DEVELOPING FERMENTED GOAT MILK CONTAINING PROBIOTIC BACTERIA

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Received September 15, 2013; accepted in revised form November 29, 2013

Abstract: The aim of this study was to develop probiotic fermented goat milk. Goat milk was inoculated with single (*Bifidobacterium longum* and *Lactobacillus acidophilus*) and mixed cultures containing *Bifidobacterium longum* and *Lactobacillus acidophilus*. Goat milk was pasteurized at 95°C for 5 min, cooled to 37±1°C, and inoculated with the required culture before incubation. The combined culture *B. longum* : *L. acidophilus* (8 : 1) was used when it had attained a pH 4.5±2 and a titratable acidity 65–70. Goat milk for fermented milk was sterilized at 120°C for 10 min, cooled to 37°C, and inoculated with 8–10% of the bifidobacterium culture, and goat milk was pasteurized at 95°C for 20 min, cooled to 42°C, and inoculated with 3% of the L. acidophilus culture. The cultures were used when they attained pH 4.3 and 4.5 and titratable acidity between 56 and 800T. The developed technology of fermented milks and the characteristics of fermented goat milk were studied. According to the findings, we concluded that fermented goat milk was balanced by the amino acid content and products of high biological value. Fermented goat milk with the expected beneficial health effect is based on a high concentration of probiotic bacteria.

Key words: probiotics, *Bifidobacterium longum, Lactobacillus acidophilus*, amino acids, biological value

UDC 637.12'6.04/.07
DOI 10.12737/2050

INTRODUCTION

Fermented milk enriched with probiotic bacteria has developed into a very successful category of functional foods.

In recent years, interest has increasingly focused on foods that affect health positively beyond their nutritional value. Among these functional foods, much attention has been given to probiotic products. Probiotic foods contain microorganisms or components of microbial cells that have a beneficial effect on the health and well-being of the consumer host [5]. The viability of probiotic bacteria of high counts (at least 10^7 cfu/g, or cfu/mL, of product) is recognized as an important requirement during the manufacturing and marketing of probiotic foods in order to achieve the claimed health benefits.

Goat milk has been described as having a higher digestibility and lower allergenic properties than cow milk. In addition, goat milk has been attributed with certain therapeutic values in human nutrition [1].

According to statistical data, the livestock population in Mongolia increased to 42 million head. The goat population is increasing especially due to the growing price of cashmere in the world market. Therefore, the goat milk recourse is increasing in Mongolia.

In order to organize the industrial processing of goat milk and the production of dairy products in Mongolia, we have studied the chemical composition of the goat milk of the Mongolian breed, especially to identify amino acids, minerals, and vitamins, as well as the fractional structure of whey proteins in this goat milk. We also determined toxic elements and radio nucleoids in goat milk to assess safety. Moreover, we studied the technological properties of goat milk.

The objective of this study was to evaluate the effect of the starter cultures (*Bifidobacterium longum* and *Lactobacillus acidophilus*) during the manufacture of fermented goat milk, grown separately as single species and in combination with bacteria for probiotic production. Then the characteristics of products manufactured from fermented goat milk were studied.

MATERIALS AND METHODS

The object of the study was goat milk from private farms. The starter cultures, *Bifidobacterium longum* and *Lactobacillus acidophilus*, were obtained from Chr. Hansen Laboratories (Copenhagen, Denmark) and were used to develop the technology of fermented milks.

Chemical analysis. The pH value was measured using an pH meter. Total acidity percentage (as lactic acid), fat, protein, lactose, and total solids were determined according to AOAC (2000).

Total bacterial counts were determined by using plate count agar according to the Standard Methods for the Examination of Dairy Products [2, Case et al.].

The amino acid composition was determined using the automatic amino acid analyzer LG-5000 (Germany), based on ion-exchange chromatography. For the estimation of protein quality, the irreplaceable amino acid

score was evaluated using the following formula [FAO/WHO].

RESULTS AND DISCUSSION

At present, probiotic products manufactured from *B. longum* and *L. acidophilus* are practiced widely.

The combined culture was prepared from *Bifidobacterium longum* and *Lactobacillus acidophilus* in a particular proportion (2:1; 5:1; 8:1). The characteristics of the combined cultures were studied. Results are shown in Table 1.

Table 1. Selection the optimal proportion of culture in the combined starter culture

Rate of culture	Incubation time, h	Acidity, ^{0}T	pH	Viability bacterial count (log cfu/g)	
				Bifidobacteria (*B. longum*)	*L. acidophilus*
2 : 1	4.5	73–78	4.64	7×10^7	4×10^8
5 : 1	6.0	70–75	4.72	5×10^8	3×10^8
8 : 1	7.5	60–65	4.80	3×10^9	2×10^8

According to the data in the table, the duration of fermentation for different cultures was 4.5–7.5 hours.

The findings show that the viable cell count of the combined culture was quite high, 2×10^8 cfu/g.

Therefore, the 8 : 1 ratio of the cultures was selected to develop a fermented milk technology. Probiotic fermented milk was prepared from fresh goat milk.

The development of *B. longum*, *L. acidophilus*, and *B. longum : L. acidophilus* (8 : 1) cultures was inoculated at 10.3 and 4% and was followed by measuring changes in titratable acidity and pH. At the first stage, the prepared fermented combined culture was used.

The goat milk was pasteurized at 95°C for 5 min, cooled to 37±1°C, and inoculated with the required culture before incubation. The combined culture *B. longum : L. acidophilus* (8 : 1) was used when it attained pH 4.5±2 and titratable acidity 65–70.

The next stage of preparing fermented milk used two different starter cultures.

Goat milk for fermented milk was sterilized at 120°C for 10 min, cooled to 37°C, and inoculated with 8–10% of the bifidobacterium culture, and goat milk was pasteurized at 95°C for 20 min, cooled to 42°C, and inoculated with 3% of the *L. acidophilus* culture.

The cultures were used when they attained pH 4.3 and 4.5 and a titratable acidity between 56 and 80^{0}T.

The developed technology of fermented milks and the characteristics of fermented goat milk were studied.

Biological value of fermented milk. The quality of foodstuffs is characterized by their chemical composition, physical properties, and nutrient and biological values. For all this, biological value is the most important parameter as it determines how products correspond to the optimal needs of human physiological norms.

As we all know, biological value reflects the quality of protien components in products and the level of balance in amino acidity composition.

Proteins in some traditional foodstuffs and in foods obtained from new sources differ in the content of irreplaceable amino acids. Therefore, their amino acidity was calculated for evaluating the biological value of fermented milk (Table 4).

Table 2. Physicochemical and microbiological characteristics of fermented goat milk

Parameter	Fermented milk		
	With *L. acidophilus*	With bifido bacteria	With combined culture
Fat, %	3.5	3.5	3.5
Protein, %	3.3	3.3	3.3
Acidity, ^{0}T	80	56	70
Bacterial count, (cfu/g)	10^8	10^9	10^9

Table 3. Free amino acid compositions of goat fermented milk

Amino acids, %	Fermented milk		
	With *L. Acidophilus*	With bifido bacteria	With combined culture
Valine	5.5	6.7	6.9
Isoleucine	3.9	3.8	6.2
Leucine	8.7	8.4	9.1
Lysine	7.3	7.2	7.5
Methionine + Cystine	6.4	6.7	3.7
Tryptophane	1.3	1.6	1.8
Threonine	4.48	4.87	4.9
Phenylalanine + Tyrosine	8.43	8.63	9.4
Alanine	3.85	3.34	3.6
Arginine	7.48	7.44	3.5
Aspartate	7.54	7.55	6.9
Hystidine	2.95	2.95	24.9
Glycine	1.95	3.04	2.1
Glutamate	14.24	13.64	22.0
Proline	5.06	4.91	10.6
Serine	3.97	3.55	5.7

Table 4. Irreplaceable amino acids of fermented goat milk

Amino acids, %	Fermented milk		
	With *L. Acidophilus*	With bifido bacteria	With combined culture
Valine	122.6	108.0	133.7
Leucine	143.6	140.5	124.0
Isoleucine	109.6	104.5	145.6
Lysine	134.2	130.1	131.2
Methionine + Cystine	115.1	110.2	118.9
Threonine	133.5	122.6	133.7
Tryptophane	144.3	156.0	124.0
Phenylalanine + Tyrosine	145.2	137.3	145.6

The biological value of protein is characterized to a considerable extent by the content of irreplaceable amino acids compared to the "ideal" FAO/WHO protein.

The data in the table show that irreplaceable amino acids in fermented milks are well balanced.

CONCLUSIONS

According to the results of the study, we concluded that fermented goat milk products were balanced in their amino acid content and were of a high biological value. The fermented goat milk retains high counts from added probiotics, which are recommended to produce therapeutic effects.

REFERENCES

1. Alférez, M.J., Barrionuevo, M., López-Aliaga, I., Sanz-Sampelayo, M.R., Lisbona, F., Robles, J.C., and Campos, M.S., Digestive utilization of goat and cow milk fat in malabsorption syndrome, *Journal of Dairy Research*, 2001, vol. 68, no. 3, pp. 451–461.
2. *Standard Methods for the Examination of Dairy Products*, Richardson, G.H., Ed., Washington, DC: American Public Health Association, 1985, 15th ed.
3. *Mongolian Statistical Yearbook 2013*, Ulaanbaatar: National Statistics Office of Mongolia, 2013.
4. Tsend-Ayush, Ch. and Ganina, V.I., The micronutrient composition of the milk of Mongolian small pasture cattle, *Khranenie i pererabotka sel'khozsyr'ya (Storage and Processing of Agricultural Raw Materials), 2009, no. 9, pp. 32–34.*
5. Salminen, S., Ouwehand, A., Benno, Y., and Lee, Y. K., Probiotics: How should they be defined? 1999, *Trends in Food Science & Technology*, vol. 10, no. 3, pp. 107–110.