KOREAN J. DIETARY CULTURE
Vol. 3, No. 1(1988)

Extrusion Technology for the Production and Processing of Korean Traditional Foods

Cherl-Ho Lee

Department of Food Technology. Korea University, Seoul, Korea.

(Received March 7, 1988)

Extrusion 기술을 이용한 전통식품의 생산과 가공

이 철 호

고려대학교 식품공학과

(1988年 3月 7日 接受)

Abstract

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.

Introduction

Extrusion-cooking is a modern high-temperature-short-time(HTST) process, and is used in more and more traditional food processing for their modernization and industrialization. During extrusion cooking, plant and animal tissues are deformed, or disintegrated, starches are gelatinized or dextrinized protein denatured or texturized and sugar dissolved within a few second at about 100-180 °C range. It replaces much conventional equipments which work at low temperatures and pressures and with long residence times, such as drum dryer, batch cookers, mixers, formers, stirred tank reactors and ovens.[1-3]

The extrusion system has been used for many years in traditional food making. For instance in Korea, rice cakes, which were made by pounding steamed rice by hand, are produced by a single or small non-intermeshing twin-screw mixing extruder. Many traditional noodles are made by single screw noodle extruder today.[4] The introduction of extrusion-cooking technology into Korea is not so old (Table 1). In 1974, a confectionary company in Seoul first used a puffing gun type small single screw extruder for cereal snack making. In 1977 an oil extraction company launched TVP

Table 1. Introduction of Extrusion Cooking Technology in Korea

1974 :	Snack production with puffing gun (Nhong-Sim Confec. Co.)
1977 :	TVP production with Wenger single-screw extruder (Dong-Bang Oil Co.)
1978 :	Protein supplimented Food Snacks with single screw extruder (Meals for Million)
1982 :	Rice-bran extrusion stabilizer (KAIST project)
1983 :	Kellogs Honey Puffs with Clextral twin-screw extruder (Nhong-Sim Kellog)
1983 :	Experimental single-screw extruder (Korea Univ.)
1984 :	GF Post breakfast cereals with W & P twin-screw extruder (Dong-Suh Food Co.)
1986 :	Experimental single-screw extruder (AFMC-FRI)

*Review paper presented to The 2nd International Food Convention, Feb 18-23, 1988, Mysore, India

production by using Wenger extruder, but failed in commercial in a short period of marketing, due to the fact that consumers did not well accepted the product as meat substitute for Korean dish preparation at home. Recently, the industrial use of TVP is expanding rapidly, due to the growth of frozen Mandu, Korean traditional fast food, market.

Although the use of extrusion cooking has been most popular in confectionary snack food industry, there are many possiblities of applying this modern technology in the preparation of traditional food and their raw materials treatment. In this paper, recent research results and applications of extrusion cooking in Korean traditional food processing are reviewed.

Rice bran extrusion stabilizer

Rice bran oil is an important lipid resource in many rice eating countries, especially in East Asia. In general, rice milling plants are in small scale and scattered throughout the country. For the collection and transportation of rice bran from rice milling plants to oil extraction company, it takes long time and the bran deteriorates mainly by enzymatic lipid oxidation during this period. A low-cost extrusion cooker was designed to stabilize rice-bran at the site of rice milling plant by KAIST research group.[5] As shown in Fig. 1, heat is supplied by electric heating band around barrel, and the screw compression ratio is 1, which means a simple forward displacement. The numbers of die hole opening can be adjusted depending on the desired residence time, feed rate and temperature. The temperature distribution in the barrel showed that it reached to 120-130 °C at the end of barrel near to the die. The formation of free-fatty acid by enzymatic lipid oxidation could be stopped at 130 °C of extrusion temperature. The more effective enzyme inactivation was achieved by the lower moisture content of rice bran and the lower feed rate. By using extrusion stabilizer, the acid value of the degummed rice bran oil was substantially lowered, from 26.5 of untreated sample to 10.4 of treated one and the color of oil was improved remarkably. This stabilizer is presently installed at over 50 rice milling plants in Korea and also introduced to many countries in South East Asia, for example, Thailand and Indonesia.

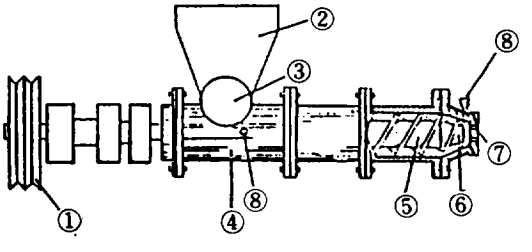

Fig. 1. Schematic structure of rice bran extrusion stabilizer
1) Drive pulley, 2) Hopper, 3) Feed screw, 4) Barrel, 5) Main screw, 6) Screw top, 7) Die plate, 8) Thermocouple

Instant rice cake

The use of instant rice cake in instant cup-noodle products is considered as a new successful case of extrusion-cooking. By conventional drying method, the slices of rice cakes are too hard and hardly reconstituted for 5 min in hot water. An extrusion cooker which produces rice-cake slices having fine porous structure was designed. A specially designed double die was used as shown in Fig. 2.[6] A mixture of rice flour, wheat flour and salt is extruded at 150 °C of autogeneous single screw extruder, and then cooled, sliced and dried. The product is easily reconstituted within 3 min in hot water, and still retaining the characteristic elastic and chewy rice-cake texture. Due to the development of the instant rice-cake,

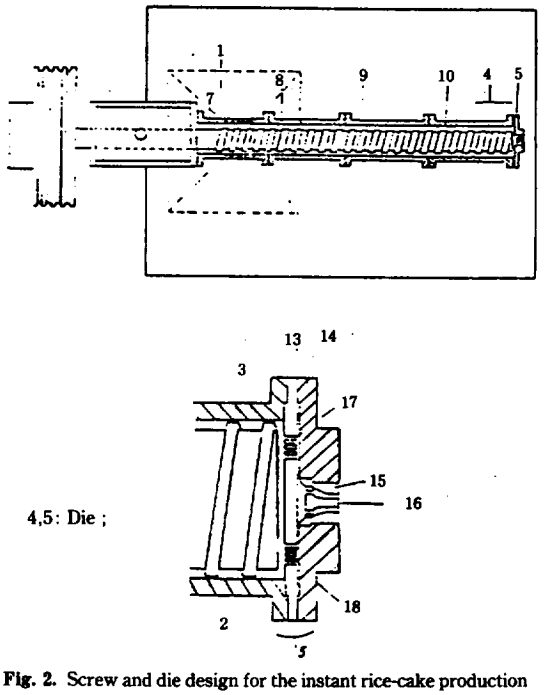

Fig. 2. Screw and die design for the instant rice-cake production

the quality of instant cup-noodle was greatly improved.

Cereal based lactic beverage

Lactic fermentation of cereals and vegetables is an important traditonal food processing technology in Korea. Kimchi is a typical lactic fermented vegetable food in Korea and Sikhae is a salt-fermented fish product made by lactic fermentation of added cereals. Some important microorganisms were isolated from Sikhae and used for the preparation of cereal based lactic beverage.

A new method of lactic fermentation of cereals was studied.[7] It consisted of three important steps; prefermentation, extrusion-cooking and lactic fermentation. Prefermentation of cereal powders was carried out in solid state by the innoculation of the mixture of a strong proteolytic bacteria, *Bacillus laevolactis,* and a strong amylolytic yeast, *Saccharomyces,* in order to increase the contents of sugars and other nutrients needed for the subsequent lactic fermentation.

Extrusion-cooking was applied to the prefermented mass in order to reduce the microbial load of the material, to eliminate the unpleasant smell originated from *Bacillus* and yeast, and also to disintegrate and gelatinize the flour structure. An autogeneous single screw extruder was used and the start-up period heat generation conditions were examined.

The start-up period heat generation rate varied with the kind of cereals; soybean flour marked the highest rate, but rice flour the lowest and wheat and barley flours were intermediate.[8] When the particle size was reduced to 120 mesh range, the compression section was abnormally heated and jamming was occurred.

Higher feeding rate also tended to increase the compression section temperature. When die section was not cooled, die temperature exceeded metering section temperature, and this resulted in unstable operation.

The optimum operation condition for the extrusion-cooking of prefermented cereal flours was thus established as shown in Fig. 3.

Extrusion-cooking enhanced the content of soluble solid of prefermented rice flours from 20% level to 70%. The dispersion stability of the flours was also remarkably improved.[7]

Extrusion-cooking alone did not influence the production of lactic acid during lactic fermentation of rice or rice and defatted soybean meal blend, but prefermentation increased the acid production significantly and reduced the pH down to below 4.0. It was also evidenced by the number of viable cells in the lactic fermentation broth; prefermented materials could grow 10^3 times higher number of cells compared to the control.

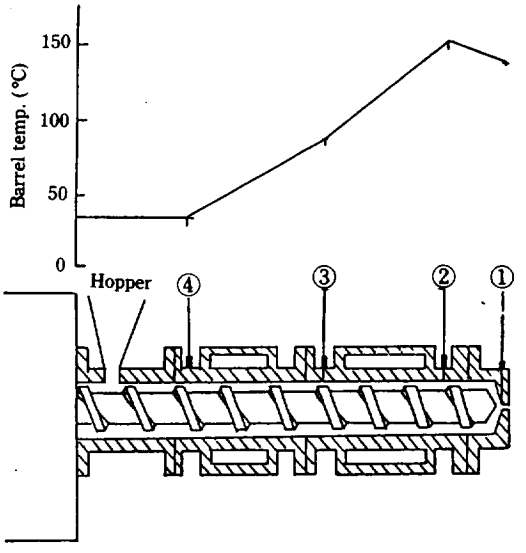

Fig. 3. The optimum barrel temp. distribution of the model extruder set-up

Extrusion-cooking reduced the viscosity of lactic fermented cereal suspension. However, the addition of DSM prior to extrusion cooking exerted detrimental effect for the color and consumer acceptance.

The results of sensory evaluation of the differently treated cereal based lactic beverage showed that extrusion cooking was able to remove the ill-effect of prefermentation, such as viscosity increase, off-flavor formation and contamination of non-lactic microorganisms (Table 2). By combining prefermentation and extrusion-cooking, the quality of lactic fermented cereal beverage was improved significantly.

Traditional alcoholic beverage

An attempt is presently under investigation for the application of extrusion cooking to Takju processing, a traditional Korean turbid alcoholic beverage made from rice. It had been widely consumed by labors and farmers, because it provides high and rapid energy supply to

Table 2. Advantage and disadvantage of prefermentation and extrusion-cooking on the quality of lactic fermented cereal beverage.

	Advantage	Disadvantage
Prefermentation	-Increase reducing sugar -Reduce fermentation time	-Increase viscosity -Improve acceptance -Decrease solubility and dispersion stability, if D.S.M. added without neutralization
Extrusion	-Decrease viscosity -Increase solubility -Improve flavor -Improve dispersion stability	-Reduce acceptance, if soybean added prior to to extrusion
Prefermentation-Extrusion	-Reduce fermentation time -Decrease viscosity -Increase solubility -Improve dispersion stability -Improve sensory acceptance	-Reduce sensory acceptance, if DSM added prior to extrusion(taste, color)

the body. The most important quality problem of this product inhibiting its modernization is the poor keeping quality, it becomes sour in 2-3 days even in refrigerator, and phase separation by sedimentation. By a new method using extrusion-cooker, 75% of the raw material can be extrusion-cooked and added directly to the second fermentation mixture. Some preliminary data indicate that the alcohol yield is substantially increased by using extrusion-cooker and the suspension stability is improved same as shown in lactic fermented cereal beverages.

Conclusion

Extrusion-cooking is a promising technology for the industrialization of traditional foods. Although many sophisticated and expensive extruders have been developed and are available in the market, simple and low-cost extruders find wider application in the developing countries. More studies on the application of extrusion-cooking for the traditional food processing and their raw materials treatment are needed.

요 약

식품 압출 성형공법을 이용한 전통 식품의 가공 및 개선에 관한 국내 연구 동향을 조사 평가한 것이다. 여기에서는 특히 Extruder를 이용한 미강안정화공법, 즉석 떡 제조법, 곡류를 기질로한 젖산 발효 음료 및 탁주 제조법에 관한 연구 결과를 다루었다.

References

1. Lee, C.H., Kim, D.C., Chun, J.H., Kim, C.J., Kim, J.B., Kim, J.D. and Son, C.C., 1987, Food Extrusion Technology (Korean), YuRim Moon Hwa Sa, Korea.
2. 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.
3. Han, O. and Lee, C.H., 1987, The structure and function of food extruder, Food Science (Korean), 20(2), 44.
4. Han, O., 1986, The state of extruded noodle processing technology in Korea, Presented to the 2nd Annual Meeting of Korea Society of Food Extrusion Research, Korea University, Seoul.
5. Kim, C.J., 1986, Thermal inactivation of rice bran lipase by extrusion-cooking for production of edible oil, Ph.D. Thesis, Korea Advanced Institute of Science and Technology, Seoul.
6. Park, Y.H. and Kim, N.S., 1986, Production of instant rice cake and the machine design, Korea Patent No. 86-1243.
7. Souane, M., Ryu, K.H., Kim, J.Y. and Lee, C.H., 1987, The effect of prefermentation and extrusion-cooking on the lactic fermentation of rice-soybean

based beverage, Presented to the 39th Annual Meeting of Korean Society of Food Sci. and Technol., Konkuk Univ., Seoul.

8. Ryu, G.H. and Lee, C.H., 1988, The effects of the type of cereal powder and extruder operation conditions on the barrel temperature distribution, Korean J. Food Sci. Technol., in printing.