

DETERMINATION OF TECHNOLOGICAL PROPERTIES OF VARIOUS STARTERS FOR OBTAINING OF FERMENTED MILK PRODUCTS FROM GOAT MILK

Zhanara Tulemissova, Zubaira Kozhakhmetova, Gulmira Kassenova,
Akkenzhe Omarova, Hamidullah Alizada

Kazakh National Agrarian University, Abay Avenue 8, Almaty 050010, Kazakhstan

Abstract

The article presents results of researches on the use of goat milk as raw material for the preparation of fermented milk products. The comparative characteristics of technological properties obtained by the fermentation of goat milk with different starter cultures are shown.

Key words: *technology, goat milk, starter, fermentation, lactic acid bacteria, bifidobacteria, sensory properties*

In recent years consumers interest in goat's milk has significantly increased, as this valuable product, due to its composition, has unique properties - it improves the immune system, and improves the body's ability to combat diseases. It is probably no accidents that are so many centenarians in the southern regions, where a lot of goat's milk is commonly used. Goat's milk is traditionally considered to alleviate gastric diseases, prevent loss of vision, diabetes and many other diseases.

In developed countries, the production of fermented milk products on an industrial scale depends on quality ferments with a certain composition and high technological properties. However, starter cultures are developed mainly for cow's milk and are not optimal for milk obtained from animals of other species. The principles of selecting strains of bacteria in the starter cultures depend on the type of fermented milk product, while the main criteria for selecting starter cultures are: suppression of growth of opportunistic and technologically harmful micro flora, activity of coagulation of milk, absence of mutual suppression, the number of viable bacterial cells in the production starter. In this case, the microflora of fermented milk products should not disturb the normal intestinal microflora (Serikbaeva et.al.2008).

Market of dairy products is mainly prepared from cow's milk in the republic of Kazakhstan. But, the problem is that 40% of the population does not suffer from digesting milk sugar lactose, which is found in large amounts in cow's milk and due to which children are exposed to such disease as diathesis (Alashbayeva et.al.2014).

More efficient use of traditional fermented milk products based on modern starter technology would be an example of biotechnological approaches ensuring the production of new, high-quality foods and thus improving the economic conditions, nutrition and health of both producers and consumers.

Properties and composition features of goat milk and its processed products could be effectively alternative for cow's milk. Therefore, there is a big social challenge to feed pregnant and breastfeeding women, infants and children. The result shows that goat milk is different than cow. Its fractional composition of proteins almost never causes allergic reactions and digestive disorders (Rockova et al., 2011).

It is known that casein is the main protein of cow's milk causes strong allergen for people. The content of this protein fraction in goat's milk is 2 times less than in cow's milk. The content of beta-casein, is 2.3 times more, and due to this goat's milk forms a soft clot, easily digested in the human stomach (Zabodalova et.al. 2012).

The size of the protein molecules of goat milk are smaller than cow milk, which leads to more rapid and complete decay under the action of digestive enzymes of man. The fat content of goat milk and cow milk are almost on the same level, but if fat content 4, 1-4, 5% goat's milk is digested with almost

100%. Feature of goat milk is high in calcium, magnesium, chlorine, phosphorus, manganese, selenium and less compared to cow the amount of sodium, iron, sulfur, zinc and molybdenum.

The assortment of products produced from goat milk in our country is very meager. However, the prospects for processing goat's milk for sour-milk products are very wide, which is related to consumer demand.

There have been some studies focused on selected strains from goat's milk with a technological potential to be used as adjunct, or starter culture in dairy products (Ayad et al. 2004; Badis et al. 2004a, b). The isolation of strains from goat's milk has the advantage of giving a higher choice of selection and can be considered as proper source for new *Lactobacillus* strains susceptible to be used as adjunct cultures in dairy products with safety and technological potentials (Ahmed Marroki et.al. 2014).

So far, little attention has been paid to the study of organoleptic, physical-chemical and biotechnological properties of milk of small cattle milk, particularly goats.

In this regard, we conducted research for the process of fermentation of goat milk by different kinds of starter cultures in order to obtain fermented milk based on goat milk, and the characteristics of the resulting clots were studied. For this purpose, we studied indicators as the rheological, physicochemical and organoleptic properties of the clots, as well as the technological properties of the final fermented milk product.

MATERIALS AND METHODS

For the fermentation of goat's milk, 9 kinds of different starter cultures were used in the experiment, which included monocultures of lactic acid and bifidobacteria: *Lb. acidophilus* 015k-1; *Lb. bulgaricus* 018k-1; *Lactococcus lactis* 010k; *Bifidobacterium bifidum* 4/7, as well as the same cultures in different compositions: composition 1 - *Lb. bulgaricus* 018k-1 + *B. bifidum* 4/7; Composition 2 - *Lb. acidophilus* 015k-1 + *B. bifidum* 4/7; Composition 3 - *Lb. acidophilus* 015k-1 + *B. bifidum* 4/7 + *Lactococcus lactis* 010k; Composition 4 - *Lb. bulgaricus* 018k-1 + *B. bifidum* 4/7 + *Lc. lactis* 010k.

As a raw material for fermentation, three versions of goat milk were used: raw milk: milk, sterilized at 1 atmospheric pressure with a holding time of 10 minutes and milk pasteurized at 65 ° C with an exposure of 30 minutes.

For fermentation, the milk was cooled to 35-37°C, after which the above-mentioned starter cultures were added in an amount of 5%. The samples were mixed in thermostat at 35°C until the appearance of clot. The ratio of introduced cultures in the composition of poly component starter was 1: 1: 1.

When choosing ferments, we have considered the stability of technological and functional properties, such as organoleptic properties, ability to accumulate biomass, the ability to form viscous clots, and also the criteria for probiotic microorganisms were taken into account. Sensory properties are one of the defining indicators of the quality of the final fermented milk product. In addition, when selecting starter cultures for a combined starter, it is necessary to study the degree of production of antibiotic substances by the cultures under study.

RESULTS

Initially, the dynamics of acidification of starter cultures was studied in the process of fermentation of goat milk up to three days. The results are shown in Table 1.

Table 1. Dynamics of acid formation of mono- and mixed cultures in goat milk with different exposure

Strains	Goat milk		
	Raw	Pasteurized	Sterilized
Lb.acidophilus 015κ-1	108	90	95
Lb.bulgaricus 018κ-1	109	90	98
Lactococcus lactis 010k	105	72	80
Bifidobacterium bifidum 4/7	128	97	100
Lb.acidophilus 015κ-1 + Bifidobacterium bifidum 4/7	130	113	102
Lb.bulgaricus 018κ-1 + Bifidobacterium bifidum 4/7	132	115	105
Lb.acidophilus 015κ-1 + Bifidobacterium bifidum 4/7 + Lactococcus lactis 010k	130	119	113
Lb. bulgaricus 018κ-1 + Bifidobacterium bifidum 4/7 + Lactococcus lactis 010k	126	117	110

According to the results of the activity of acid accumulation, it was found that the best for obtaining a dairy product was raw goat milk. In this case, the active acidity was 108-130⁰T, in the second and third options in sterile and pasteurized milk the acid production decreased by 10-150T, activity acid accumulation was within the 90-1190T.

From starter cultures used, the best was sourdough, which included three crops: Lb.acidophilus 015κ-1 + Bifidobacterium bifidum 4/7 + producer Lactococcus lactis 010k. In all three options it showed high activity at acid accumulation compared to other starter cultures used.

The next task of our research was to study the technological properties of the final product based on the studied cultures. The results are shown in Tables 2-9.

Table 2. Technological properties of the product obtained from goat's milk with a monoculture of LB.acidophilus 015κ-1

Types of research		Goat milk		
		Raw	Pasteurized	Sterilized
The clotting time, in hours.		12	15	16
Active acidity, ⁰ T		108	90	95
Ultimate acidity, after 7 days, 0T		225	202	209
Sensory properties	Consistency	Homogeneous	Homogeneous	Homogeneous
	Smell	Fermented milk	Fermented milk	Fermented milk
	Colour	White	White	White
	Taste	Pleasant sour	Nice, slightly acidic	Pleasant dairy
Diacetyl, mg %		0,02	0,015	0,015
Volatile acids, mEq/lit		1,2	1,1	1,1
The number of cells, million/ml		5,0	4,0	4,0
The formation of antibiotic substances, mm		13-15	10-12	10-11

Table 3. Technological properties of the product obtained from goat's milk with a monoculture *Lb.bulgaricus* 018κ

Types of research		1 st sample	2 nd sample	3 rd sample
The clotting time in an hour		15	16	16
Acidity, °T		109	90	98
The limit acidity after 7 days		295	266	260
Sensory properties	Consistency	Homogeneous, viscous	Homogeneous, viscous	Homogeneous, viscous
	Smell	Pleasant dairy	Pleasant dairy	Pleasant dairy
	Color	White	White	White
	Taste	Fermented milk	Fermented milk	Fermented milk
Diacetyl, mg %		0,02	0,15	0,02
Volatile acids, mEq/lit		1,2	1,1	1,2
Number of cells, million/ml		5,0	4,0	5,0
The formation of antibiotic substances, mm		10-12	10-11	9-10

Table 4. Technological properties of the product obtained from goat's milk with a monoculture producer *Lactococcus lactis* 010k

Types of research		1 st sample	2 nd sample	3 rd sample
Clotting time, in a hour		13	18	16
Acidity, °T		105	72	80
Ultimate acidity, after 7 days, °T		269	266	260
Sensory properties	Consistency	Homogeneous, there is a finely flocculent clot	Homogeneous, there is a finely flocculent clot	Homogeneous, there is a finely flocculent clot
	Smell	Fermented milk	Fermented milk	Fermented milk
	Color	White	White	White
	Taste	Sour-milk with a pleasant taste	Sour-milk with a pleasant taste	Sour-milk with a pleasant taste
Diacetyl, mg%		0,025	0,02	0,02
Volatile acids, mEq/lit		1,2	1,2	1,15
Number of cells, million/ml		4,0	3,0	3,8
The formation of antibiotic substances, mm		10-11	10-11	9-10

Table 5. Technological properties of the product obtained from goat's milk with Bifidobacterium bifidum monoculture 4/7

Types of research		1 st sample	2 nd sample	3 rd sample
The clotting time, in a hour		16	20	17
Acidity, °T		128	97	100
The limit acidity after 7 days		165	160	158
Sensory properties	Consistency	Homogeneous, velvety	Homogeneous, velvety	Homogeneous, velvety
	Smell	Fermented milk	Fermented milk	Fermented milk
	Color	White	White	White
	Taste	Pleasant, slightly acidic	Pleasant, slightly acidic	Pleasant, slightly acidic
Diacetyl, mg %		-	-	-
Volatile acids, mEq/lit		0,2	0,25	0,2
Number of cells, million/ml		3,5	3,3	3,0
The formation of antibiotic substances, mm		8-10	8-10	8-10

Table 6. Technological properties of the product obtained from goat milk with two cultures: Lb.bulgaricus 018k-1 + B.bifidum 4/7

Types of research		1 st sample	2 nd sample	3 rd sample
The clotting time in an hour		13	15	16
Acidity, °T		109	80	88
Ultimate acidity, after 7 days		260	248	245
Sensory properties	Consistency	Homogeneous, dense	Homogeneous, dense	Homogeneous, dense
	Smell	Fermented milk	Fermented milk	Fermented milk
	Color	White	White	White
	Taste	Sour, sweet in taste	Sour, sweet in taste	Sour, sweet in taste
Diacetyl, mg%		0,2	0,15	0,15
Volatile acids, mEq/lit		1,2	1,2	1,2
Number of cells, million/ml		5,0	4,8	4,5
Formation of antibiotic substances, mm		10-12	10-12	10-11

Table 7. Technological properties of the product obtained from goat's milk with two cultures:
Lb.acidophilus 015κ-1 + B. bifidum 4/7

Types of research		1 st sample	2 nd sample	3 rd sample
Clotting time, per hour		15	16	16
Acidity, °T		130	113	102
Ultimate acidity, after 7 days		268	250	250
Sensory properties	Consistency	Homogeneous, finely floccous clot	Homogeneous	Homogeneous
	Smell	Fermented milk with a pleasant aroma	Fermented milk with a pleasant aroma	Fermented milk with a pleasant aroma
	Color	White	White	White
	Taste	Sour-milk sweet	Sour-milk sweet	Sour-milk sweet
Diacetyl, mg %		0,02	0,01	0,01
Volatile acids, mEq/lit		1,2	1,2	1,1
Number of cells, million/ml		5,0	5,0	4,7
The formation of antibiotic substances, mm		12-13	11-12	10-12

Table 8. Technological properties of the product obtained from goat's milk with three cultures:
Lb.acidophilus 015κ-1 + B. bifidum 4/7 + Lc.lactis 010k

Types of research		1 st sample	2 nd sample	3 rd sample
Clotting time, per hour		12	13	15
Acidity, °T		130	119	113
Ultimate acidity, after 7 days		257	252	248
Sensory properties	Consistency	Homogeneous, dense, finely flocculent clot	Homogeneous, dense	Homogeneous,
	Smell	Fermented milk	Fermented milk	Fermented milk
	Color	White	White	White
	Taste	Fermented milk	Fermented milk	Fermented milk
Diacetyl, mg%		0,03	0,02	0,02
Volatile acids, mEq/lit		1,2	1,2	
Number of cells, million/ml		6,0	5,8	5,5
The formation of antibiotic substances, mm		14-16	10-14	10-12

Table 9. Technological properties of the product obtained from goat's milk with three cultures:
Lb.bulgaricus 018к-1 + *B. bifidum* 4/7 + *Lc.lactis* 010k

Types of research		1 st sample	2 nd sample	3 rd sample
The clotting time in an hour		13	15	16
Acidity, °T		126	117 ⁰ T	110 ⁰ T
The limit acidity after 7 days				
Sensory properties	Consistency	Homogeneous	Homogeneous	Homogeneous
	Smell	Fermented milk	Fermented milk	Fermented milk
	Color	White	White	White
	Taste	Fermented milk, pleasant	Fermented milk, pleasant	Fermented milk, pleasant
Diacetyl, mg%		0,02	0,02	0,02
Volatile acids, mEq/lit		1,2	1,2	1,15
Number of cells, million/ml		6,0	5,8	5,6
Formation of antibiotic substances, mm		12-13	10-12	9-12

In conclusion it was found that with all the leaven used, clot formation is observed earlier in raw milk than on pasteurized and sterilized goat milk. If the coagulation time in the starter cultures on cheese is 12-16 hours this time will be changed in pasteurized 13-20 and in sterilized 16-20 hours. Ultimate acidity was found in foods fermented with all the ferments in question on raw goat milk.

All samples had a pleasant sour-milk taste and smell. The consistency of the sour-milk product obtained on the basis of polystyrene crops had a more dense structure. In some cases, the consistency of the product obtained on raw milk had a finely flocculent rather compact structure.

Ferment containing the strain *B. bifidum* 4/7 gave the product a pleasant flavor and taste. It should be noted that with the fermentation of sterile milk, the clot had a poorly expressed consistency. The diacetyl content is greatly increased in raw goat milk, and Vice versa, in 2 and 3 embodiment, the diacetyl content is reduced.

The formation of antibiotic substances in the finished product was investigated on the surface of the agar plate in relation to the saprophytic, opportunistic and pathogenic test-cultures. For this purpose, a single drop of liquid from ready fermented milk product was applied point-by-point on a surface preliminarily uniformly sown with a solid culture.

By the formation of antibiotic substances, the highest rates were observed in products fermented with natural goat milk with a mixed culture *Lb.acidophilus* 015к-1 + *B.bifidum* 4/7 + *Lc.lactis* 010k and monoculture of the acidophilus rod *Lb.acidophilus* 015к-1 (zone Suppression of test cultures was 14-16 mm and 13-15 mm, respectively).

CONCLUSION

The data obtained allow to conclude that for the preparation of fermented milk product based on goat's milk best is raw milk, as in the final product remain an important biotechnological properties starter cultures.

The obtained data make it possible to conclude that for the preparation of a dairy product based on goat milk, raw milk is optimal, since in the final product, important biotechnological properties of starter cultures are preserved.

For all parameters the technological properties of the tested starter cultures was a starter on the basis of cultures of *Lb.acidophilus* 015к-1 + *B. bifidum* 4/7 + *Lc.lactis* 010k.

REFERENCES

1. Serikbaeva A.D., Dzhangalina E.D., Makazhanova H.H., 2008, Lactulose bifidobacteria and lactogenic prebiotic. *Materials I.U. scientific practice.conf. "Food safety and consumer goods."* Almaty, pp. 200-202.
2. Alashbayeva L.Zh., Tungishbayeva D.K., Kenzhehojayev M.D., 2014, Preparation of fermented milk product from goat's milk. *European science review*, vol. 1-2, pp. 9-11.
3. Rockova S, Rada V, Marsik P, Vlkova E, Bunesova V, 2011, Growth of bifidobacteria and clostridia on human and cow milk saccharides. *Anaerobe*. vol.17, pp. 223–225.
4. Zabodalova L.A., Mochalov P.V., 2012, Research of fermentation goat's milk by different starter. *Scientific journal - Processes and Food Production Equipment* , vol. 2, pp. 12-19.
5. Ayad EHE, Nashat S, El-Sadek N, Metwaly H, El-Soda M., 2004, Selection of wild lactic acid bacteria isolated from traditional Egyptian dairy products according to production and technological criteria. *Food Microbiol.* Vol. 2, no.6, pp. 715-725.
6. Badis A, Guetarni D, Moussa-Boudjemaa B, Henni DE, Tornadijo ME, Kihal M., 2004, Identification and technological properties of lactic acid bacteria isolated from raw goat milk of four Algerian races. *Food Microbiol.* vol. 21, no. 3, pp. 343-349.
7. Ahmed Marroki^{I, II*}; Leila Bousmaha-Marroki, 2014, Lactobacilli isolated from Algerian goat's milk as adjunct culture in dairy products. *Braz. arch. biol. technol.* vol.57, no.3, pp. 28-31.