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A Yogurt Like Product Development from Rice by Lactic Acid Bacteria

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Abstract

Non sticky short grain rice was liquidized by α-amylase from *Bacillus* species after cooking 20 min at 121 °C and a lactic acid bacteria fermentation proceeded. The product using mixed culture of *S. thermophilus, L. bulgaricus* and *L. plantarum* was superior than the one of any single or mixed culture. The most acceptable pH of it was 3.70. It is suggested that *L. plantarum* is more deeply related to the product quality. Skim milk promoted lactic acid fermentation but the quality of the final product was not acceptable in the result of sensory evaluation. The acceptable dilution rate of final product was 1:3 (rice: water) by weight.

Key words: rice fermentation, lactic acid fermentation, α-amylase

Introduction

Because of continuing rice surplus in Korea[1-2] and other country[3], new applications for increasing the utilization of this crop need to be developed. Grain hydrolysis products which include "Yut" (maltodextrin) and "Hikkae" (using malt) are in popular in Korea as traditional foods. But their total consumpution of rice are negligible.

Recently there is a trend to utilize the rice for snack preparation[4], bread[5] and other processed products in several countries[5-8] but not many attempts were made to utilize rice as a substrate of lactic acid fermentation except a few works[8-10].

Most of lactic acid fermented product are used malk and milk based substances because of taste and simple proliferation of lactic acid bacteria[11-12]. Non of commercial lactic acid fermented beverages are based on grains, especially rice or their related products yet except very few traditional foods in Africa and South Asia[13].

Therefore the present study was conducted to develop and test a procedure for lactic acid fermented yogourt like product from rice.

Materials and Methods

Materials

Short and non sticky grain rice of 1986 crop from Califonia was used for all test. Liquefactive α-amylase were obtained from Sigma Co. which were bacterial, crude type α-amylase from *Bacillus* species showed 90 units per mg solid(1 unit hydrolyzes 1.0 mg of maltose from starch in 3 min at pH 6.9 at 20 °C) and 1,4-α-D-glucan glucano hydrolase from *Bacillus licheniformis*, 695 units per mg protein (1 unit is same as above). The skim milk was obtained from Difco Co.

Rice liquefaction

After soaking rice in water overnight at 20 °C, sterilized it for 20 min at 121 °C in petri dish containing 30 g of rice (rice: water = 1:1 by weight finally). Enzyme solutions of 20,000 units aseptically filtered were added into the petridishes respectively and left them for 24 hours at 37 °C. The liquefaction degree after α-amylase application by above conditions was suitable for proceeded lactic acid bacteria fermentation and it's final Brix checked by refractometer was 20-25 (Fig. 1).

Lactic acid bacteria and enumeration

The lactic acid bacteria starter cultures, *Lactobacillus plantarum, Streptococcus thermophilus and Lactobacillus bulgaricus* which were obtained from Rosell Institute Inc. were enumerated separately with Elliker broth for 24 hours at 37 °C.

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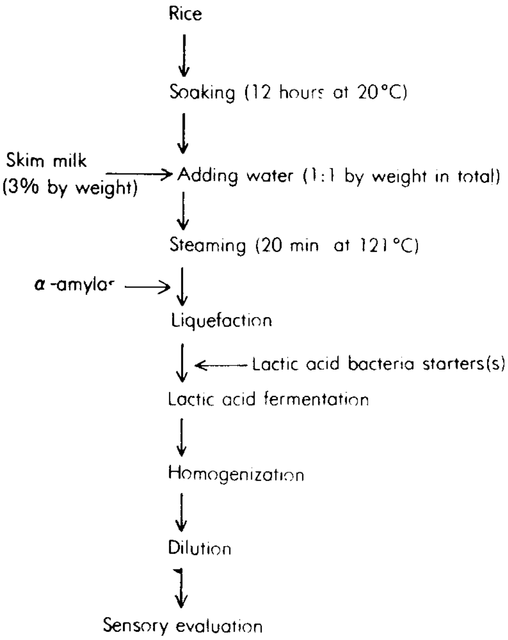

Fig. 1. Schematic of laboratory method for liquefaction and lactic acid fermentation of rice.

Lactic acid bacterial fermentation

The lactic acid bacterial starters(2 m*l*) were innoculated in liquidized rice in each petri dish and incubated at 37°C. The stater was applied singly or mixed two or three strains at innoculation stage.

Acidity and pH

The acidity was measured by titration method with 0.1N NaOH and pH was measured by Beckman pH meter.

Sensory evaluation

All fermented samples were evaluated for flavor, texture, and taste by 20 panel members. A scale of 1 to 10 was used in the order of acceptance: 1 indicates extremely poor and 10 extremely good.

Analytical data was statistically tested using the ANOVA and check the difference by LSD between treatments.

Results and Discussion

The titrable acidity and pH of liquidized lactic acid fermented rice using various lactic acid bacteria applied singly or mixed form are in Table 1.

For the process as a whole, pH and acidity were greatly changed within 12 hours incubation and kept go on until 48 hours incubation rather slowly. *S. thermophilus* and *S. thermophilus* mixed with *L. bulgaricus* showed slower acid production than other species especially comparing with *L. plantarum*. In case of mixed culture with *L. plantarum* was rather higher acid production than any

Table 1. Titrable acidity and pH[a] during incubation of liquidized rice by lactic acid bacteria.

Lactic acid Bacteria[b]		Time in hour 12	18	24	48
L. plantarum	pH[c]	4.00[d]	3.85	3.75	3.45
	acidity (%)	0.30	0.38	0.49	0.72
S. thermophilus	pH	4.80	4.70	4.50	4.20
	acidity(%)	0.17	0.17	0.20	0.29
S. thermophilus + *L. bulgaricus*	pH	4.60	4.40	4.40	4.40
	acidity (%)	0.36	0.41	0.38	0.41
S. thermophilus + *L. bulgaricus* + *L. plantarum*	pH	4.20	3.90	3.80	3.55
	acidity (%)	0.49	0.66	0.70	0.94

a) Commercial yogurt: pH 4.2, acidity 1.3%, Brix 11
b) Each species was incubated separately and mixed at innoculation stage if needed.
c) Initial pH was 5.8.
d) All data are mean value of triplicates.

Table 2. Titrable acidity and pH during incubation of liquidized rice mixed with 3% skim milk[a] by lactic acid bacteria.

Lactic acid Bacteria[b]		Time in hour			
		12	18	24	48
L. pantarum	pH[c]	4.45[d]	4.00	3.90	3.50
	acidity(%)	0.35	0.50	0.75	0.91
S. thermophilus	pH	4.70	4.50	4.50	4.35
	acidity(%)	0.20	0.35	0.38	0.43
S. thermophilus + *L. bulgaricus*	pH	4.70	4.60	4.55	4.30
	acidity (%)	0.56	0.56	0.58	0.63
S. thermophilus + *L. bulgaricus* + *L. pantarum*	pH	4.50	4.05	3.80	3.65
	acidity(%)	0.62	0.89	1.02	1.26

a) Skim milk was added to soaked rice and sterilized.
b), c), d); Same as foot note of Table 1.

other species used singly or mixed. Comparing with commercial yogurt, most of the treatments except *S. thermophilus* showed lower pH and higher acidity.

In order to fortify nutrients for lactic acid bacteria and improve the tastse of the final product, skim milk was mixed with liquidized rice in 3% level by weight. The titrable acidity and pH of each treatment were in Table 2.

The overall trend on pH and titrable acidity of are nearly same as Table 1., but a little lower pH and higher acidity in general. It means skim milk may accelerate lactic acid fermentation as already known.

The final taste of lactic acid fermented products including yogurt[11] and Kimchi[14-15] are deeply influenced by their pH. The sensory evaluation result of the lactic acid fermented liquidized rice is shown in Table 3. The minor differences found from flavor and texture but there were not significant differences detected by sensory panal mambers. But in taste, pH 3.7 was significantly different with pH 4.9 and pH 3.5. Depending upon product characteristics, their optimum pH are known[11, 14, 15] and commercial products must fit the optimum pH. It is possible to recommend that new lactic acid fermented rice products would be pH around 3.7.

Table 4 shows sensory evaluation results of fermented products using various lactic acid bacteria. There are no significant difference found from texture but flavor and taste. Mixed culture product using *S. thermophilus, L. bulgaricus* and *L. plantarum* together was superior significantly than the one with *S. thermophilus* and *L. bulgaricus* together. This results suggest that *L. plantrarum*

Table 3. Mean values for sensory traits of the fermented products[a] upon their various pH.

	pH			
	4.2	3.9	3.7	3.5
Sensory score[b]				
Flavor	4.6^{a}	5.4^{a}	5.5^{a}	5.1$_{a}$
Texture	5.3^{a}	5.0^{a}	5.1^{a}	4.8^{a}
Taste	4.9^{b}	5.9^{a,b}	6.0^{a}	4.9^{b}

(a) Rice used only and fermented by *S. thermophilus, L. bulgaricus* and *L. plantarum* mixed together.
(b) Mean scores of 20 panelist followed by unlike subscripts are significantly different ($P<0.05$)

Table 4. Mean values for sensory traits of the fermented products[a] using various lactic acid bacteria.

	L. plantarum	*S. thermophilus* *L. bulgaricus*	*S. thermophilus* *L. bulgaricus* *L. plantarum*
Sensory score[b]			
Flavor	5.65^{a}	4.74^{b}	6.10^{a}
Texture	6.15^{a}	6.00^{a}	6.10^{a}
Taste	6.65^{a}	4.90^{b}	6.35^{a}

a) Rice used only.
b) Same as Table 3.

Table 5. Mean values for sensory traits of the fremented products using various lactic acid bacteria and skim milk.

	Rice		Rice+Skim milk	
	S. thermophilus L. bulgaricus	S. thermophilus[b)] L. bulgaricus L. plantarum	S. thermophilus L. bulgaricus	S. thermophilus[b)] L. bulgaricus L. plantarum
Sensory score[a)]				
Flavor	5.3[a]	5.6[a]	4.6[a]	4.9[a]
Texture	4.9[a]	5.3[a]	5.1[a]	4.6[a]
Taste	4.9[b]	6.2[a]	4.5[b]	4.8[b]

a) Same as foot note No. 2 of Table 3.
b) Same as foot not No. 2 and Table 1.

Table 6. Mean values for sensory traits of the fermented product[a)] by dilution rate.

	Dilution Rate (Rice: Water)[b)]		
	1:2	1:3	1:4
Sensory score[c)]			
Flavor	4.35[b]	5.05[a,b]	5.60[a]
Texture	4.80[b]	6.20[a]	5.90[a]
Taste	4.60[b]	6.85[a]	6.05[a]

a) The product used mixed S. thermophilus, L. bulgaricus and L. plantarum.
b) Gel type products was diluted by adding water and homogenized by waring blender of 5 minutes.
c) Same as foot note No. 2 and Table 3.

is more suitable than other lactic acid bacteria for rice fermentation.

Although skim milk helps lactic acid production faster as Table 2, it doesn't any good to taste as the result of sensory evaluation in Table 5. Flavor and texture are not significantly different by lactic acid bacteria and substrate but taste is worse than rice used only ($p < 0.05$). It is agreed with Table 4. In some case, *Lactobacillus bulgaricus*[16] and *Lactobacillus spp*[17] were better than other lactic acid bacteria for barley fermentation.

The product prepared by procedure on Fig. 1. is a gel or paste type. It is some time not accepted to consummer, especially the people adapted to liquid lactic acid fermented products.

Table 6 shows which types of products are more acceptable to panel members. The most preferable dilution rate is 1:3. Actally there is no significantly different between 1:3 to 1:4 ratio, but it trends rather 1:3 ratio in general.

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쌀을 이용한 젖산 발효 음료 개발

신 동 화

전북대학교 농대 식품가공학과

현재까지 젖산 발효 음료는 우유나 혹은 그 관련 제품을 이용하여 제조하였으나 쌀을 액화 혹은 당화시켜 젖산균을 증식시키므로서 기호성 있는 젖산 발효제품 생산 가능성을 확인하였다.

멥쌀을 12시간 침지 후 총 흡수량이 무게비율로 쌀 : 물이 1 : 1이 되게 하여 121℃에서 20분 살균 후 액화 효소인 α-amylase를 작용시켜 액화한 후 이 액에 *Streptococcus thermophilus*, *Lactobacillus bulgaricus*, *Lactobacillus plantarum*를 단독으로 혹은 혼합하여 접종한 후 배양하여 쌀을 이용한 젖산 발효 제품을 얻었다.

제품의 관능검사 결과 최적 pH는 3.7 부근으로 발효시작 후 18시간이 소요되었으며 젖산균은 세 균주를 혼합하는 것이 가장 좋았으나, *L. plantarum*과 가장 관계가 깊었다.

Skim milk는 젖산 발효를 촉진하나 제품의 관능검사 결과 열등하였고 호상보다는 액상(쌀1 : 물3) 제품이 우수하였다.