. Jens Adler-Nissen. Prof. Lee and Mrs. Lee were both invited to Cheju University as special lecturers for its Citizen School in November.

Jung-Sil was selected as an exchange student of Hongik University and left for the study at the University of North Carolina. Charlotte, USA in August. She will stay there for one year to take her junior class courses in Science of Art. Moon-Sil entered Korea University, Department of Oriental History, and she is busy with extra-curriculum activity in University Orchestra as a member of violin player. Han-Sil is becoming 3rd year of highschool, and the only thing she can do is studying and playing piano for the university entrance examination in 1997.

Report of Food & Biomaterials Science and Engineering Laboratory 1997

At present, we work together with 19 members, 11 Ph.D. course (full time: 6, part time: 5) and 5 MS. course and 3 Postdoc under the guidance of Prof. Cherl-Ho Lee. Eun-Joo Lee, Taek-Dong Yi and Sung-Won Yoon joined our group for Ph.D. course and Seong-Jun Cho for MS. course in the spring semester. Sung-Won Yoon completed her MS thesis 'Studies on the leakage of intracellular materials of *Saccharomyces cerevisae* by Ohmic heating' in spring and Gui-Myung Kim finished his Ph.D. thesis(Thermal resistance of Takju yeast, *Saccharomyces cerevisiae*, under static tube and dynamic coil heating conditions) and Young-Shick Hong, his MS. thesis(Studies on the hydrolysis system of wheat gluten with the combination of acid and enzyme) in the Autumn.. Dr. Imm, Bue-Young finished her Ph.D with the dissertation title'Individual Differences in Perceived Intensities of Astringency and Bitterness 'at Cornell University, USA, and joined our lab as a post-doc researcher from October.

Research paper presentations

♠ *The Graduate School Seminar, Dept. of Food & Nutr., Wayne State Univ., Detroit, USA. Feb. 11*
C.H.Lee : Health Concepts in Traditional Korean Diet.

♠ *Nestec Seminar, Vevey, Swizerland, Aug. 8*
C.H. Lee : Soya as a Main Ingredient for Drinks,

♠ *Unilever Central Research Laboratory Seminar, Aug. 14*
C.H. Lee: Health Concepts in Traditional Korean Diet

♠ *58th Meeting of Korean Soc. of Food Sci. and Technol., 5/31, KAIST, Daejeon*
Jeon, Hye-Joo (Studies on the functional properties of Palatinose)
Lee, Do-youn (The formation of bitter and burnt flavor compounds by heating of Korean rice beer, *Takju*)
Kim, Mi-Ryung (Studies on the bitter taste formation by trypsin hydrolysis of 11s globulin)
Jung, Sun-Wha (Changes in the texture of frozen Tofu by addition of cryoprotectants)
Hong, Young-Shik (Combined acid/enzyme hydrolysis of high conc. wheat gluten system)

♠ 59th *Meeting of Korean Soc. of Food Sci. & Technol. 11/1, Duksung University, Seoul*
Imm, Bue-Young (Individual Differences in Perceived Intensities of Astringency and Bitterness)
Lee, Eun-Joo (Studies on the functional component and safty of Enzyme foods)
Lee, Jin-Youl (The combined acid/enzyme hydrolysis of the high conc. defatted soy flour suspension)
Lee, Taek-Dong (Applies of HACCP method for prevention of harmful insects in dried green onion)
Lee, Byung-Il (Effect of degree of gelatinization on the enzyme activity of rice Koji with *Asp.oryzae*)

Center for Advanced Food Science and Technology(CAFST)

CAFST organized its 3rd International Symposium on the 'Granular and Molecular Structure of Starch' on March 26th-27th at Technocomplex, Korea University. Dr. Yashinori Nakamura (National Institute of Agrobiological Resources, Japan), Prof. Susumu Hizukuri(Kagoshima Univ., Japan), Prof. Jay-Lin Jane(Iowa State Univ., USA), Dr. Steve Ring(Institute of Food Research, Colney Lane, UK), Dr. Buwalda(AVEBE, Netherlands), Prof. Paul Seib (Kansas State Univ., USA), Prof. Seung-Taik Lim(Korea Univ., Korea) and prof. Sung-Kon Kim(Dankook Univ., Korea)were the lecturers. Over 200 scientists were participated to this symposium.

Korea Society of Food Extrusion Research organized together with CAFST, '97 summer course on Extrusion Cooking Technology, July, at Inchon Memorial Building, Korea University. Dr. Jung-Hoon Han(University of California, Davis) visited us on Nov. 29th and presented a CAFST invited lecture.

News from the graduates(Hogonghoi News)

This year Hogonghoi seminar was held at Yesan by the invitation of prof. Ryu, Gui-Hyung of Gongju University. Over 50 alumni, who studied under prof. Cherl-Ho Lee, including Prof. Chan-Wha Kim, prof. Seung-Taik Lim and Dr. Hye-Sook Son Kim, prof. Chan-Shick Kim and prof. Gui-Young Lee and their disciples, stayed together at Suduk Temple in the night of July. Next year, we are planning to have it in Cheju Island, and prof. Chan-Sik Kim volunteered to be the host. Dr. Jung-Jun Han finished his Ph.D. at KAIST and started postdoc research in Japan, furthermore got married. Byung-Ill Lee started to work at Nongshim Co. Taik-Dong Lee and Kang-Kwon Lee moved to Everland Co. in YongIn.

News from Prof. Lee and the family

Prof. Lee was very much occupied this year by the consulting work for Korea FDA, Korea Health Food Association, Korea Academic Promotion Foundation, and National Atomic Energy Research Fund Committee. He visited USA twice. in February for Wayne State University lecture in Detroit and Nutraceutical conference in Palm Beach, Florida, and in June for IFT Annual Meeting in Orlando, Florida. On the return way from IFT Meeting, he visited U.C.Davis to meet prof. Bruhn, prof. O'Mahony, prof. Dewy Ryu amd Dr. Jung-Hun Han, and also visited Japan to meet Dr. Tokuji Watanabe, Dr. K. Saio in Tokyo, Dr. Akinori Noguchi in Tsukuba and Dr. Y. Mori in Kyoto University. Prof. Lee visited Nestle Research Center in Vevey, Swizerland and Unilever Central Laboratory in Netherland in August. He participated FAO/IAEA/WHO Joint Study Group Meeting on High Dose Food Irradiation in Geneva in September, and ICGFI Annual Meeting in Mexico in October.He also attended to the 5th Symposium on Chinese Dietary Culture in HongKong in November. He met there Chung-Yong Lee and Mrs. Collado at HongKong University.Prof. Lee was appointed to an Elder of Hanil Presbitarian Church in Seoul.

Prof. Ro was busy with the chairmanship in the Department of Nursing of Shin Heung College. They had the 1st Graduate's Medal Ceremony in November. Jung-sil returned from Univ. of North Carolina in Charlotte after 1 year of exchange student study in June. Moon-sil appeared twice in Korea University Symphony Orchestra performance as 2nd violinist in March and in September. She became vice-chairman of KU Orchestra. Han-sil took the national exam for university entrance and waiting for the practical exam on piano in coming January.

Report of Food and Biomaterials Science and Engineering Laboratory 1998

There was a great change in our lab this year. Our laboratory moved to the temporary building in the medical science complex from the Natural Science and Resource building in the middle of Jan. 1998. Prof. Lee has rejoined his duty at the beginning of August after finished his visiting professorships at Research Institute for Food Science, Kyoto University, Japan , started from the 1st of February.

Presently we have 15 members in our laboratory, 2 Postdocs and 5 Ph.D. course and 9 Ms. course under the guidance of Prof. Cherl-Ho Lee. Suk-Jong Lee and Young-Shik Hong joined our lab for Ph. D. course and So-Jung Han, Jae-Min Shin, Sun-Young Park, Yoon-Taek Lim, Se-Kyung Joo, You-Sin Lee and Hyun-Hwa An joined our group for Ms. course. In the spring, 3 members completed their Ms. course, Jin-Yeol Lee(Studies on the hydrolysis system of defatted soybean flour with acid and enzymes), Byoung-Il Lee(Studies on the enzyme activity of *Aspergillus oryzae* grown on the rice of different degrees of gelatinization), and So-Young Jang(Comparison of quality characteristics of traditional hot-bean pastes made by different methods) and Chang-Ho Lee completed his Ph. D. dissertation; The Separation of Gingko Flavonoglycosides by High-Speed Countercurrent Chromatography. In the autumn, Do-Youn Yee completed her Ph.D. dissertation; Characterization of the bitterness and burnt flavor compounds in heated *Takju*. and Hye-Joo Jeon (Studies on the functional properties of Palatinose as a substitute for sucrose) and Sun-Hwa Jung (Effects of Cryoprotectants on the Textural Changes of Soybean Curd(Dubu) during Frozen Storage) completed their Ms. degree studies.

Research paper presentation

* Visiting Professor Lectures, Kyoto Univ., Japan
Cherl-Ho Lee (Lactic acid fermentation in traditional Korean foods, 15 May)
(Health concepts in traditional Korean diet, 8 July)

* Seminar in Nestle Research Center, Lausanne, Switzerland, 21 August
Cherl-Ho Lee (Soya as a main ingredient for drinks)

* 5th JIRCAS Int. Symposium on Postharvest Technol., in Asia, Sept. 9-10, Tsukuba, Japan
Cherl-Ho Lee (Development and constraints of food industries in Korea)

* 15th Meeting of ICGFI, 20-22, Oct., IAEA, Vienna, Austria
C.H. Lee , M.W. Byun (Status report on food irradiation in the Rep. of Korea)

* 1998 IFT Annual Meeting, Atlanta, Georgia in USA, 20th-25th June
Mi-Ryung Kim (Isolation of bitter peptide hydrolysates of soy protein synthesized in *E. Coli*)
Do-Youn Lee (Formation of bitter compounds by heating of Korean rice beer, *Takju*)

* 60th Meeting of Korean Soc. of Food Sci. Technol., May 30 Bu-San Univ., Bu-San
Cherl-Ho Lee (Human brain wave measurement evoked by taste compounds).
Do-Youn Lee (Examination on the unpalatable aroma in the heated *Takju*.)
H.D. Lee, Y.S. Hong (Optimization of high protein beverages made by defatted soy flour)
Mi-Young Kim (Qualitative characteristics in Kochoojang made by different types of bacteria)
Bo-Sun Ahn, Yim-Suk Yee, Sung-Jun Cho (Studies on the shelf life of Korean rice cake)
Seong-Jun Cho (Purification of protease using aqueous two phase system)
Hye-Ryon Lee, Eun-Joo Lee (Relationships between cholesterol level and food habits)

*61st Annual Meeting of Kor. Soc. of Food Sci. Tech., Nov 7, Ewha Womens Univ., Seoul
Cherl-Ho Lee (The origin and characteristics of Korean fermented fods)
H.D. Lee (Threshold values of basic taste compounds including astringent & umami).
Man-Ho Lee (Comparison of safety in red pepper flour treated with gamma ray)
M.H. Lee, Y.T. Lim, H.D. Lee (Changes in color of red pepper powder treated with γ - ray)

* Korean Society for Industrial Food Engineering , May 30, Chungbuk Univ., ChungJu,
Won-Seok Choi (Changes in rheological properties of Surimi gel by heating methods)

Center for Advanced Food Science and Technology (CAFST)

Prof. Cherl-Ho Lee was appointed Director of CAFST in January 1998. In conjuntion with the FAO/IAEA/ICGFI Regional (RCA) Workshop on Harmonized Procedures and Regulations on Irradiated Foods held in April 27-29, Seoul, CAFST organized its 4th Seminar on the Acceptance and Trading on Irradiated Foods in April 30. The content of seminar was published in the title of "Acceptance and Trading on Irradiated Foods" by Korea University Press.

CAFST founded Korean Traditional Food Industrialization Research Association in September and Prof. Lee was elected Founding President. Its 1st Symposium " Industrialization of Traditional Food – What is the problem?" was held in 14th November, and attracted 150 participants.

News from the graduates

Dr. Byung-Seung Yoo left his position at Korea Standard Institute and became Professor of the Department of Food Engineering at Dong Kook University. Dr. Jung-Hoon Han got a professor positions of the University of Manitoba in Canada. Dr. Do-Youn Lee started post-doctorate research at KFDA from August and Dr Ki-Myung Kim joined to Prof. Hyun-Jin Park' lab. as a post doc from November. Ms Mi-Ryung Kim rejoined to the lab after finished her training at Dr. Kawamura's lab of National Food Research Institute (NFRI) in Japan for 6 months. Sung-Won Yoon visited NFRI, Japan for 2 weeks to learn about Microchannel Analyzer in Dr. Kikuchi's lab.

Ho-Kong Hoe News

Members of the graduate of our lab.(Ho-Kong Hoe)who have positions of professor got together with their disciples in Jeju Island and had a seminar at Jeju University. Next meeting will be held in Pusan next summer and Prof. Sung-Gu Kim will be the host.

News from Prof. Lee and the family

Professor Lee had a Half-year Sabbatical leave, serving as a visiting professor of the Research Institutie for Food Science of Kyoto University starting from 1st February 1998. During this period he gave two special lectures on Korean Dietary Culture and Lactic Acid Fermented Foods, and wrote a report on these subjects. All the family and Yong-Jin Jin, Jung-Sil's boyfriend, joined him in Kyoto and enjoyed sightseeing for 10 days in July. In June, Prof. Lee attended IFT Meeting in Atlanta, Georgia, with two of his students, Mi-Ryung Kim and Do-Yon Yee. He dropped in Washington D.C. to visit Dr. Terry Sharrer of Smithsonian Institution, and got to know Dr. Kary Mullis, the '93 Novel Prize Laurate in Chemistry. Both of them were invited to the 2nd International Symposium of the Graduate School of Biotechnology of Korea University in November, and had wonderful time together.

In August he and Mrs. Lee visited Prague of Czecho to see Korean Ambassodor Mr. Myung-Chul Ham, one of their old friends. They also spent one week in Vevey, Switzerland, to visit Nestle Research Center and the museum "Alimentarium" and enjoyed the beauty of Lake Leman. Prof. Lee visited Moscow, Russia to meet Prof. Vitalij Volkov of Karpov Institute of Physical Chemistry, Russian Academy of Science, and met Prof. Rimareva and other scientists in Russia. In October, he attended the 15th ICGFI Meeting in Vienna, and visited Prof. Jacques Raffi of Marseille Univsersity in France. Prof. Lee received a National Merit-Medal (Sokleujang) from President Dae-Jung Kim in April.

Jung-Sil graduated the Department of Science of Art, Hong-Ik University this year and is preparing for study abroad, Moon-Sil stayed in Kyoto with her daddy to learn Japanese, and Han-Sil entered Ehwa Women's University, College of Music in Piano major.

Report of Food and Biomaterials Science and Engineering Laboratory 1999

It has a special meaning to send you the 20th century's last annual report of our laboratory. There is an overflow of good news in our lab. Prof. Cherl-Ho Lee was nominated as a member of the Korea Academy of Science and Technology. He was appointed Secretary General of the IUFoST 11th World Congress of Food Science and Technology, which will be held in Seoul COEX ASEM Convention Center during April 22-27, 2001. CAFST was appointed as an official testing center for food quality standards of Korea Food and Drug Administration.

At the moment, we have 22 members in our laboratory, 2 post-docs and 10 Ph.D candidates and 10 MSc. course students under the guidance of Prof. Cherl-Ho Lee. Among them, Ki-Rim Kang rejoined master degree course after finishing his military service and other new members for the course include Min-Sun Kim, Jong-Hoon Shin, Ki-Jeong Seo, Jeong-Hang Heo and Choong-Heon Cho. Eun-Kyung Yoon of Korea FDA and Hyun-Ju Ahn of Korea Atomic Energy Research Institute also joined for Ph.D course. In spring, three members completed their Ph.D dissertations, Ji-Young Kim (Changes in the digestibility and molecular structure of high amylose corn starch by extrusion cooking), Mi-Ryung Kim (The isolation and structural characteristics of bitter peptides from soybean 11S glycinin) and Won-Seok Choi (Changes in rheological properties of surimi gel by ohmic heating). Four members completed their MSc. degree course, Im-Sook Lee (Studies on the shelf-life and texture of rice-cake treated with preservatives), Hyun-Hwa Woo (The product characteristics of Kochoojang based hot sauce and Tabasco sauce), Young-Joo Cho (Studies on the effective components and quality of commercial fermented plant extracts) and Hae-Ryun Lee (Studies on the relationships between food habit and plasma lipoprotein level of Korean adults). In autumn, Man-Ho Lee (Biological safety and quality characteristics of red pepper treated with gamma irradiation) completed his MSc. thesis. We are very honored to have Prof. Vitaly Volkov from the Institute of Crystallography, National Academy of Science of Russia, Moscow to join our center as a visiting professor for collaboration of NMR research.

Research paper presentation

- Asia Productivity Organization Workshop on Intl. Trade & Food Security, Jan. 27-Feb. 4, Tokyo, Japan
  C.H. Lee (Impact of trade liberalization on food security in Korea)
- CIFST International Conference on Orient Foods, Oct. 11-14, Beijing, China
  C.H. Lee (The evolution of Korean Dietary Culture)
- Intl. Conf. on Irradiation to Ensure Safety and Quality of Food, Antalya, Turkey, Oct. 19-22, 1999
  C.H. Lee & H.D. Lee (Changes of consumer attitude toward the irradiated food through education)
- 7th Inje Forum, April 9, Inje Univ., Pusan, Korea
  C.H. Lee (Strategies for industrialization of traditional foods)
- Annual Meeting of Korean Society of Dietary Culture June 12, Sungshin Univ., Seoul
  C.H. Lee (Primitive Potery Age of Northeast Asia and its importance in food history)
- 3rd Ann. Symposium of the Graduate School of Biotechnology, Korea Univ., Nov. 12, Seoul
  C.H. Lee (Food security of Korea in the age of trade liberalization)
- 1999 IFT Annual Meeting, July 24-28, Chicago, USA
  W.S. Choi (Changes in rheological behavior & textural properties of surimi gel by heating)
  J.Y. Kim (Changes in digestibility and mol. structure of high amylose corn starch by extrusion cooking)
  S.Y. Yoon (Effect of ohmic heating on the structure and permeability of cell membrane S. cerevisiae)
- 10th IuFoST World Congrecs of Food Sci. & Technol., Sydney, Australia, Oct. 1-8.
  S. J. Cho (Purifying method of protease by aqueous two phase system)
- 62nd Annual Meeting of Korean Soc. of Food Sci. and Technol., June 4-5, Korea Univ., Seoul
  H. D. Lee (Studies on consumer attitudes toward irradiated Foods)
  H. D. Lee & Y. S. Hong (Studies on optimization of high protein beverages using defatted soy flour)
  B. S. Ahn (Analysis of hydrocarbons in irradiated Chunkukjang)
- 63rd Annual Meeting of Korean Soc. of Food Sci. and Technol., Oct. 30, Kyung Hee University Suwon
  Y.S. Lee (Studies on rapid fermentation of traditional soybean paste (Doenjang) using Chunkukjang)
  J.M. Shin (The properties of alcholic beverages fermented at low temperature with Nuruk)
  Y.J. Cho (Studies on the qualuty evaluation of commercial plant extracts)
  S.Y. Park (Studies on the SOD like activity of the young green barley)
  B.S. Ahn (Changes in volatile compounds of irradiated Chunkukjang)
  C.Y.J. Lee(Competence of vit. E on cell-mediated immunity & oxidative stress of healthy individuals)

Center for Advanced Food Science and Technology(CAFST)

CAFST was appointed as an Official Testing Center for Food Quality Control from Korea Food and Drug Administration (KFDA) and is executing food related testing service for small and medium size food industries. Korean Traditional Food Industrialization Research Association founded by CAFST held a Technical Workshop in winter (Feb.22-23) and in summer (Aug. 23-24). CAFST managed the KoSFoST/ILSI-Korea Joint International Symposium on Safety Assessment of Genetically Modified Foods at Korea University in October 29.

News form the Graduates

Dr. Hyun-Duck Lee became a research professor of Korea Univ. and is in charge of Testing Center for Food Quality Standards. Dr. Ki-Myung Kim went to Nebraska University in USA for his post-doc research and Dr. Won-Suk Choi left for the University of Manitoba in Canada to accomplish his post doc research. Dr. Do-Youn Lee re-posted her post-doc position to Korea University from KFDA and Dr. Mi-Ryung Kim started her post-doc research at Prof. Sung-Ku Kim' s lab.of Bukyung University. Dr. Boo-Yong Lee of KFRI is proceeding his post-doc research at the University of Georgia, USA. Dr. Chung-Yung Lee joined our center as a post-doc since March and got married to MD of Cha Hospital in May. Sung Won Yoon got married with Sang-Yong Choi who is a graduate of our Department. Mr. Sung-Jun Cho went to Research Institute of Nestle Research Center at Lausanne in Switzerland to continue his research project with Nestle. Mr. Kang-Kwon Lee of Samsung Everland got married in autumn.

In August, members of the graduates from our lab and their students got together in Pusan. Dr. Sung-Gu Kim, Professor of Bukyung University was the host of this year meeting. Next year meeting will be held at Kye-Myung University in Taegu, hosted by Dr. Sam Pin Lee.

News form Prof. Lee and his family

Prof. Lee had a very busy life this year as the Secretary General of Korean Society of Food Science and Technology, and also as the Secretary General of the IUFoST 11th World Congress of Food Science and Technology of the year 2001 in Seoul. Last July he traveled to USA with Mrs. Lee, to attend the IFT Meeting in Chicago. They met Mr. Chong-Dae Lee' s family there who is an old friend from Prof. Lee' s student period in Denmark. They further traveled to Washington D.C. to visit first daughter, Jungsil, who is studying at Maryland Univerity, Graduate Course of Art History and Archeology. They met Dr. Terry Sharrer of Smithsonian Institution and had a wonderful time together.

Prof. Lee visited Australia to attend the Executive Committee Meeting of IUFoST in Melbourne and the 10th World Congress of Food Science and Technology in Sydney, Oct. 1st-8th. He met many old friends there, among them, Dr. Karki of Nepal, Dr. Nishnary of Osaka City Univ., Dr. Isobe of NFRI, Mr. Loaharanu of IAEA, Dr. Maneepun of Thailand, Dr. Wienarno of Indonesia and Dr. Lustre of Philiphine, and many new friends from IFT, USA. Right after Sydney, Prof. Lee attended ICOF '99 in Beijing with Prof. Tai-Wan Kwon, Chairman of Organizing Committee of 2001 Congress X1 in Seoul. They met also many old friends, among them, Dr. YinZong Lun of CIFST, Dr. Xue- gui Kaon of MOH, in P.R. China, Dr. Kyoko Saio, Dr. Akinori Noguchi, and Dr. Parpia of India, and acquainted with many Chinese food scientists and food industrialists. Prof. Rong Hwi Chen of Keelung Marine Univ. of Taiwan visited Korea in September to give lecture at the Chitosan Symposium in Mokpo Univ. He stayed with Prof. Lee one night and traveled together to Mokpo.

Mrs. Lee started her Ph. D. study in Nursing at Hanyang University this year. She traveled to USA to present a research paper to the 15th Annual Q Conference at Univ. of Missouri, Columbia. Moon-Sil is preparing for Japanese Language examination this winter, and Han-Sil is preparing for the language school training of Maryland University next January.

Report of Food and Biomaterials Science and Engineering Laboratory 2000

Presently, we have 24 members, 2 post-docs, 10 Ph.D candidates and 12 Msc. course students in our laboratory under the guidance of Prof. Cherl-Ho Lee. Six new members entered our lab this year; five in master course, Byung-Gog Choi, Jo-Hanna Hur, Byung-Hee Yoo, Sung-Han Kim and Myung-Hwa Yum. and Hee-Ra Park in doctoral course. In spring, four members completed their Msc. course. Sun-Young Park(Studies on the SOD-like activity of young green barley leaves, *Hordenum vulgare* L.), Jae-Min Shin(Comparative studies on the fermentation conditions of Samhaeju), You-Sin Lee(Studies on the rapid fermentation of traditional Doenjang using Chongkukjang), Hyun-Hwa Ahn(Changes in quality characteristic of Chongkukjang by high dose irradiation). Two members finished their Ph.D dissertation; Bo-Sun Ahn(Studies on the volatile compounds in Chongkukjang irraidated with high-dose gamma irradiation) Kwang-Kwon Lee(Studies on the changes in flavor components during salt aging of Doenjang(fermemted soybean paste) made by different starters). Prof. Vladimir Skirda of Kazan State Univ. of Russia joined us this March as visiting professor for 6months, and constructed Pulsed-Field Gradient NMR together with Prof. Vitaly Volkov, who stayed with us for one year as visiting professor from the Shbnikov Institute of Crystallography, Russia.

Research paper presentation

- Nestle Research Center Seminar, Feb. 10, Lausanne, Switzerland.
  Lee, C.H.(Develop. of functional peptide drinks by using soybean protein hydrolysates)
- Int. Conf. on Appl. of Magnetic Resonance in Food Sci, Sept. 18-20, Aveiro, Portugal.
  Lee, C.H.(Detection of free radicals in irradiated soybean paste by ESR spectroscopy)
  Lee, E.J.(Free radicals in irrad. soybean paste components & model systems on ESR)
- Symposium on Health Foods, KoSFoST, Aug. 18. Kwachong Bldg. Seoul.
  Lee, C.H.(Present status and regulations on health food in China and Taiwan)
- 2000 IFT Annual Meeting, June 11-14, Dallas, Texas, USA.
  Kim, M.S.(Influence of capsaicin on blood flow and oxidation stress)
  Yoon, S.W.(Determination of blood flow using micro-channel flow analyzer)
- Int.Meet. on Rec. Adv. in MR Applications to Porous Media,Oct. 9-11, Bologna, Italy.
  Hong, Y.S.(Charge properties of PETF track etched membrane pore surface on Cu^{2+}ESR)
  Cho, J.H.(Cu^{2+} ESR investigation in acrylonitile sulfocation exchange membranes)
  (Self-diffusion of water & membrane structure in new type cation-exchange PA membr)
- 3rd Int. Soybean Processing and Utilization Conference, Oct. 15-20, Tsukuba, Japan.
  Jin, H.M.(Changes in the constitution and contents of isoflavones in fermented soybean)
- 64th Ann. Meet. of Korean Soc. of Food Sci. and Technol., May 27, Taeku Univ.
  Volkov, V.I.(Some magnetic resonance applications to foodstuffs and model systems)
  Choi, H.D.(Mol. structure and rheological properties of barley β-glucan and its effects)
  Hong, Y.S.(The track etched membrane investigation by ESR technique)
  Cho, J.H.(The sulfocation exchange membrane investigation by ESR technique)
  Lee. E.J.(Detection of free radicals in irradiated soybean paste & model system by ESR)
  Kim, M.S.(The effects of capsaicin on antioxidant activity & lipid metabolism)
- 65th Ann. Meeting of Korean Soc. of Food Sci. & Technol., Nov. 3-4, Konkuk Univ.

Choi, H.D.(The effects of barley β-glucan on gelatinization of starch)
Lee, S.J.(Effect of fermentation temp. & period on flavor changes in rice-wine brewing)
Lee, E.J.(Free radicals in irradiated soybean paste components & model system by ESR)
Kang, K.R.(Rheological properties of Cholrella powder cultured in fermenter & pond)

Center for Advanced Food Science an Technology(CAFST)

CAFST was selected to excellent research institute of Korea Univ. and got 10 million Won prize. As a Korea FDA approved analytical center, CAFST is continuing its testing service for food industries under the leadership of Dr. Hyun-Duk Lee.

News from the Graduates

This year Ho-Kong Hoe(our lab alumni meeting) annual meeting was held at Korea University in commemoration of moving our laboratory to the new building Graduate School of Biotechnology. In the meeting, we offered Dr. Han Ouk's mourning, who passed away suddenly last February. Dr. Boo-Yong Lee came back to KERI in July after his post-doc research at the University of Georgia, USA. Dr. Jae-Gak Lim promoted to Director of Cheil Jedang's Foods R & D Center in November. Four graduates of this year got a job; Sun-Young Park, researcher at IlSung Pharmaceuticals Central Research Lab, You-Sin Lee, researcher at Quality Control Lab of Hyundai Department Store, Hyun-Hwa Ahn, dietitian at Chung-Won Elementary School, Ki-Rim Kang, food ingredients specialist of Nestle Korea. Dr. Chung-Yung Lee gave birth to a tiny pretty girl on Nov. 15. Hur Jung-Hang got married on Nov. 18.

News from Prof. Lee and his family

Prof. Lee devoted most of his time for the Organizing Committee of the 11th IUFoST World Congress of Food Science Technology, to be held in April 22-27, 2001 in Seoul. He went to Tokyo in February for one day visit to meet representatives of Japanese food related societies, Prof. Shoich Arai and Prof. Kyoden Yasumoto. He went to Chile, Santiago in May for the IUFoST Governing Council Meeting, and participated IFT Annual Meeting in Dallas in June. He visited Aveiro, Portugal, in September for the 5th International Conference on Application of Magnetic Resonance in Food Science, and went to Tsukuba, Japan, in Octorber for the Third International Soybean Processing and Utilization, chaired a session of modern processing and utilization for food, and met most of his friends in Japan.

Prof. and Mrs. Lee went to Denmark in February on the way to Nestle Research Center in Switzerland, and got a surprise party celebrating their Silver Wedding at Skovgaard, Gylling. Moon-Sil joined to the party from her visit to Paris. Han-Sil stayed with Jung-Sil in Washington D.C. for her language course study and piano lesson at Maryland University from January to August. Jung-Sil completed her 3rd semester study at the Graduate School of Art History and Archeology, Maryland University, and is planing to visit home for a month in the New Year Season. Prof. Lee moved to Kalmaedong House in July. His new phone number at home is +82-2-973-9332.

IUFoST Congress XI
Season's Greetings 2002!
The old Korean Paradox
was scientifically verified.
溯丁(소정) 李哲鎬 教授 出版紀念會
『식품위생사건백서 II』
2005년 9월 24일
고려대학교 인촌기념관
Magnetic Resonance (MR) microimaging and pulsed field gradient (PFG) NMR shows the water distribution and water diffusion in the starch crystals in germinating brown rice
Merry Christmas and Happy New Year 2006 !
The 15th Session of FAO/WHO Coordinating Committee for Asia
Merry Christmas and Happy New Year 2007 !
Left figure represents metabolic changes in traditional Korean soy sauce during aging of 12 years and right figure summarizes the metabolic pathway with individual changes of metabolites in the soy sauce (published from our lab., J. Agric. Food Chem. 2009, 57, 6862-6870)
Merry Christmas and Happy New Year 2010 !


2008 Hoganghoi Annual Meeting
Season's Greetings 2002!
IUFoST Congress XI
The old Korean Paradox
was scientifically verified.
Head group of surfactant
Magnetic Resonance (MR) microimaging and pulsed field gradient (PFG) NMR shows the water distribution and water diffusion in the starch crystals in germinating brown rice
Merry Christmas and Happy New Year 2006 !
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Left figure represents metabolic changes in traditional Korean soy sauce during aging of 12 years and right figure summarizes the metabolic pathway with individual changes of metabolites in the soy sauce (published from our lab., J. Agric. Food Chem. 2009, 57, 6862-6870)
Merry Christmas and Happy New Year 2010 !

Report of Food and Biomaterials Science and Engineering Laboratory 2001

This year we have 9 Ph.D. and 9 MSc.students, and 1 Post-Doc. under the supervision of Prof. Cherl-Ho Lee. Among them, 5 students Hong-Uk Park, Hee-Joo Choi, Young-Won Park, Yoo Kim and Jin-Ho Song joined us this year for the MSc. course. This spring, 3 students, Kirim Kang (Physical properties of Chlorella powder cultured in fermenter and pond), Minsun Kim (Effect of capsaicin on antioxidative activity and blood cholesterol in rat) and Hyun-Min Jin (The changes in the contents of isoflavones and total phenolic compounds during soybean fermentation with different microorganisms), and also, in summer 5 students, So-Jung Han (Producing enzymatic hydrolysates of soybean protein and effects of feeding these hydrolysates on animal serum cholesterol), Jong-Hoon Shin (Microencapsulation of fish oil using freeze drying technique), Jung-Haeng Hur (Studies on the Angiostein I-Converting Enzyme inhibitory activities of soybean protein hydrolysates produced by protease from *Bacillus amyloliquihefaciens* separated from *meju*), Ki-Jeong Surh (Measurement of self-diffusion coefficient of water in yeast cell by using pulsed field gradient NMR), and Joong-Hun Cho (Investigation of water diffusion in *Chlorella sp*. by pulsed high field gradient NMR) completed their MSc. dissertation. Eun-Joo Lee (Electron spin resonance studies on free radicals in γ-irradiated soybean paste and model system) received her Ph.D. under the assistance of Prof. Vitaly Volkov in summer.

Research Paper Presentation

♣ *NATO ARW Magnetic Resonance in Colloid and Interface Science, St. Petersburg, Russia, June 26-30, 2001*

Lee, C.H. (Self-diffusion of water and membrane structure in cation-exchange polyamide-acid membrane on the Pulsed Field NMR and ESR data)

♣ *Nestle Central Research Laboratory Seminar, July 2, 2001, Lausanne, Switzerland*

Lee, C.H. (ACE inhibitory activity and blood cholesterol level reducing activity of soybean protein hydrolysate by the crude enzyme preparation of *Bacillus amyloliquifaciens* isolated from meju)

♣ *International Symposium on Lycium and Antiaging Agents, Aug 6-9, 2001, Ningxia, China*

Lee, C.H. (Paradigm shift, harmonization of eastern and western food systems)

♣ *11th World Congress of Food Science and Technology, April 22-27, Seoul, Korea*

Lee, C.H. (The importance of primitive pottery age of N.E. Asia in the history of food fementation)

Volkov, V.I. (Application of magnetic resonance in food value and process assessment)

Cho, S.J. (Purification and characterization, and structure of main protease *Bacillus* strain 68 isolated from *meju*)

Kang, K. (Rheological properties of chlorella powder cultured in fermenter and pond)

Lee, E.J. (Free radicals in gamma-irradiated soybean paste component and systems on ESR data-Thermal evolution, the radical nature)

Lee, G.G. (The characterization of Korean soybean paste, Doenjang, made by different starter cultures)

Ahn, H.J. (Breakdown of carcinogenic N-nitrosamines by gamma irradiation)

Hur, J. (The use of twin screw extruder as bioreactor for the enzymatic hydrolysis of rice starch)

Rhee, S.J. (Microbial characterization and flavor formation during rice wine *Samhaeju* brewing)

Rhee, S.J. (Effect of fermentation temperature on the biochemical changes of rice wine)

Chung, N.H. (Inhibitory effect of fermented soy extract on MCF-7 cells)

Lee, H.D. (Changes in Korean consumers attitude toward food irradiation through education)

Yoon, S.W. (Ingestion of ethanol extracts of fermented soybean products to male rats and its effect on the productive hormone receptors)

♣ *66th Ann. Meeting of Korean Soc. of Food Sci. & Technol., Oct. 19-21, Cheju University*

Hur, J.H. (ACE inhibitory activities of soybean protein hydrolysates produced by protease from *B. amyloliquihefaciens* from *meju*)

♣ *Ann. Meeting of the Korean Society of Food Science & Nutrition, Dec. 8-9, Korea Univ.*

Choi, H.J. (Investigation of gamma-irradiated beef and red pepper powder using ESR)

Choi, B.G. (Analysis of indicator microorganism during the processing of soybean curds (Dubus) and establishment of HACCP scheme)

Hur, J. (The use of twin screw extruder as bioreactor for the enzymatic hydrolysis of rice starch)

Center for Advanced Food Science and Technology

This June we were sad to bid our farewell to Dr. Hyun-Duck Lee who have decided to leave us for the USA. Her contribution and services to the CAFST including the set up for the testing center of Korea FDA was much valuable. Her successor for the management of CAFST is Dr. Chung-Yung Lee. We are also sad to announce that Prof. Lee has retired as the director of CAFST and his newly appointed successor is Prof. Seung Taik Lim from December 2001.

News from the Graduates

Year 2001 has been a special year for Prof. Lee. His former students held a congratulatory dinner in May for the launching of his book entitled, Fermentation Technology in Korea. After receiving her Ph.D., Dr. Eun-Joo Lee is now in Iowa State University doing her Post-Doc. research. Young-Shick Hong has joined the military service in June. Seong-Jun Cho returned to our laboratory to complete his Ph.D. after 2 years of joint research at Nestle, Lausanne, Switzerland. He will be getting married to Jin-Yeol Lee, also a graduate of our lab in December 22. Dr. Won-Suk Choi returned from Manitoba and joined Korea University for a Post-Doc. position. It was baby boom for two of the graduates, Sung-Won Yoon and Dr. Do-Youn Lee who both gave birth to lovely girls.

News from Prof. Lee and His Family

Prof. Lee had the most busy but a rewarding year as the Secretary General of the Organizing Committee of the 11th World Congress of Food Science and Technology, which was successfully held in April 22-27, Seoul. Many of his old friends from all over the world came to the conference. Prof. and Mrs. Lee visited Russia and Switzerland in June and met Prof. and Mrs. Volkov in Russia. Prof. Lee visited China in August for Lycium conference in Ningxia and met Prof. Dang Yi. He traveled to Denmark, Sweden and Norway in November for a study tour leader for Food Industry CEO Academy of Korea University and Prof. Jens Adler-Nissen of DTH, Lyngby, kindly assisted him for the benchmark tour. He could also meet his Danish family in Gylling, Denmark. Mrs. Lee (Prof. Ro) completed her doctoral dissertation, Healing experience of liver cancer patients by complementary and alternative diet therapy, at Han Yang University. Jungsil completed her Master degree thesis, Sasaku Hanga, Japanese modern creative prints, at Maryland University, USA. Moonsil graduated from Korea University, majoring in East Asian History, and left for the USA to prepare for her graduate study. Hansil finished her graduation piano recital in November. Apart from being busily involved in the academic society during the year, Prof. Lee and his family has been continuing their services at the choir of the Hanil Presbyterian Church.

Food and Biomaterials Science and Engineering Laboratory News, 2002

The bustling atmosphere of our lab has continued into 2002. Although it was the sabbatical year for Prof. Lee, his popularity for mentorship continues among students. This year Yoo-Mi Park, Kyoung-Il Kang and Bum-Joon Kim have joined our lab for their Msc. and Ji-Eun Park for Ph.D. We now have 9 Msc., 5 Ph.D. students and 1 Research Assistant Professor in the lab. Byoung-Hee Yoo (Studies on the antioxidant activity of soybean protein hydrolysates produced by protease from *Bacillus amyloliquefaciens* separated from *Meju*), Byoung-Gook Choi (Analysis of indication microorganisms during the processing of soybean curd (dubu) and establishment of HACCP scheme) and Johannan Hur (Use of twin-screw extruder as a bioreactor for enzymatic hydrolysis of rice flour) have completed their Msc. degree in Spring and Sung-Han Kim (Studies on the ACE inhibitory acitivities of soy protein hydrolysates prepared by neutral and alkaline proteases from *Bacillus amyloliquefaciens* FSE-68) in summer.

Research Paper Presentation

* *Ann. Meeting of the Institute of Food Technologists, Jun. , Anaheim, USA*
  Ahn, B.S. (Changes in volatile compounds and sensory quality of fermented soybean paste, Chungkukjang, by high dose irradiation)
* *6th International Conference on Applications of Magnetic Resonance in Food Science, Paris, France, September 4-6*
  Lee, C.H. (Determination of water self-diffusion in microorganisms by PFG-NMR)
  Lee, C.Y. J. (Investigation of cell membrane permeability of erythrocytes of smokers and non-smokers using PFG-NMR)
* *69th Ann. Meeting of Korean Soc. of Food Sci. & Technol., Oct. 25-26, Muju, Korea*
  Lee, C.H. (The application of PFG-NMR in food and biotechnology)
  Rhee, S.J. (Sensory and quality evaluation of Chongju)
* *Korean Society for Industrial Food Engineering, Nov. 16, Sangnok Resort, Korea*
  Park, H.W.(Evaluation of fatty acid in commercial vegetable oil using GC&^{13}C-NMR)
  Cho, S.J. (Purification of neutral proteases from *Bacillus amyloliquefaciens* FSE-68 by using pilot scale Ultrafiltration Technique)

News from the Graduates

This year we held a summer camp at Gwangreung in commemoration of the foundation of Gwangreung Institute of Health and Bioscience (GIHB) by Prof. Lee and Mrs. Lee (Prof. Ro). It was a great opportunity to meet many of our senior graduates and to exchange current activities going on in their institution. Also it was a pleasure for us to have Prof. Vitaly Volkov to re-visit Korea University this winter and Prof. Kyoung-Hee Koh to our lab during her one year sabbatical. Dr. Won-Suk Choi has left Korea University for professorship at Chungju University and Dr. Mi-Ryoung Kim returned from NFRI, Japan for Post-Doc. at Korea University. Wedding bells were ringing for Sae-Kyoung Joo who got married in November and also for Tae-Hoon Kim. Jin-Ho Cho became a father early this year.

Book Publication

Prof. Lee and Prof. Ro co-authored a book on 'Experiences of patients in remedying cancer by diet.' It was based on the Doctoral dissertation of Prof. Ro, who interviewed 5 male patients who recovered from liver cancer over 5 years of diet therapy.

Gwangreung Institute of Health and Bioscience (GIHB)

Prof. Lee's laboratory in Kalmaedong has moved to Gwangreung, near the National Arboretum, in July. Please visit homepage www.gihb.co.kr for more information and communication.

News from Prof. Lee and His Family

For the first half of the year, Prof. Lee was busily involved in setting up his new house and laboratory at Gwangreung near the National Gwangreung Arboretum. Enclosed by a beautiful view of the natural environment, his house is surrounded by a mini-farm.

As usual, Prof. Lee visited Nestle Research Center in Lausanne, Switzerland early September and met up with Dr. Alexandre Juillerat. The Lee family has continued their choir duties at Hanil Church. Jung-Sil finished her Master of Art degree study in Art History at Maryland University and has begun her Ph.D. study at University of California, Los Angeles (UCLA). She was lucky to be awarded Chancellor's Scholarship for four years. On the way to Maryland University for Jung-Sil's graduation ceremony in June, Prof. Lee and Mrs. Lee visited MIT and met Prof. Chokyun Rha and Dr. Se Kyung Oh, and many other old friends in Boston. Also, Moon-Sil entered Master course in History of East Asia at Pittsburg University, USA and Han-Sil graduated from Ewha Women's University in Piano major. She joined Namgung Yon's studio as music mixer and is busy coordinating large-scale music concerts in Korea.

Food and Biomaterials Science and Engineering Laboratory News, 2003

This year Jin-Young Jung, Mi-Sun Hwang and Se-Moon Park joined our lab for their MSc. We now have 8 MSc., and 3 Ph.D. students. Dr. Chung-Young Lee moved this summer to the Faculty of Medicine, Department of Biochemistry, National University of Singapore. Seong-Jun Cho (Cholesterol-lowering peptide from soybean protein hydrolystaes prepared with proteases from *Bacillus amyloliquefaciens* FSE-68) completed his Ph.D. and Hong-Wook Park (Analysis of fatty acids and triacylglycerol composition of vegetable oil by gas chromatography and ^{13}C NMR spectroscopy), Young-Won Park (Comparative studies on HPLC and spectrophotometric analysis of the Zeaxanthin content in *Lycii fructus*) and Hee-Ju Choi (ESR studies on gamma-irradiated beef and red pepper powder) finished their MS thesis in Spring. In this Summer Yoo Kim (Studies on the pilot scale production of neutral proteases by *Bacillus amyloliquefaciens* FSE-68) and Jin-Ho Song (Studies of water diffusion in soybean oil emulsion by using pulsed field gradient NMR spectroscopy) have also completed their MS degree. Prof. Vitaly Volkov of the Korpov Institute of physical chemistry in Moscow visited us again from July for 3 months.

Research Paper Presentation

▶ *Ann. Meeting of Korean Soc. for Microbiol. Biotech., June 24-26, Muju, Korea*

Kim, Y. (Studies on the pilot scale production of neutral proteases by *Bacillus amyloliquefaciens* FSE-68)

Cho, S.J. (Cholesterol lowering mechanism of soy protein hydrolysates prepared with *Meju* proteases)

▶ *70th Ann. Meeting of Korean Soc. of Food Sci. & Technol., June 26-28, Kyung-ju*

Cho, S.J.(Identification of novel hypocholesterolemic peptides derived from soybean protein hydrolysate)

Song, J.H. (Studies of water diffusion in soybean oil emulsion by using PFG NMR spectroscopy)

▶ *12th IUFoST World Congress of Food Sci. Technol., July 16-20, Chicago, USA*

Lee, C.H. (Role of biotechnology in modern food production)

Lee, C.Y. (Modification of blood rheology and erythrocyte water permeability in hypercholesterolmic male)

Park, H.W. (Analysis of fatty acids and triacylglycerol composition of vegetable oil by GC and ^{13}C NMR)

Rhee, S.S. (Antioxidant peptides from Korean rice-wine)

▶ *FOOMA JAPAN 2003, June. 10-13, Tokyo, Japan*

Kim, B.J. (Effect of drying condition on the quality and functional property of *lycii Fructus*)

▶ *8th ASEAN Food Conference, Oct. 8-11, Hanoi, Vietnam*

Lee, C.H. (Functional food of interest to ASEAN; from traditional experience to modern produc./trading)

▶ *Intl. Symposium on Fermented Food, IFFE, Oct. 25, Jeonju, Korea*

Lee, C.H. (History of fermented food and its function in modern society)

Rhee, S.S. (Antioxidant peptides from Korean rice wine, *Samhaeju*)

Yoon, S.W. (Effects of fermented soybean on oxidative damage of cultured *Sertoli cell* induced phthalate)

Kim, K.C. (Water and nonionic surfactant self-diffusion in Tween-80 aqueous solution studied by PFG NMR)

Park, Y.M. (Alcohol fermentation method using fresh and dry *Lycium Chinesis*)

Kwak, J.E. (Alcohol dehydrogenase activity and sensory evaluation in gruel of *Hovenia delcis Thunber* Stem

Jo, Y.S. (Hepato protective effect of compound isolated frcm *Lycium chinense* Mill)

Book publication

Prof. Lee published two books this year, both in Korean. 'Modern Biotechnology and Bioindustry' co-authored by Chun Mun-Jin, Kwon Suk-Tae, Lee Cherl-Ho and Lim Bun-Sam was published by Academy Book Co., Seoul. 'Introduction to Korean Food' was written by Prof. Cherl-Ho Lee and Prof. Tai-Wan Kwon of Inje University and published by Korea University Press, Seoul. Colleagues and friends of Prof. Kwon and Lee gathered together to celebrate the book publication at Inchon Memorial Building of Korea University in September 26.

News from the Graduates

The 2nd Hogonghoi summer camp was held on July 17, at Gwangreung Institute of Health and Bioscience (GIHB) with two lectures from Dr. Lim Bun-Sam(History of Science) and Dr. Lee Boo-Yong(Chungkuk-jang) and introduction of ongoing researches in our lab. Dr. Lee Do-Yeon was appointed to Research Professor of our Institute.

News from Prof. Lee and His Family

As the president of Korean Society for Food Engineering, Prof. Lee devoted much of his time and effort to organizing Korean Association of Food Machinery Industries. KAFMA launched on April 23 at the occasion of KSFE Symposium on Present Status and Future Prospect of Food Machinery Industry in Korea held in COEX, Seoul. He was invited to Academic Plaza of Fooma Japan 2003 held in Tokyo Big Site, Japan in June 10-13.

Prof. Lee was invited to the 12th IUFoST World Congress of Food Science and Technology, held in July 16-20, Chicago, USA, to present a paper on 'The role of biotechnology in modern food production'. He was elected to the Fellow of International Academy of Food Science and Technology (IAFoST) in Chicago. IUFoST also invited him to give a plenary lecture on Functional Food to the 8th ASEAN Food Conference held in October 8-11, Hanoi, Vietnam. Prof. Lee together with the members of Food Industry CEO Academy of Korea University visited the Oceanic University of China in Quingdao and Beijing Agricultural University in China in November 6-10. Mrs. Lee, Prof. Seung-Ok Ro, was appointed to the Chairwoman of the Department of Nursing, ShinHeung College, and acts as vice-president of the Korean Society of Complementary and Alternative Nursing. Jung-Sil married with Yong-Jin Chin in June 28, and lives in Los Angeles, USA. She is continuing her Ph.D. study in Art History at UCLA. Prof. Lee and Mrs. Lee visited her in USA this summer. Moon-Sil is studying food history of Han dynasty (BC 200-AD220) of China for her MS degree thesis at Pittsburg University, USA. Han-Sil is preparing the entrance examination for the graduate study in Music Engineering. She is busy with giving piano lessons, and accompaniments of Hanil Church Choir and Joyful Singers Choir of ShinHeung College.

Food and Biomaterials Science and Engineering Laboratory News, 2004

This year Eun-Su Lee, Yoo Park (Captain of Korean Army) and Ok-Ham Park have joined our lab for their MSc. We now have 7 MSc., and 3 Ph.D. students. Dr. Sook-Jong Lee has moved to the Food Packaging Laboratory, College of Biotechnology, Korea University and is working as a Post Doc. Bum-Joon Kim (Effects of drying and extraction conditions on the chemical composition of water extract in *Lycium chinense Miller*), Yoo-Mi Park (Comparative studies on the alcohol fermentation method using fresh and dry *Lycium chinense Miller*), Yeon-Sook Cho (Studies on hepatoprotective effects of the compounds isolated from the Fruits of *Lycium chinensis*) and Ki-Chan Kim (Studies on the blood rheology and water permeability of erythrocyte membrane in hypercholesterolemic male) have finished their MS thesis in this Spring. In the Summer Kyung-Il Kang (Hepatoprotective effects of *Lycium chinense* fruit on CCl_4-induced liver damage in rats) has also completed his Ms. degree. Prof. Vitaly Volkov of the Korpov Institute of Physical Chemistry in Moscow visited us again from July for 3 months. Dr. Yaara F. Haruvy of the Soreq NRC in Israel visited us and gave lecture on "Selection of material ensembles for reliable packaging of radiation-processed food."

Research Paper Presentation

▶ *Intl. Conference on Engineering and Food, March 7-11, Montpellier, France*

Lee, C. H. (Effect of heat treatment on water permeability of yeast cell as measured by Pulsed-field Gradient NMR)

Hong, Y. S. (Water and nonionic surfactant self-diffusion in Tween 80 aqueous solution studied by PFG-NMR)

▶ *FOOMA JAPAN 2004, July. 8-11, Tokyo, Japan*

Hong, Y. S. (The self-diffusion of water in Tofu by Pulsed-field Gradient NMR)

▶ 7th *Intl. Conference on Application of Magnetic Resonance in Food Science, 13-15 Sep. Denmark*

Lee, C. H. (Determination of the apparent diffusion coefficient of water in red blood cell by high field PFG-NMR using various pulsed sequences)

▶ *Japan-Korea Joint Symposium on Food Engineering, Oct. 21-22, Kitakyushu, Japan*

Lee, C. H. (Measurement of water movement in food and biomaterials by PFG-NMR)

▶ *Ann. Meeting of Korean Soc. for Microbiol. Biotech., June 21-23, Daegu, Korea*

Park, S. M. (Water Permeability in *Escherichia coli* by Pulsed-field Gradient NMR)

▶ *71th Ann. Meeting of Korean Soc. of Food Sci. & Technol., June 23-25 , Yong-pyung, Korea*

Hong, Y. S. (The self-diffusion of water in Tofu by Pulsed-field Gradient NMR)

Jung, J. Y. (Studies on the Antioxidant effects of Korean traditional rice wine)

Hwang, M. S. (Studies on the relationship between molecular weight and viscosity of β-glucan from yeast)

▶ *Ann. Meeting of Korean Soc. of Food Sci. and Nutr., Nov. 17-19, Jeju, Korea*

Jung, J. Y. (Comparison of the quality of red wine made by the addition of different sugars)

Hwang, M. S. (Rheological properties and distribution of molecular weight of β-glucan hydrolyzed by enzyme)

News from the Graduates

Dr. Jae Kak Lim, Director of Food Research Inst. of CJ Corp., became Professor of Korea Polytechnic Univ., Department of Food Technology. Major Byung Kuk Choi joined Jema camp dispatched to Irac for peace construction. Dr. Do Yon Lee moved to CJ Bioresearch Institute. Dr. Mi Ryung Kim finally married with Kwang Duk Seo and Min Sun Kim also married with Ho Sun Chang. Sung Won Yoon got her son in Oct. Kyung Il Kang obtained not only work but also marriage.

The 3rd Hogonghoi (鎬工會) summer camp was held on Aug. 21, at Gwangreung Institute of Health and Bioscience (GIHB) and Young Shick Hong and Ji Eun Kwak gave presentation on the ongoing researches in our lab. The 1st Hogonghoi's year-end party was held on Nov. 26, at Yangjae with 50 attendants, and Mr. Kwang Kyu Lee, President of Shin-An Food Co. succeeded chairmanship after Prof. Young Han Kim.

Academic activities

The Korean Society for Food Engineering (President: Cherl-Ho Lee), was successful to enlist its journal, Food Engineering Progress, to the list of excellent journal of Korean Research Foundation. The society also became a member of Korean Federation of Science and Technology Societies. Prof. Lee was appointed to the chairman of the Functional Food Advertisement Council of the Ministry of Health and Welfare in January. He is continuing to serve as a Technical Consultant of Korea Food and Drug Administration.

Prof. Lee was elected to the President of International Life Science Institute-Korean Branch(ILSI-Korea) effective from May 1 for 3 years. Prof. Lee will be the President of Korean Society of Microbiology and Biotechnology, and the President of Korean Federation of Microbiological Societies in 2005.

News from Prof. Lee and His Family

This year Moon-sil married with Jin-Hyung Kim in July and they stayed in Gwangreung for two months. For this occasion, Jung-Sil and Yong-Jin came from L.A., USA, so all the family could get together in Seoul. Following to Moon-Sil's Honey Moon trip, all the family went to Jeju island and had wonderful time. Moon-Sil finished her MS study in History of East Asia at Pittsburgh University in November and moved to Maryland with Jin-Hyung.

Prof. Lee and Ro visited Denmark in September and stayed with their Danish family in Skovgaard, Gylling, for four days, visiting Jetter and Beny's house and enjoyed their daughter's birthday party. On the way to Denmark, they visited Moscow and stayed at Prof. Volkov's house, and had wonderful time with his family.

Prof. Lee met Prof. Tokuji Watanabe, Mrs. Satoko Musumi and Dr. Kyoko Saio on the occasion of participating *FOOMA 2004* Held in Tokyo. He also met Prof. Sagara and Prof. Miyawaki of Tokyo Univ. and many other Japanese friends at the Japan-Korea Joint Symposium on Food Engineering held in Kitakyushu in October.

This year as usual, Prof. Lee and the family enjoyed their natural life in the forest of Gwangreung, Arboretum, raising geese, ducks, hens and bees. Han-Sil stays with her sister Jung-Sil in Los Angeles, USA, during her winter vacation.

Food and Biomaterials Science and Engineering Laboratory News, 2005

This year **Kang-Kyung Lee** (Captain of Korean Army), **Na-Ri Kim** and **Wo-Jin Park** joined our lab for their MSc. study. We now have 7 MSc., 1 Ph.D. students and 1 Post-doc. **Young-Shick Hong** finished his Ph.D. thesis (Studies on structural and dynamic properties of polyoxyethylene sorbitan monooleate micelle in water dispersion by PFG NMR) in this Spring and continues as Post-doc. in our lab. **Hee-Ra Park** (Effect of Gamma Irradiation on the Radiolytic and Antioxidative Characteristics of Phytic Acid) and **En-Kyung Yoon** (Dietary Risk Assessment of Polycyclic Aromatic Hydrocarbons using Biomarkers) finished their Ph. D. studies and continue their work at Korea Food & Drug Administration (KFDA). Three MScs were produced in this Spring and found new jobs; **Mi-Sun Hwang** (Physical properties of the enzymatic hydrolysates of yeast β-glucan) to Korea Tomorrow and Global (KT&G), **Se-Mun Park** (Soy protein and plant sterol feeding on blood composition and rheological effects of rats) to LG Household & Health Care, and **Yoon-Hee Kim** (Exposure assessment of polycyclic aromatic hydrocarbon in the Korean model menu systems) to Hynix Semiconductor Company. In this Summer **Jung-In Kim** (Crystal structure of CD14 and its implications for lipopolysaccharide signaling) finished her Ph.D. and continues her work at KAIST. **Jin-Young Jung** (Comparison of fermentation characteristics of *Lycii* fruits and grapes) and **Ji-Yeon Hwang** (Studies on the antimicrobial and antioxidant activities of the extracts of propolis produced in Korea) also completed their Ms. degree in the autumn.

Prof. **Vitaly Volkov** visited us again from March to June for 3 months and from October to next January for 3 months as a visiting Professor in our laboratory. He moved his position from the Karpov Institute of Physical Chemistry to the Russian Academy of Science in Moscow, Russia.

Research Paper Presentation

▶ *IuFoST Fi Asia-China Conference, March 1-2, Shanhai, China*

Lee, C. H. (Functional food from traditional experience to modern production)

▶ *230th American Chemical Society National Meeting, Aug. 28- Sept. 1, Washington D.C., USA*

Hong, Y. S. (Characterization of proton behavior in gelatin films plasticized with glycerol using low field NMR)

▶ *72th Intl. Conference and Annual Meeting of KoSFoST, June 15-17, COEX, Seoul, Korea*

Hong, Y. S. (Structural and dynamic properties of POE-SMO micelle in water dispersion by PFG-NMR)

Park, H.R. (Effect of Gamma Irradiation on the Radiolytic and Antioxidative Characteristics of Phytic Acid)

Yoon, E. K. (Dietary Risk Assessment of Polycyclic Aromatic Hydrocarbons using Biomarkers)

Lee, E. S. (Water distribution and structural changes in cooked rice by MRI)

Hwang J. Y. (Studies on the antimicrobial and antioxidant activities of the extracts of propolis produced in Korea)

▶ *Annual Meeting of Korean Soc. for Microbiol. & Biotech., June 30-July 1, Korea University, Seoul, Korea*

Jung, J.Y. (Comparison of fermentation characteristics of *Lycii* fruits and grapes)

▶ *2005 Annual Meeting of the Korean Nutrition Society, Nov. 3-5, Gyeongju, Korea*

Park. O. H. (Changes in molecular size and immune activity of yeast β-glucan by enzyme treatment)

News from the Graduates

Ji-Eun Kwag got married on June and moved to USA with her husband. Dr. **Gi-Myung Kim** returned from University of Nebraska after 4 years of his staying in USA, and joined to Prof. Sung-Ku Kim's laboratory of Pukyoung National University, Pusan, Korea as a research professor. Dr. **Sook-Jong Lee** moved from the Food Packaging Lab. of our institute to the Division of Food Material Processing Technology, Korea Food Research Institute. **Ho-Young Kim** was promoted to Lieutenant Colonel in this summer. **Byung-Kuk Choi** was also promoted to Lieutenant Colonel and returned from Jema camp for peace construction in Irac. **Jin-Ho Song** and **Yoo Kim** got married on this June and September, respectively.

Celebration party for the publication of Prof. **Cherl-Ho Lee**'s book; A White Book for Food Hygiene Incidences Ⅱ, was held on the week of his 60 years birthday (Aug. 18th in the lunar calendar) at Inchon Memorial Hall, Korea University, with over 100 guests and graduates (Hogonghoi members).

Academic activities

Professor Lee has been busy with academic activity this year as usual. He is President of Korean Society of Microbiology and Biotechnology (KSMB), and President of the Federation of Korean Microbiological Societies (FKMS). KSMB had the Annual Meeting at Korea University as a part of the Centennial Anniversary Celebration of the University in June. FKMS held the Joint Conference and Exhibition at Seoul Education Culture Center in October. As the President of ILSI-Korea, Prof. Lee attended ILSI Annual Meeting in New Oleans in January. ILSI-Korea organized two symposiums; International Symposium on Quantitative Microbial Risk Assessment of Foodborn Pathogens for Scientific Food Safety Management in April 1, and Symposium on Nutritional and Safety Assessments of Food and Feeds Nutritionally Improve through Biotechnology on May 27.

Prof. Lee devoted much of his time to the establishment of Soy-World Museum and Center in Korea as the Secretary General of the Committee. He edited the book "Soybean" written by 17 authors with over 800 pages, and the book celebration party was held in October 25 at Central-City in Seoul.

News from Prof. Lee and His Family

Prof. Lee and Mrs. Lee (Prof. Ro) visited their first daughter, Jung-Sil, in Los Angeles, USA, on the way to ILSI Annual Meeting. Han-Sil from Korea and Moon-Sil together with her husband in Washington D.C., joined to the family meeting in January in LA. Jung-Sil passed doctoral exam and is preparing her thesis proposal in Art History at UCLA, and Moon-Sil is applying for her Ph.D. study in History of East Asia and Archaeology at Pittsburg Univ., USA. Han-Sil is busy with her graduate study in New Media Music at Hanyang University and accompaniment of the choir of Hanil Church. Jung-Sil and her husband, Young-Jin, visited Seoul and stayed in Gwangreung Forest in August. Prof. Lee and Prof. Ro visited Shanghai, China, in March for IUFoST Fi Asia-China Meeting, and Singapore in December for ILSI's First International Conference on Nutrigenomics.

Food and Biomaterials Science and Engineering Laboratory News, 2006

There are several newcomers in the laboratory. Four new students, Jang Eun Lee for Ph.D, and Byung-Dae Park, Sang-Eui Choi, and Mi-Hyun Kim, for MS degree entered to the graduate program. Among the graduates who earned MS degree in February include Yu Park (Studies on the blood cholesterol lowering and fatty-liver preventing effects of lycii fructus liquor), Eun Soo Lee (Studies on the water diffusion in milled rice and sprouted brown rice by using Pulsed Field Gradient NMR spectroscopy), Piao yuxian (changes in molecular weight and immune activity of yeast cell-wall β-glucan by enzymic treatment). Lab group went to *Daechun* last August for M.T. where food manufacturing establishment of Byung-Dae Park is located. Dr. Young-Sik Hong went to Prof. Jeremy Nicholson's Lab of London Imperial College, UK, for postdoctoral work in July and Dr. Myeong-Ae Yu, the Director of ILSI Korea, has joined the laboratory as a postdoctoral researcher since February this year.

Research Paper Presentation

▶ 5th Food Safety Day *International Symposium,* May 11, 2006, Seoul, Korea

Lee, C. H. (Analysis of food hygiene incidencies and their corresponding provisions in Korea)

▶ UKC, *Korean-American Scientists and Engineers Association*, Aug 10-13, Marriot at Glenpointe, Teaneck, USA

Lee, C. H. (Application of PFG-NMR and MRI in water diffusion measurement of food and biomaterials)

▶ 53rd Annual Meeting of Japanese Society of Food Sci. and Techn, Nihon Univ., Kanakawa, Japan, August 28-30

Lee, C. H. (Functional Food from traditional experience to modern production)

▶ Korean Soc. of Food Hygiene & Safety 20th Anniversary Symposium, November 17, 2006, Seoul

Lee, C. H. (Food Safety in Korea, Historical perspectives and Future experience)

▶ *Intl. Conference and Annual Meeting of Korean Society for Food Engineering, March 22, KINTEX, Ilsan, Korea*

Lee, K. K. (A study on volatile aromatic ingredients of phytoncide)

Park, W. J. (Pilot plant production & purification of neutral & alkaline protease from *Bacillus amyloliquefaciens* FSE68)

Yoon, S.W. (Effects of MEHP on TM4 Sertoli cells)

▶ *73th Intl. Conference and Annual Meeting of KoSFoST, June 15-17, ICC, Jeju, Korea*

Hong, Y. S. (Water distribution and diffusion in rice using MRI and PFG-NMR)

Lee, K. K. (A study on volatile aromatic ingredients of phytoncide)

Kim, N. R. (Water distribution and diffusion in soaking soybean using MRI and PFG-NMR)

▶ *13th IUFoST World congress of food science & technology, Sep. 17-21, Nantes, France*

Kim, N. R. (Water distribution and diffusion in soaking soybean using MRI and PFG-NMR)

Park, W. J. (Pilot plant production and purification of NPR and APR from *Bacillus amyloliquefaciens* FSE68)

Academic activities

Professor Cherl-Ho Lee has been elected as a life member of the Korea Academy of Science and Technology on November 17, 2006. He has also been elected as the President of the Korean Society of Food Science and Technology for 2007. Recent Dr. Lee's publications, 'White paper on Food Hygiene Incidences in Korea vol. II ' and 'Soybean' in which he was editor in chief, have been selected and distributed as outstanding reference books in the field of Basic Sciences by the National Academy of Sciences, Republic of Korea. Dr. Lee has taken sabbatical leave on the second half of 2006, yet is spending the busiest year of all so far.

1. As the president of ILSI Korea, Dr. Lee has been deeply involved in organizing International Symposia and a workshop in the field of food safety and functional foods including a) International Symposium on National Food Safety Control System in Korea (May 11), b) International Symposium on Maternal and Infant Nutrition (May 26; Sponsorship), c) Workshop on Use of Quantitative Microbiological Risk Assessment & Food Safety Objectives in Food Safety Management (October 26) and d) International Symposium on Scientific Substantiation and Labeling of Health Claims of Food for Consumer Protection (November 17).

2. As a co-chair of the Organizing Committee, Dr. Lee put great effort for the organization of Korea Conference on Innovative Science and Technology (KCIST) 2006 on Nutrigenomics, which was held on July 20-22 in Muju, Korea. It was an exclusive international meeting in English, inviting Ca, 50 researchers for in-depth discussion on Nutrigenomic; its new perspectives and applications.

3. Dr. Lee resided the 15th meeting of Codex Coordinating Committee for Asia (CCASIA) held on November 21~24, 2006 (Seoul, Korea) as the Chairperson upon the invitation of the Korean government. In preparation of the meeting he attended the 28th session of Codex Committee on Nutrition and Foods for Special Dietary Uses held on October 30~November 3 (Chiang Mai, Thailand) as a part of Korean delegation.

News from the Graduates

Dr. Kwang Ho Lee took up the Director position at the Analytical Center, Gyeongin Regional Office of Korea Food and Drug Administration this year. Dr. Hyun Pa Song went abroad for postdoctoral research to Cornell University (USA). Dr. Ki Myong Kim joined the laboratory of Professor Hyun Jin Park at Korea University as a research professor, while Dr. Sook Jong Rhee moved to the laboratory of Professor Kwang Soon Shin at Kyonggi University as a postdoctoral fellow both in last September. Hyunmin Jin and Ki-Lim Kang married with their respective soulmates in July and October, respectively. Jin-Young Chung married in December 3. Last, but not the least, is the news of a newborn baby, the second child of Ji-Yeoun Whang. Our warm congratulations and best wishes for upcoming 2007 go to the graduates mentioned and all other graduates as well.

News from Prof. Lee and His Family

Prof. Lee and Mrs. Lee (Prof. Seung-Ok Ro of ShinHeung College) visited Jung-Sil in LA, USA, on the way to the 2006 ILSI Annual Meeting in Puerto Rico in January, and Moon-Sil in Washington D.C. on the way from Puerto Rico. During their visit, Moon-Sil delivered a healthy baby, Diane, on Jan. 27. Moon-Sil with her family came to Seoul and stayed for two months, before she start for her Ph.D study in History of East Asia at the University of Pittsburgh.

In July 3rd a group of Danish family (Kristen and Inge Larsen, Jette's family, Per's family and Aunt Inge, total 12 people) came to Seoul for the occasion of Kristen's 70-year birthday and stayed with Prof. Lee for two weeks. They had wonderful time going all together to Jiri Mountain, Everland, Ocean Castle, Panmunjom, Gwangreung Arboretum and etc.

Jung-sil came to Korea on August for her study trip to Korea and Japan sponsored by Korea Foundation. She visited Japan together with Han-Sil for 10 days in August/September. Han-Sil finished her MA in Newmedia Music at HanYang University, and now stays in Pittsburgh with Moon-Sil.

Food and Biomaterials Science and Engineering Laboratory News, 2007

2007 has been another busiest year for the laboratory full of activities and good news! Three new students joined the lab: Mr. Bong-Kuk Ko for Ph.D program, Mr. Hong-Seok Sohn and Mr. Chang-Yong Lee for master's. Dr. Sung-Won Yoon earned her Ph.D. degree with the dissertation on "Antioxidant activity of soybean hydrolysate peptides on monophthalate-induced toxicity on TM4 Sertoli cells". Captain Gang-Kyung Lee finished his masters program successfully with thesis on "Characterization of the aroma compounds isolated from the aqueous distillate of softwood and oriental medicinal herbs" and returned to his military position; Ms. Woo-Jin Park got MS degree with her thesis on "Study on the functional beverages using peptide mixtures from soybean protein hydrolysate"; Ms. Nari Kim with her thesis on "Studies on water distribution and diffusion in soybean by MRI and PFG-NMR"; and Ms. Mi-Young Suh with the thesis on "Study on the identification of microorganisms during Kochujang fermentation and its functional effects".

Sung-Won Yoon continues her postdoctoral work in the lab. Dr. Young-Shick Hong returned from England and joined our lab as a Research Professor, and Dr. Myeong-Ae Yu continues her postdoctoral position in the lab, and elected as the new Executive Director of ILSI Korea.

Graduate students had opportunity to visit Japan as a part of their projects. The places they visited were a winery at Yamanashi, Natto manufacturing establishment at Ibaraki, and a Sake fermenting establishment.

Research paper presentations

Lee, C.H., Studies on the quantitative evaluation indices for Korean scientific journal by using food science field as a model, KoFST, April 2, 2007.

Lee, C.H., Harmonization of Eastern and Western health knowledge; Nutrigenetics and Sasang Typology, UKC 2007, Aug 9-12, Washington D.C, USA.

* 2007 IFT Annual Meeting and Food EXPO, 28/7-1/8, Chicago, Illinois USA

- Lee, C.H., Kimchi;the synbiotic food of Korea, Kimchi Symposium
- Yoon, S.W. (Antioxidant activity of peptides isolated from soy hydrolysate on the MEHP-induced TM4 Sertoli cells)
- Park, B.D. (Rheological Changes of Gochujang by Hydrocolloidal Compounds)
- Choi, S.E. (Isolation and Characterization of Aroma Compounds from Pineapple Sage, Lavender and Rosemary)
- Kim, M.H. (Ginsenoside profile modification of red ginseng by acid impregnation)

* 74th Annual Meeting of KoSFoST. June 20-22, Busan. Korea.

- Lee, J. E. (Deacidification of blackberry wine by malolactic fermentation)

Academic activities

As the President of ILSI Korea, Prof. Lee attended 2007 ILSI Annual Meeting on January 18~24th at Cancun, Mexico. Prof. Lee has served as the President of the Korean Society of Food Science and Technology(KoSFoST) this year, and organized the Society Annual Meeting in the theme of "Social Obligation of Food Science and Technology". He organized and presided a round-table discussion on "Scientific Food Safety Control and Communication" at the Annual Meeting. He became the Founding Chairman of the Korean Federation of Food Related Societies. Prof. Lee received the Academic Excellency Award of Korean Society for Microbiology and Biotechnology on June 29, 2007 at the Annual Meeting of the Society. Prof. Lee attended the 30th session of CODEX Alimentarius Commission held in Rome, 2-7 July, as the chairman of the 15th CCASIA Meeting.

Prof. Lee devoted much of his time for the construction of cyber museum 'Soy-world Science Park' (http://soyworld.org), which will open on Jan, 2008.

News from the graduates

Nari and Woo-Jin, started their new career at Samyang Co., Ltd. and Nongshim Co., Ltd, respectively. Mrs. Jang-Eun Lee got married in January this year and is now expecting a baby in February 2008.

Hogonghoi, the alumni group of the laboratory. Summer Camp was held on June 9 at the residential house of Prof. Lee in Gwangreung. Approximately 70 participants joined this annual activity(see the picture in the card). Dr. Won-Seok Choi of Chungju University got married on November 24th. Mr. Seok-Hyung Lee working at Samsung Tesco and his wife Dr. Suk-Jong Lee left to London, UK, in October for 6-month oversea work position. Dr. Gang-Kyu Lee, the President of Hogonghoi, opened a new on-line shopping mall, Well-Being Story (www.delicin.net). Thank you all the graduates for sharing the news.

News from Prof. Lee and the family

Prof. Lee and Mrs. Lee (Prof. Seung-Ok Ro of ShinHeung College) visited their daughters, Jung-Sil in LA and Moon-Sil in Pittsburgh, USA, on the way back from Cancun, Mexico. They celebrated the first-year birthday of their granddaughter, Diane, in Washington D.C. They visited their daughter in USA again in summer. Jung-Sil is now writing her Doctoral thesis at UCLA and recently found a nice house in West Hills, Los Angeles. Moon-Sil transferred to the University of California in Santa Babara last July following her adviser. Han-Sil enjoyed traveling around the world after finishing her MA degree in Newmedia Music at Hanyang University. She visited Moo-sil in Pittsburgh last winter, and came to Cancun, Mexico. She traveled to Rome and Paris with her parents in July and stayed in LA with Jung-Sil in August. In December she traveled again to LA, and will stay there for some months.

Food and Biomaterials Science and Engineering Laboratory News, 2008

The year 2008 was also challenging and prosperous year for the members of our laboratory. Presently we have two postdoctoral Research Associates, Dr. Young-Shick Hong and Dr. Myeong-Ae Yu, and four doctoral candidates and two MS students. Mr. Hyuk-Jin Ahn joined the lab in the spring semester for MS program, working on a wine project. Ms. Sang-Eui Choi (Studies on characterization of volatile compounds of herbal extracts using GC/MSD and development of their soft drink) and Ms. Mi-hyun Kim (Discrimination of origins of soybean using relaxational NMR spectroscopy) finished their MS degree at the spring semester. Ms. Mi-hyun Kim continues her career at the Korean Food Research Institute after graduation. Mr. Byung-Dae Park finished his MS degree (Effects of culinary salt on the physical properties of aqueous hydrocolloid solution and their applications in salt fermented foods) and started his Ph. D program.

Research Paper Presentations

■ 2008 IFT Annual Meeting and Food Expo., New Orleans, LA, June 28 – July 1.
- Hong Y.S. (Artifacts in measurement of water distribution in soybeans using MR imaging)
- Son H.S. (A novel approach for estimating sugar and alcohol concentrations in wines using refractometer and hydrometer).

■ 75th Annual Meeting of KoSFoST, Kwang-Ju, Korea, June 18 – 20.
- Ko B.K. (Comparison of chemical composition between Korean and Japanese soy sauces)
- Son H.S. (Metabolomic characterization of Korean geographical grapes and their wines)
- Choi S.E. (GC/MSD analysis of volatile compounds in herbal extracts for soft drink)
- Lee J.E. (Malolactic fermentation of Meoru wine using LAB strains)
- Kim M.H. (Discrimination of origins of soybean using relaxational NMR spectroscopy)

■ 2008 Annual Meeting of Korea Society of Brewing Science, Seoul, Korea, July 16.
- Son H.S. (Metabolic characterization of Korean geographical grapes and their wines)
- Hong Y.S.(Metabolomic characterization of wines from grape varieties and growing countries)

■ 14th IUFoST World Congress of Food Sci. & Technol., Sanghai, China, October 19-23.
- Hong Y.S. (NMR-based metabolomic characterization of wines from grape varieties and growing countries)

Academic Activities

Prof. Lee published a textbook “Food Preservation” together with Prof. Hyun-Jin Park. The celebration party was held at Korea University Alumni Hall on September 8 and organized by Hogonhoi, the alumni group of the laboratory, and by the Health Food Research Center of Korea University. Hogonghoi annual meeting was held on December 5th at Min-Soo's restaurant "Dr. Robbin" at Sinsa-dong and elected its new president, Dr. Je-Gak Lim, who is a professor in Korea Polytechnic University.

News from the Graduates

There were happy, pleasant news from 4 graduates of the lab on newborn babies-Mr. Jung-Hang Huh, Ki-Rim Kang and Jang-Eun Lee got baby boys and Dr. Sung-Won Yoon got her third son. Dr. My-Rung Kim who got a professorship at the Silla University, Busan in September is expecting a baby soon. Mr. Seok-Hyung Lee and his wife Dr. Suk-Jong Lee came back home on April after 6 months work at the headquarter of Tesco in London, and Suk-Jong is continuing her postdoctoral work at Kyung-gi University. Dr. Mousa Sousane in Senegal visited Korea on October for KOICA workshop and met old friends including Chang-Su Kim.

ILSI Korea Activities

Professor Cherl-Ho Lee has devoted most of his out-campus activities for International Life Sciences Institute of Korea (ILSI Korea). Dr. Myeong-Ae Yu became the Executive Director of ILSI Korea as of January and has organized several important meetings throughout the year. "GM food Safety and Labeling" and "Detection Methods on Irradiated Food" have been among hot food-related issues in Korea, which urged ILSI Korea to organize two meetings for GMO and one for detection of irradiated foods, in addition to other interesting meetings on science and communication. Mr. John Ruff, President of ILSI, and Dr. Ib Knudsen, President of ILSI Europe, visited Korea and presented their views on world food supply and biotechnology at the Korea Press Foundation-ILSI Korea Media Forum and an International Workshop on GMOs during October 27-29th. They also shared their experiences of being with ILSI at a Food Industry CEOs Breakfast Meeting in the late October.

News from Prof. Lee and the Family

Moonsil, Jinhyung and Diane visited Korea in June and stayed for two months in Kwangreung. Jungsil and Yongjeen got their first son, Daniel Wonjang Jin, on August 18th, and Mrs. Lee (Prof Ro) visited them for helping the baby delivery. Professor Lee visited Jungsil's family in LA on the way to the 2008 IFT Annual Meeting in New Orleans, USA. He also attended the 14th IUFoST World Congress in Shanghai on Oct. 19-24th. Hansil entered the Graduate School of Education, Yonsei University in the fall semester, and currently works as an administration staff at the School of Electrical & Electronic Engineering of the same University. She also started to play the electric pipe-organ for the Han-Il Church's Sunday Service. On November 18th, the family had one year memorial service for Prof. Ro's mother, who passed away last year.

Food and Biomaterials Science and Engineering Laboratory News, 2009

This is the last Christmas card from our laboratory, because Professor Cherl-Ho Lee is retiring in August 2010 after his 31 years service at Korea University. We are proud of that we have kept the tradition of issuing the Christmas annual report for the last 27 years. Postdoctoral Research Associate, Dr. Young-Shick Hong and four doctoral candidates and one MS student are working in our lab at this moment. Mr. Chang-Yong Lee finished his MS degree (Studies on determination of optimal extraction condition and chemical composition of herbs through pattern recognition method) and continues his career at Taekyung Nongsan Co.. Prof. Lee got the national award 'Red Stripes Order of Service Merit' from the President of the Republic of Korea.

Research Paper Presentations

■ Korea Academy of Science and Technology (KAST) Project Seminar, Feb. 26, Marriot Hotel, Seoul
- Lee, C.H.(World food situation-the changes and problems)

■ The 2^{nd} KAST-USNA Bilateral Symposium on The Science of Food Safety Risk Assessment, Aug. 24, The Korea Chamber of Commerce and Industry, Seoul
- Lee, C.H. (The science of risk assessment for national food safety control and communication)

■ IUFoST-Japan Symposium on Food Safety and Security, Sept. 12, Nagoya Univ., Japan
- Lee, C.H. (Food safety and security in Korea)

■ KAST Food Security Forum on National Food Security Problems and Provisions, Oct. 28, EL Tower, Seoul
- Lee, C.H. (A proposal on national food security policy)

■ Food/Beverage News Symposium on Food Industry Promotion and Vision, Nov. 26, aT Center, Seoul
- Lee, C.H. (A proposal for food industry upbringing policy)

■ Metabomeeting 2009, Norwich, UK, July 5 – 8. - Hong Y.S. (Wine bacteria affect primary and secondary metabolites in wine: ^{1}H NMR- and GC-based metabolomic approach)

■ 76^{th} Annual Meeting of KoSFoST, Daejeon, Korea, May 27 – 29.
- Ko B.K. (Effect of high pressure treatment on chemical composition in Korean traditional soy sauces)
- Ahn H.J. (Chemical characterization of grape varieties grown in a green house)
- Lee J.E. (Fermentative behaviors of LAB in grape wines through ^{1}H NMR- & GC-based metabolic profiling)
- Son H.S. (Characterization of wines from grape varieties by using ^{1}H NMR-based metabolomics)

■ Joint Meeting of Korean Societies of Food Culture and Food & Cookery Science, Seoul, April 24.
- Lee C.Y. (Comparison of antioxidant activities of various herbal extracts)

Academic Activities

Prof. Lee devoted most of his time for Korea Academy of Science and Technology (KAST) and ILSI Korea activities. He carried out a KAST Research Project on "National Food Security Problems and Provisions" as the Principal Investigator. He organized and co-chaired with Prof. Michael Doyle of Georgia Univ., USA, the KAST-US National Academies Bilateral Symposium on "The Science of Food Safety Risk Assessment" held in Seoul on August 24-25. Prof. Michael Doyle, Dr. Robert Buchanan of Univ. Maryland, Dr. Robert Brackett of US Grocery Manuf. Assoc. and Dr. Ann Yaktine, Dr. Linda Meyers and Mrs. Effie Bentsi-Adoteye from USNA came to Korea for the event (http://food.kast.or.kr). The outcomes of the symposium will be published in a book 'Food Safety Risk Assessment' in Korean. He also organized "KAST Food Security Forum" on October 28 in Seoul.

As a member of National Food Safety Policy Council under the Prime Minister's Office, Prof. Lee visited AFSSA in Paris, France, and DVFA in Copenhagen, Denmark in February. He also worked for the formulation of the Basic Plan for National Food Safety Management. Prof. Lee together with Mrs. Lee attended IFT Annual Meeting held in Anaheim, USA, in June.

The Committee for Soy World Science Park Construction made MOU with Youngju City for the construction of Soyworld Museum in Youngju. Soyworld Ciber Museum (www.soyworld.org) opened last year is running well. Ms. Mi-Kyung Yu took over the web-master position in September from Dr. Young-Shick Hong who is planning to move to Reims University, Champagne, France, as a researcher from the end of this year.

ILSI Korea Activities

Prof. Lee, Mrs. Lee, Dr. Ik-Boo Kwon and Dr. Myoung-Ae Yu attended ILSI Annual Meeting held in Tucson, USA, in January. ILSI Korea organized/sponsored several symposia and workshops including International workshop on GMO on March 23, AgroFood Safety Workshop on Risk Assessment of Chemical Residues and Antimicrobial Resistance in Food on June 2, Workshop on Scientific Management of Irradiated Foods on Sept. 29, Workshop on Environmental Risk Assessment of Biotech Crops on Dec. 9. Prof. Lee organized and chaired the 1st ILSI BeSeTo Meeting on Food Safety held on Aug. 26-27 at Korea University; four delegates led by Dr. Junshi Chen from ILSI Focal Point in China and four delegates led by Mr. Hiroaki Hamano from ILSI Japan came to Korea for the successful event. ILSI Korea organized ILSI session on Threshold and Food Safety Risk Assessment in Asia for the 2009 IAFP Asia Pacific Symposium on Food Safety held in Seoul on Nov. 11-14. All Asian ILSI Branches participated to the session.

News from the Graduates

There are happy and pleasant news from graduates of the lab. Dr. Mi-Ryung Kim and Ms. Jin-Young Jung got their first daughters, and Ki-Jung Suh also got his second daughter. Woo-Jin Park got married in September. Dr. Ki-Myung Kim moved from Korea University to Jeonnam Biofood Technology Center (Naju-city, Jeollanamdo) and is working as a R&D team manager. Dr. Eun-Ju Lee got P & S (Professional and Scientific) outstanding new professional award for her work as an assistant scientist in Iowa State University.

News from Prof. Lee and the Family

The biggest news from Prof. Lee's family this year is that Hansil, the youngest daughter, married on July 11th to Mr. Sooyoung Moon, who is a Ph. D. student of Film Art major at Yonsei University in Seoul. All the family members abroad, Jungsil and her husband Yongjeen Jin and their son Wonjang Daniel from West Hills, CA, and Moonsil and her husband Jinhyung Kim and their daughter Diane in Santa Barbara, CA, came to Seoul for the wedding and stayed for a month in Prof. Lee's Seoul residence, Noblesse Tower. Jungsil continues working on her Ph.D. dissertation, and plans to complete her study at UCLA in the next summer. Moonsil, as a teaching assistant at UC Santa Barbara, has taught three classes of 'Japanese History through Art and Literature' for 12 weeks started from September. From this fall, Diane finally started to stay all day long at her preschool, where she used to stay only a half day in the past. Hansil and Sooyoung took their honeymoon trip to Europe for 2 weeks and found a tiny, yet sweet nest near Yonsei University to start their newly wedded life. Mrs. Lee (Prof. Ro) has finally been promoted to a full Professor of Shin Heung College, and will celebrate her 60-year birthday (Hoegab) on December 24th in the lunar calendar. Trees, herbs and animals (geese, ducks, chickens, rabbits, cats and dogs) in their country-side residence near Kwangreung National Arboretum are growing well. A new steam distillation system for herbal essential oil production and a new electric heating system in the green house were installed this year as well.

List of Graduates

◐ Entrance Year 1978

	김영만 / Kim Young-Man	011-9752-4382
	MS: Korea Univ.(1980)	PhD: Korea Univ.(1985)
	Hankyong National Univ./Professor	01197524382@nate.com
	박장열 / Park Jang-Yeoul	016-736-0764
	MS: Korea Univ.(1981)	
	Korea Hotel Technical College/Professor	pjy0764@hanmail.net

◐ Entrance Year 1979

	박명한	
	MS: Korea Univ.(1981)	
	retirement	ginffee@hanmail.net
	이광수 / Lee Kwang-Soo	010-5207-2855
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◐ Entrance Year 1980

	김찬화 / Kim Chan-Wha	016-710-3439
	MS: U of Hawaii.(1982)	PhD: MIT, USA (1987)
	Korea Univ./ Professor	cwkim@korea.ac.kr
	김찬식 / Kim Chan-Shick	010-3690-5826
	MS: Korea Univ.(1982)	Kyoto Univ.(1990)
	Jeju National Univ./ Professor	chshkim@cheju.ac.kr
	김철원 / Kim Chor-Won	016-294-6229
	MS: Korea Univ.(1982)	
	Gallery Monticello/ President	glazedoc@hanmail.net
	김성구 / Kim Sung-Koo	010-4564-6188
	MS, Korea Univ.(1984)	PhD: MIT, USA (1992)
	PuKyong National University/Professor	skkim@pknu.ac.kr

	김학량	019-695-0010
	MS: Korea Univ.(1982)	PhD: SIK, Sweden
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	변명우 / Byun Myung-Woo	011-430-4264
	MS: Korea Univ.(1982)	PhD: Kyoto Univ.(1995)
	Woosong Univ./ Professor	mwbyun21@hanmail.net
	정경식 / Chung Kyeong-Sik	011-306-4843
	MS: Korea Univ.(1981)	
	Self-employed	nissikorea@hanmail.net

◐ Entrance Year 1981

	임재각 / Lim Jae-Kag	010-9033-1048
	MS: Korea Univ.(1983)	PhD: Kyushu Univ.(1989)
	Korea Polytechnic Univ./ Professor	jklim@kpu.ac.kr
	김정교	010-9767-5359
	MS: Korea Univ.(1983)	
	김재득 / Kim Jae-Deuk	010-5534-1928
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	The Salvation Army Dongducheon Church/ Commanding officer(pastor)	jaedkim@hanmail.net
	조태숙	
	MS: Korea Univ.(1983)	
	현승원 / Hyun Seung-Won	019-382-6265
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	Ilshin wo Ilshin, Ltd/ CEO	mingki0709@yahpp.co.kr

◐ Entrance Year 1982

	오성훈 / Oh Sung-Hoon	011-749-9932
	MS: Korea Univ.(1984)	PhD: Korea Univ.(1993)
	Ansan College of Technology/Professor	sungoh@act.ac.kr
	권오훈 / Kwon O-Hun	010-7139-2855
	MS: Korea Univ.(1984)	
	Wooilpulp & Paper/ CEO	paperrider@hotmail.com
	김대환 / Kim Dae-Hwan	010-3717-8651
	MS: Korea Univ.(1984)	
	NIWA / President	oksan93@chollian.net
	박형우 / Park Hyung-Woo	010-9965-6561
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	KFRI / Reseacher	hwpark@kfri.re.kr
타계	이순우	
	MS: Korea Univ.(1984)	

◐ Entrance Year 1983

타계	한억	
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	손혜숙 / Son Hye-Sook	010-5026-6907
	MS: Korea Univ.(1985)	PhD: Kansas State Univ.(1990)
	Korea Society Food Science and Technology / Editor	foodlim@gmail.com
	이현덕 / Lee Hyun-Duk	
	MS: Korea Univ.(1984)	PhD: Korea Univ.(1992)
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타계	이주순	
	MS: Korea Univ.(1985)	
	김영택 / Kim Young-Taek	010-9327-3669
	MS: Korea Univ.(1985)	
	HaeMa Food/ CEO	ytkim@hmfood.co.kr
	이호택 / Lee Ho-Taik	017-267-5804
	MS: Korea Univ.(1985)	
	Seoul Dairy Co-op / General Manager	lht8031@seoulmilk.co.kr

◐ Entrance Year 1984

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	Hangil Co./ Vice president	naawon@hanmail.net
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	MS: Korea Univ.(1986)	PhD: Cornell Univ. (1993)
	Keimyung Univ./ Professor	splee@kmu.ac.kr
	임정배	
	MS: Korea Univ.(1986)	
	Daesang	
	태원택/ Tae Won-Tack	011-360-1113
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	Sungwon Food Co./ President	twtlsa@dreamwise.com

	성웅경/ Sung Ung-Kyung	019-418-9388
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	MS: Korea Univ.(1986)	

◐ Entrance Year 1985

	이부용 / Lee Boo-Yong	010-7306-9074
	MS: Korea Univ.(1987)	PhD: Korea Univ.(1993)
	CHA Univ. / Professor	Lbyong8172@empal.com
	홍성희 / Hong Sung Hie	010-3919-5656
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	김영욱	
	MS: Korea Univ.(1987)	
	김동철 / Kim Dong-Chul	011-383-4922
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	Korea Food Research Institute	krpck@kfri.re.kr
	안현숙	
	MS: Korea Univ.(1987)	
	이광규 / Lee Kwang-Kyu	010-3732-7515
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	Cin-An Corp./ President	kklee0119@hanmail.net
	이준경 / Lee Joon-Kyoung	017-316-0885
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	안현웅	
	MS: Korea Univ.(1987)	

◐ Entrance Year 1986

	강일준 / Kang Il-Jun	010-4003-4003
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	Hallym Univ. / Professor	ijkang@hallym.ac.kr
	김낙경 / Kim Nak-Kyung	615-231-2043
	MS: Univ. of Georgia(1989)	PhD: Univ. of Georgia(1992)
	Captain D's/ Director of Quality Assurance	NK_Kim@captainds.com
	김정 / Kim Jung	
	MS: Korea Univ.(1988)	
	BaKery, Sidney, Australia	
	류기형 / Ryu Gi-Hyung	011-9880-0906
	MS: Korea Univ.(1988)	PhD: Kansas State Univ.(1992)
	Kongju National Univ./ Dean	ghryu@kongju.ac.kr
	무사 스완네 / Moussa Souane	
	MS: France	PhD: Korea Univ.(1991)
	Food Research Inst. Dakar, Senegal	kafoonutrition@yahoo.fr
	최희돈 / Choi Hee-Don	010-8530-3297
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	KFRI / Senior Researcher	chdon@kfri.re.kr
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◐ Entrance Year 1987

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	이승우	
타계	MS: Korea Univ.(1989)	
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	MS: Korea Univ.(1989)	
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◐ Entrance Year 1988

	이석형 / Rhee Suk hyung	010-8715-1936
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	신동훈	
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	윤의정 / Yoon Eui Jeong	010-9079-9246
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	김나영	
	MS: Korea Univ.(1990)	
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	양승용 / Yang Seung-Yong	011-795-2070
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	정영길	
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	한복진 / Han, Bokjin	018-317-9115
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	황남효	
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	홍향란	
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◐ Entrance Year 1989

	이숙종 / Rhee Sook-Jong	019-530-1937
	MS: Korea Univ.(1991)	PhD: Korea Univ.(2004)
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	김미희	
	MS: Korea Univ.(1991)	
	김선영 / Kim Sun-Yong	
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	Mrs. Souane, Senegal	
	박용호 / Park Yong-Ho	011-9715-2171
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	정만기 / Chung Mahn-Kie	010-2013-6710
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◐ Entrance Year 1990

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	MS: Korea Univ.(1992)	
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	Sun Jae co. / Director	hunkim77@daum.net
	조정숙	
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	Emigrated to USA	

◐ Entrance Year 1991

	이강권/ Lee Gang-Gweon	010-5329-2004
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	이도연/ Lee Do-Youn	010-9299-2590
	MS: Korea Univ.(1993)	PhD: Korea Univ.(1999)
	CJ/ QA manager	dylee@cj.net
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◐ Entrance Year 1992

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	Pulmuone	
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◐ Entrance Year 1993

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	Binggrae/ Marketing Dept. Senior Manager	thkim@bing.co.kr
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	Chungju National Univ./ Professor	choiws@paran.com
	김제중 / Kim Je-Jung	011-319-6732
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	한숙자	
	MS: Korea Univ.(1995)	

	엄미나 / Eom Mi-Na	010-4723-6301
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	정경훈 / Jung Kyung-Hoon	010-6363-1837
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	CJ/ Senior manager	khjung@dreamwiz.com

◐ Entrance Year 1994

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	CJ / Manager	jinyeollee@cj.net
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	MS: Koea Univ.(1996)	
	김호영 / Kim Ho-Young	010-5079-5623
	MS: Korea Univ.(1996)	
	ROK Army HQ / Lieutenant Colonel	minsdady@hanmail.net
	안보선 / Ahn Bo-Sun	017-623-3389
	MS: Korea Univ.(1996)	PhD: Korea Univ.(2000)
	Daeji high school / Teacher	hoahn@hanmail.net
	최성진 / Choi Sung-Jin	010-8885-0391
	MS: Koea Univ.(1996)	
	Jupiter International/ Team Leader	sjch0i@hotmail.com
	김학철	
	MS: Koea Univ.(1996)	
	박형석 / Park Hyeung-Suk	011-758-5963
	MS: Korea Univ. (1998)	PhD: Konkuk Univ (2006)
	Kimjungmoon Aloe/ Director	lionhs@hanmail.net

	신호 / Shin Ho	011-320-1751
	MS: Korea Univ.(1996)	
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	이자현	
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◐ Entrance Year 1995

	윤성원 / Yoon Sung-Won	011-9993-9201
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	홍영식 / Hong Young-Shick	010-5046-2750
	MS: Korea Univ. (1997)	Ph. D: Korea Univ. (2005)
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	이창복	
	MS: Korea Univ.(1997)	

◐ Entrance Year 1996

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	김청태 / Kim, Cheongtae	010-200-9312
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	NongShim Co. Ltd, Food Safety Research Institute/ Head	kctmass@hanmail.net
	이병일 / Lee Byoung-Il	010-8823-8594
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	Nongshim/ Manager	leebyoungil@hanmail.net
	이임숙	010-6349-3989
	MS: Korea Univ.(1998)	
		atteonee@hanmail.net
	장소영 / Jang So-Young	010-9137-7443
	MS: Korea Univ.(1998)	PhD: Chungang Univ.(2007)
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	MS: Korea Univ.(1998)	
	이정엽	
	MS: Korea Univ.(1998)	
	유창현 / Yu Chang-Hyun	010-3316-9396
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◐ Entrance Year 1997

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	조성준 / Cho Sung-Jun	017-711-5205
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	조영주 / Cho Young-Ju	010-8788-8493
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	KHIDI / Senior Researcher	choyj@khidi.or.kr
	함일권	
	MS: Korea Univ.(1999)	
	Dae Hwa Pharm.	hik0307@yahoo.co.kr
	유성현	
	MS: Korea Univ.(1999)	
	이해연 / Lee. Hae Ryun	010-3110-2797
	MS: Korea Univ.(1999)	
	Seoul(Food Safety division) / Official	happyjudy@seoul.go.kr
	이현숙	
	MS: Korea Univ.(1999)	
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◐ Entrance Year 1998

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	MS: Korea Univ.(2000)	
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◐ Entrance Year 1999

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	KFDA / Scientific Officer	hjahn@kfda.go.kr
	윤은경 / Yoon Eun-Kyung	010-3764-5570
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	Pizza Hut / QA specialist	jjheon@hotmail.com
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◐ Entrance Year 2000

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	박희라 / Park, Hee Ra	010-8915-4656
	MS: Korea Univ.(1996)	PhD: Korea Univ.(2005)
	KFDA / Deputy Director	heera@kfda.go.kr
	유병희 / Yoo Byung-Hee	010-8728-7602
	MS: Korea Univ.(2001)	
	CJ Cheiljedang / Senior Researcher	marchfairy@cj.net
	최병국 / Choi, Byung Gug	010-5072-1462
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	ROK Army / Lieutenant Colonel	bkchoi6445@naver.com
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◑ Entrance Year 2001

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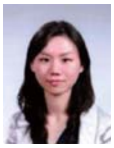	박우진 / Park Wu-Jin	010-9927-5838
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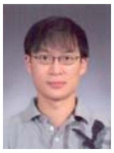	고봉국 / Ko Bong-Kuk	010-9453-7084
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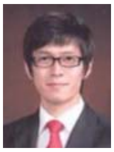
◑ Entrance Year 2008

	안혁진 / Ahn Hyuk-Jin	010-3132-3347
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Epilogue

In preparation of this archive, I was able to meet most of my students through their research papers published and research project reports. A total of 193 students completed their Master of Science degree research in my laboratory, and 24 students completed research for their doctoral dissertations.

A total of 274 original research papers were published by the laboratory in both domestic and international scientific journals, and 34 articles were published in magazines and other periodicals. I have authored or co-authored 24 books and 20 book chapters. A total of 12 patent rights were obtained through the laboratory.

Among the graduates are 19 professors, 93 researchers in both national and industrial research institutes and many are successful business people. All my activities and those of my students are described in the Christmas Annual Reports from my laboratory issued for the last 27 years. These reports include the new members of the year, paper presentations made at conferences, new jobs, and even marriages of students and children born to them. It is really a big family story.

I have served as an elder of the Hanil Presbyterian Church in Seoul since 1997, and for the last several years when I came into my laboratory in the morning, I pray to God.
"Heavenly Father, Thank you for guiding me and protecting me. Take the glory of your name through this place. Bless those who studied in this laboratory and open their road for the future. In Jesus Christ, Amen."

"But by the grace of God I am what I am, and His grace toward me was not in vain; but I labored more abundantly than they all, yet not I, but the grace of God which was with me. (1Corinthians 15:10)"

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