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Risogurt, a Mixture of Lactic Acid Fermented Rice and Soybean Protein: Development and Properties

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Abstract

Soybean protein isolate was fermented using lactic acid bacteria. The properties of the lactic fermented soybean protein (LFSP) was compared with those of the lactic fermented rice (LFR). The LFSP was superior in nutritive value and rheological properties, whereas the LFR in color, flavor and taste. Mixing of the LFR and the LFSP was attempted to utilize the merits of both the LFR and the LFSP. The mixture was named Risogurt. The Risogurt had better flavor, taste, color and overall eating quality than the LFSP, and better nutritive value and consistency than the LFR. The optimum mixing ratio for the production of the Risogurt was 75% LFR and 25% LFSP.

Key words: lactic acid fermentation, soybean protein, rice, Risogurt

Introduction

A palatable lactic acid fermented product has been processed from rice by the authors.(1) The lactic fermented rice (LFR) was considerably acceptable regarding all sensory aspects except the low consistency. The low consistency of the LFR was caused by the inevitable amylolytic enzyme treatment during the fermentation, which was aimed at enhancing the sweetness and sourness and reducing the size of the particles contained, consequently at improving the smoothness of the LFR. Regarding the nutritive value, the LFR contained considerably low protein and lysine showing 2.0% and 62.5 mg%, respectively.(1)

Rice protein has been found to be rich in sulfur containing amino acids, but deficient in lysine. In contrast to the rice protein, soybean protein is rich in lysine but deficient in cysteine and methionine. Thus, rice-soybean mixturers are nutritionally complementary.(2) Moreover soybean products are of good nutritive value from the point of view of the protein quality in relation to cost.(3) Therefore, soybean protein has outranked all of the other proposed supplements of proteins in wordwide nutrition program.(4)

Soybean protein has similar properties to milk casein and forms a curd by lactic acid fermentation.(5-29) Soymilk is commonly characterized as having a beany, grassy, or soy flavor.(5) The flavor of soymilk has been reported to be improved by lactic acid fermentation.(3,6,7,17,18) Yogurt made from soybean protein isolate was superior in quality to that from soymilk.(17,29) Mun *et al.*(18) tested five lactic acid bacteria (LAB) for soy yogurt and found that *Lactobacillus bulgaricus* produced more acid in soymilk and made soy yogurt of the best quality among the tested LAB. A single or mixed cultures of *L. acidophilus*, *L. bulgaricus* and *Streptococcus thermophilus* have been found to be suitable for the lactic acid fermentation of soymilk or soybean protein products.(3,5,6,12,14,18)

This study was attempted to improve both the nutritional quality and the consistency of the LFR by adding a curd-type lactic fermented soybean protein (LFSP) to it. The mixture of the LFR and the LFSP was named 'Risogurt', which was a composite word of the rice yogurt and the soy yogurt.

Material and Methods

Soybean protein isolate

Soybean protein isolate (PP760) was purchased from Protein Technologies International, St. Louis, MO, U.S.A., through the local agent.

Lactic acid bacteria (LAB)

A 50:50 mixed culture of *L. bulgaricus* KCTC 2179

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and *S. thermophilus* KCTC 2185 was used for the lactic acid fermentation of the SPI. The LAB was propagated separately in MRS broth for 24 hr at 37℃.

Lactic acid fermentation of SPI

The SPI contained 92% protein. The SPI was dispersed in distilled water to have the same net protein content as cow milk (4.2%) and glucose was added at 4% level as prepared by Yoo *et al.*[14] The material was sterilized by heating for 20 min at 95℃. An inoculum (1% *L. bulgaricus* and 1% *S. thermophilus*) was added and the material was incubated at 37℃ for 40 hr to make a curd-type lactic fermented soybean protein (LFSP).

Preparation of Risogurt

The LFR was prepared as described in the previous paper[1]. Risogurt, a mixture of the LFR and the LFSP, was prepared by adding the LFSP to the LFR at appropriate ratio followed by mixing for 1 min on an impeller-type stirrer rotating at 200 rpm.

Sensory evaluation

Sensory evaluation was done by 6 trained panels. The Risogurt was evaluated for color, flavor, taste, smoothness, consistency (body), and overall eating quality. The sensory properties were rated by 5 point score test as dislike very much (1) to like extremely (5).

Viable cell count

The number of viable cells in the Risogurt was enumerated by a plating method[30] on a plate count agar containing 0.004% bromophenol blue as an indiator.

Physical properties

Rheological properties of the Risogurt were determined at 25℃ on a viscometer (Viscotron Model-80 24, Brabender, OHG, Germany). The shear rate vs. shear stress reltionship was analyzed by the power law model[31], $\tau = K\gamma^n$, where τ = shear stress (Pa), γ = shear rate (s^{-1}), K = consistency coefficient (Pa · s^n), and n = flow behavior index. Color was analyzed on a color difference meter (Yasuda, Model 600-IV, Yasuda Seiki Seisakusho Ltd., Osaka, Japan) in Judd-Hunter system[32]

Chemical analysis

Chemical composition of the product was determined by AOAC methods.[33] Amino acid contents were determined on an amino acid analyzer (LKB 4151 Alpha Plus, LKB Biochrom Ltd., England). All analyses were done in duplicate.

Table 1. Physical and chemical properties of LFSP in comparison with LFR.

Properties	LFSP	LFR
Acidity (%)	1.14	0.53
pH	3.08	2.95
Saccharometer reading (° Brix)	6.5	24.0
Moisture (%)	93.7	76.1
Protein (%)	3.5	2.0
Amino acid (mg%)		
Total	2753.0	1504.0
Lysine	164.5	62.5
Methionine	19.0	48.0
Cysteine	35.0	56.0
Color		
L	64.6	61.7
a	−2.7	−0.9
b	8.7	3.7
Apparent viscosity (mPa · s)		
At 110 s^{-1}	130.2	31.7
220 s^{-1}	82.9	21.2
Viable cell count (CFU/ml)	7.45×10^7	1.54×10^8
Sensory score[a]		
Color	2.71	3.72
Flavor	2.74	3.77
Taste	1.98	4.18
Smoothness	3.29	3.71
Consistency	4.04	2.66
Overall	2.19	3.98

[a]Rated as dislike extremely (1) to like extremely (5)

Results and Discussion

The physical and chemical properties of the LFSP in comparison with those of the LFR are listed in Table 1. The titratable acidity of the LFSP was 1.14% after 40 hr fermentation, which was higher than that of the LFR, 0.53%. In contrast, the LFSP showed higher pH than the LFR. The higher pH of the LFSP in spite of its higher acidity might be due to the buffering action of the soybean protein. The moisture and the soluble solid contents expressed as the saccharometer reading of the LFSP were 93.7% and 6.5° Brix. The protein content of the LFSP was 3.5%, whereas that of the LFR was 2.0%. The total amino acid and lysine contents of the LFSP were 2.75% and

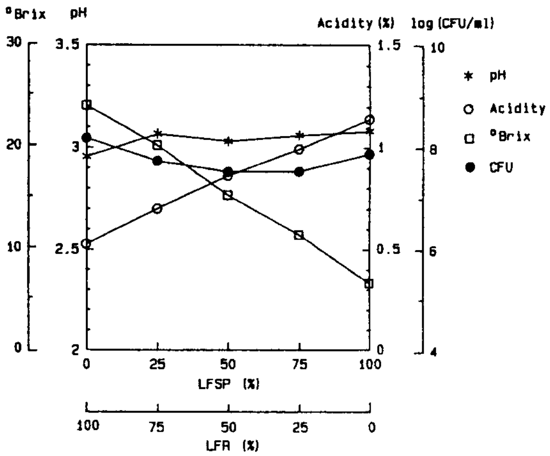

Fig. 1. General properties of Risogurt with respect to mixing ratio of LFR to LFSP

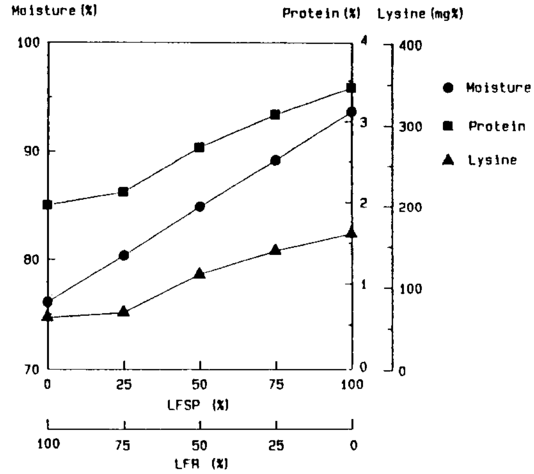

Fig. 2. Moisture, protein and lysine contents of Risogurt with respect to mixing ratio of LFR to LFSP

164.5 mg%. The calculated lysine content in the unit weight of the protein of the LFSP was 47 mg/g protein, which was higher than the provisional ideal pattern of the FAO/WHO,[34], 22 mg/g protein. Methionine and cysteine, the limiting amino acids of soybean protein, were contained higher in the LFR than the LFSP. The results meant that the LFR and the LFSP were nutritionally complementary.

The LFSP showed higher lightness and yellowness but lower redness than the LFR. The apparent viscosity of the LFSP was almost 4 times higher than that of the LFR. The viable cell count of the LFSP was 7.45×10^7 CFU/ml, which was a little lower than that of the LFR. For the sensory properties, the LFSP was inferior in color, flavor, taste and overall eating quality, but was excellent in consistency. The LFR, on the other hand, was superior in sensory qualities except the consistency. These results indicted that the taste of LFSP might be improved by mixing it with the LFR and also that the consistency of the LFR might be strengthened by adding the LFSP to it.

The mixing of the LFSP with the LFR was attempted to improve the nutritive value and the consistency of the LFR. The pH, acidity, saccharometer reading, and viable cell count of the resulted product (Risogurt) with respect to the mixing ratio of the LFR and the LFSP are shown in Fig. 1. The pH of the Risogurt was higher than the LFR, but showed consistent values with respect to the mixing ratio of the LFR and the LFSP. The acidity increased while the saccharometer reading, which was mostly attributed to sugars, decreased as the proporiton of the LFSP increased. The consitent pH of the Risogurt in spite of the increased acidity with increased proportion of the LFSP was due to the increased buffering capacity of the LFSP. These results indicated that the sourness of the Risogurt increased whereas the sweetness decreased with the increased ratio of the LFSP to the LFR. The viable cell count remained relatively constant at the level of 1.0×10^8 CFU/ml.

The moisture, protein and lysine contents of the Risogurt of varying ratio of the LFR to the LFSP are shown in Fig. 2. The moisture content of the Risogurt increased linearly with increased proportion of the LFSP. The protein and the lysine contents also increased as the ratio of the LFSP increased.

The rheological property parameters of the Risogurt of varying ratio of the LFR to the LFSP are listed in Table 2. As the proportion of the LFSP increased, the flow property became more pseudoplastic showing lower values in the flow behavior index and the Risogurt became more viscous showing the higher values in the consistency coefficient. These re-

Table 2. Rheological parameters of Risogurt with respect to mixing ratio of LFR and LFSP

Mixing ratio		Flow behavior index (n)	Consistency coefficient (K, Pa · s^n)
LFR	LFSP		
100	0	0.520	0.284
75	25	0.478	0.364
50	50	0.325	1.276
25	75	0.300	1.824
0	100	0.254	4.127

Table 3. Sensory scores[a] of Risogurt with respect to mixing ratio of LFR and LFSP

Mixing ratio		Sensory items[b]					
LFR	LFSP	Color	Flavor	Taste	Smoothness	Consistency	Overall
100	0	3.72a	3.77a	4.18a	3.71a	2.66c	3.98a
75	25	3.81a	3.92a	3.92a	3.65a	3.17bc	4.01a
50	50	3.44ab	3.32ab	3.14b	3.79a	3.65ab	3.11b
25	75	3.05bc	2.81b	2.22c	3.41a	3.71ab	2.53c
0	100	2.71c	2.74b	1.98c	3.29a	4.04a	2.19c

[a] Rated as dislike extremely (1) to like extremely (5).
[b] Values of each column with same letters are not significantly different at 0.05 level

sults indicated that the consistency (body) of the LFR could be improved remarkably by adding the LFSP to it.

The results of the sensory evaluation of the Risogurt are in Table 3. The color, flavor and taste of the Risogurt of the mixing ratio of LfR:LFSP of 75:25 were as good as the LFR itself. However those of the Risogurt of the higher mixing ratio of the LFR than 25% were inferior to those of the LFR and the degree of the inferiority was greater as the proportion of the LFSP increased. The smoothness of the Risogurt was not affected by the mixing ratio. The consistency of the Risogurt was improved greatly as the proportion of the LFSP incresed. These results indicated that the LFR and the LFSP were complementary not only for the nutritive value but also for the sensory properties. The score of the overall eating quality of the Risogurt was the highest at the mixing ratio of LFR:LFSP of 75:25 although there was no significant difference from the LFR itself. The Risogurt with mixing ratio of 75:25 of the LFR:LFSP contained 68.5 mg% lysine, 29 mg% methionine, and 49.0 m% cysteine, which were higher in lysine than the LFR and richer in methionine and cysteine than the LFSP.

It was concluded from the results of this study that the mixing of the LFSP with the LFR could utilize the advantages of the two products; the high consistency and the high protein and lysine contents of the LFSP, and the good color, flavor and taste, and high sulfur-containing amino acids of the LFR. The optimum mixing ratio for the production of the Risogurt was 75:25 of the LFR:LFSP.

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쌀젖산발효물과 대두단백젖산발효물의 혼합에 의한 라이소거트의 개발과 특성

목철균 · 한진숙 · 김영진 · 김남수 · 권대영 · 남영중

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대두단백젖산발효물과 쌀젖산발효물의 특성을 비교하였다. 쌀젖산발효물은 색택, 향미가 우수하였고 대두단백젖산발효물은 영양과 물성이 우수하였다. 쌀젖산발효물과 대두단백젖산발효물 각각의 우수한 특성을 이용하기 위하여 이들을 혼합하였고 이혼합물을 라이소거트라 명명하였다. 라이소거트는 대두젖산발효물 보다 향, 맛, 색택, 종합적기호도가 월등하였으며, 영양 및 유변학적 특성면에서 쌀젖산발효물 보다 우수하였다. 라이소거트의 적정혼합비율은 쌀젖산발효물: 대두단백젖산발효물 75:25 이었다.