Bulgarian Journal of Agricultural Science, 19 (2) 2013, 94–96
Agricultural Academy

STARTER CULTURES FOR PRODUCTION OF YOGHURT FROM SHEEP'S MILK WITH EXTENDED SHELF LIFE

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Abstract

ZVANCHAROVA, T., K. BALTOVA and Z. URSHEV, 2013. Starter cultures for production of yoghurt from sheep's milk with extended shelf life. *Bulg. J. Agric. Sci*., Supplement 2, 19: 94–96

Originally, Bulgarian yoghurt was prepared from sheep's milk, but the homemade product had only a few days of shelf life. Today under industrial conditions, yoghurt with shelf life of 20 days is routinely produced. Nevertheless, producers and exporters are still interested in sheep's milk yoghurt with even longer storage period. In this study, we produced yoghurt with three selected starters and followed up its quality during three months of storage at 5°C. All three starters had low post acidification in the products. The freshly produced yoghurt samples had a pH of 4.17–4.39 which decreased gradually, but after 90 days it was still in the range 4.12–4.30 which was within the acceptable range. Viable cells of *Streptococcus thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus* remained above the critical threshold of 10^8 and 10^6 cfu.ml^{-1} respectively for the whole period of 90 days. With the selected starters, the accumulation of products of proteolysis remained low with a slight increase only during the first month of storage. The limited proteolysis and low post acidification by the starters was achieved by the selection of weakly proteolytic strains of *L. bulgaricus* and/or a fermentation process with final viable cells of *L. bulgaricus* not exceeding 10^7 cfu.ml^{-1}. Organoleptic tests did not reveal any adverse change of product taste and aroma of yoghurt samples at day 90. In conclusion, production of sheep's milk yoghurt with selected starters can give a product that will preserve its nutritional and biological value for as long as three months.

Key words: Lactobacillus bulgaricus, proteolysis, sheep's milk, shelf life, yoghurt

Introduction

Bulgaria is famous for the traditional production of sheep yoghurt. Ewes are predominant in Bulgaria due in part to steep mountains, climate and tradition. Fat of sheep's milk forms globules smaller than fat globules of cow's milk (Assenat, 1985). Smaller fat globule diameter and greater percentage of short chain fatty acids contribute to easier and more rapid digestion of sheep's milk. Short-chain fatty acids such as caproic, caprylic and capric give its special taste and aroma and have health benefits (Havel, 1997). It is richer in vitamins A, B and E, calcium, phosphorous, potassium and magnesium than cow's milk (Berger et al., 2004). Sheep's milk is a unique product with high nutritional qualities containing more short-chain fatty acids, more protein, more calcium and more vitamins than cow's milk.

In recent years, increasing consumption of sheep yoghurt has raised the question of the possibility to extend its shelf life by preserving the nutritional value and quality of the product for longer time. The original Bulgarian homemade product had only a few days of shelf life. Today under industrial conditions, yoghurt with shelf life of 20 days is routinely produced, and this term is fixed in the Bulgarian State Standard for yoghurt (BSS 12-2010, 2010). Nevertheless, producers and exporters are still interested in sheep milk yoghurt with even longer storage period. The objective of the present work was to describe the selection and the influence of different symbiotic cultures on the technological and microbiological parameters to ensure the success of sheep milk yoghurt with extended shelf life up to 90 days at 5°C.

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Materials and Methods

Milk samples/ Yoghurt preparation

Sheep milk samples were obtained from a local commercial sheep farm. Whole sheep milk homogenized and pasteurized at 95°C with delay 10 min was cooled to inoculation temperature 43°C. Then 2% of liquid symbiotic yoghurt starter cultures LBB.BY5-12, LBB.BY53/4-23/3 or LBB. BY57/3-23/3 (LB Bulgaricum PLC, Sofia, Bulgaria) were added by stirring. Inoculated milk was poured in plastic containers and placed in a thermostatic chamber. The fermentation process continued at 43°C for about 2.5–3 hours until pH of 4.7±0.2. Then milk samples were refrigerated immediately and stored at 5°C for 90 days.

Bacterial cells enumeration

The spread plate technique was used to determine viable cell counts (cfu.ml^{-1}). Ten-fold serial dilutions were prepared and plated on MRS or M17 agar to enumerate *Lactobacillus delbrueckii subsp. bulgaricus* and *Streptococcus thermophilus* cells, respectively. Plates were incubated for 72 h at 37°C. All the plating was performed in duplicate.

Physicochemical and sensory analyses

The pH of yoghurt samples was measured at 1, 30, 60, 90 days of storage at 5°C by using a METTLER TOLEDO MP 220 pH-Meter. The proteolysis in yoghurt was assayed with the method of Church et al. (1983). The accumulated products of proteolysis are expressed as mM methionine equivalents. The hardness of the coagulum was determined with a Curd Meter Max ME-305/HI-80 equipped with a plotter. A 100 g weight distributed on a 20 mm disk was gradually lowered to the surface of the product. The unit recorded the weight applied at the moment of breaking of the coagulum. Whey separation was measured by centrifugation of 50 g product at 3000 rpm for 10 min and measuring the weight of the supernatant. The syneresis was calculated by the formula:

$$WS\% = (W/SV)*100,$$

where: WS – is the value of syneresis, W – the weight of the supernatant /g/ and SV – the weight of the initial sample, g.

Yoghurt samples, contained in white plastic covered cups and coded randomly, were scored in terms of: aroma; color; presence of whey; consistency after breaking the gel with a spoon; presence of lumps after stirring; mouth feel, taste, acidity and overall preference.

Results and Discussion

Viable cells of *Streptococcus thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus* remained above the critical

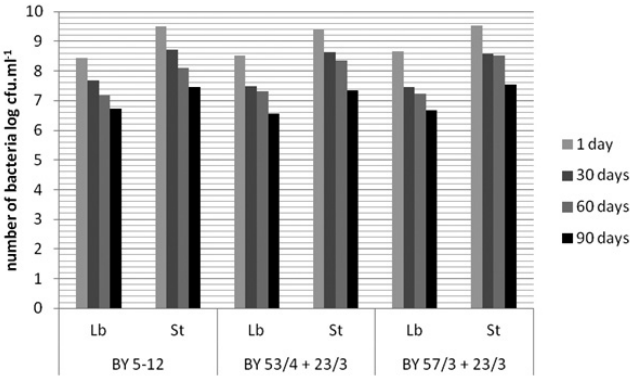

Fig. 1. Bacterial enumeration of *Lactobacillus delbrueckii* ssp. *bulgaricus* (Lb) and *Streptococcus thermophilus* (St) with starters BY 5-12, BY 53/4 + 23/3, BY 57/3 + 23/3 during storage

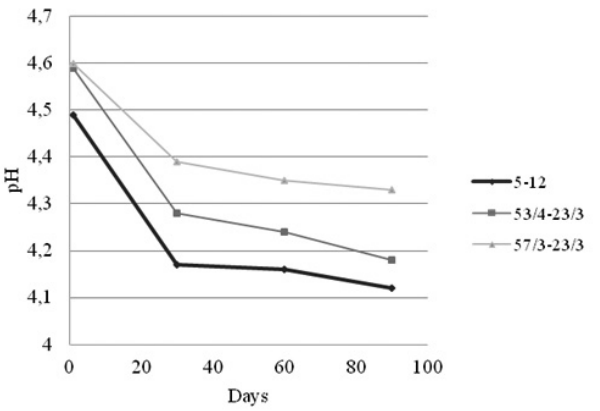

Fig. 2. Dynamics of pH in sheep's yoghurt samples produced with different starters during storage

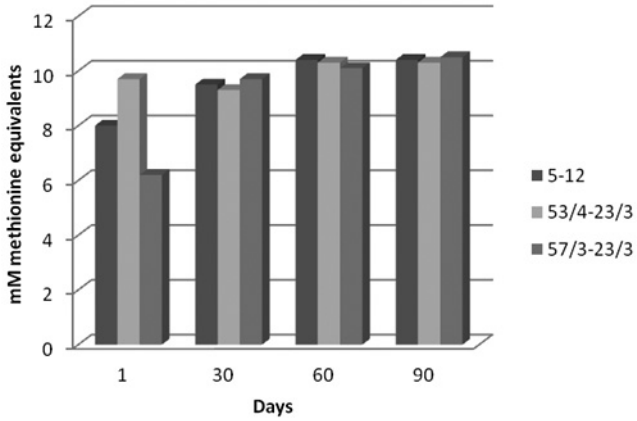

Fig. 3. Accumulation of products of proteolysis in sheep's yoghurt during storage

Table 1

Individual scores obtained by the organoleptic assessment of sheep yoghurt samples after 90 days storage

Indicators	Applied starter			
	Maximal score	BY 5–12	BY 53/4 +23/3	BY 57/3 + 23/3
Overall appearance	10	9.7±0.4	9.8±0.4	9.8±0.0
Consistency	10	9.4±0.5	9.6±0.5	9.7±0.0
Flavor	10	7.8±1.09	8.9±1.09	9.3±0.5

Table 2

Technological parameters of sheep yogurt during storage (90days, 5°C)

Product	Storage, days	pH	Hardness, g	Whey separation, %
Sheep yogurt with starter BY 5-12	1	4.49	44	19.90
	30	4.17	44	19.50
	60	4.16	45	20.21
	90	4.12	45	20.12
Sheep yogurt with starter BY 53/4-23/3	1	4.59	44	19.01
	30	4.28	45	19.42
	60	4.24	46	20.76
	90	4.18	46	21.11
Sheep yogurt with starter BY 57/3-23/3	1	4.60	47	19.81
	30	4.39	46	20.42
	60	4.35	47	21.16
	90	4.33	48	21.15

threshold of 10^8 and 10^6 cfu.ml^{-1} respectively for the whole period of 90 days (Figure 1). All three starters had low post acidification in the products. The freshly produced yoghurt samples after 24h refrigerated storage had a pH of 4.49–4.60 which decreased gradually, but after 90 days it was still in the range 4.12–4.33 which was within the acceptable range (Figure 2). With the selected starters the accumulation of products of proteolysis remained low with a slight increase only during the first month of storage (Figure 3). The limited proteolysis and low post acidification by the starters was achieved by the selection of starters containing weakly proteolytic strains of *L. bulgaricus* and/or a fermentation process with final viable cells of *L. bulgaricus* not exceeding 10^7 cfu. ml^{-1}. Organoleptic tests did not reveal any adverse change of product taste and aroma of yoghurt samples at day 90. The results from the sensory evaluation are presented in Table 1. The hardness of the coagulum was similar for yoghurts produced with each of the three starters and slightly increased during storage (Table 2). Whey separation remained low for the whole period of observation (Table 2).

Conclusion

In this study, we were able to show that the shelf life of sheep's yoghurt with selected starter cultures can be extended up to 90 days at 5°C. This product with extended shelf life would stimulate production and facilitate distribution of sheep's yoghurt while consumers would obtain a product with high nutritional and biological quality. Nevertheless the presented technology for production of sheep's yoghurt with low proteolytic starter cultures has still to be tested on the market and to receive feedback from dairy industry.

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