DEVELOPMENT OF TECHNOLOGICAL SOUR-MILK DESSERTS ENRICHED WITH BIFIDOBACTERIA

Alla Solomon
Department of Food technologies and Microbiology
Vinnitsa National Agrarian University
3 Sunny str., Vinnitsa, Ukraine, 21008
Soloalla78@ukr.net

Mariana Bondar
Department of Food technologies and Microbiology
Vinnitsa National Agrarian University
3 Sunny str., Vinnitsa, Ukraine, 21008
bondar_mar@vsau.vin.ua

Angela Dyakonova
Department of hotel and restaurant business
Odessa National Academy of Food Technologies
112 Kanatna str., Odessa, Ukraine, 65039
angela1943@ukr.net

Abstract

The work is devoted to the development of the technology of fermented sour-milk desserts, enriched with bifidobacteria and biologically active and physiologically valuable substances of fruit-berry raw materials. Bifidobacteria regulate the quality and quantity composition of the normal intestinal microfllora that is an important factor of organism protection from different intestinal infections. The healthy effect is mainly conditioned by biologically valuable properties of specially selected consortiums of lacto- and bifidobacteria, more stable for the effect of inhibitors and unfavorable environmental conditions.

At the joint use of selected consortiums of strains of bifido- and lactobacteria, the number of viable cells of bifidobacteria increases in 3–4 times, the antagonistic activity increases comparing with using separate strains of microorganisms.

The use of fructose and lactulose as a biostimulating component of sour-milk desserts raises the activity, growth and development of bifidobacteria. For stabilizing the structure of sour-milk clots, there were used hydrocalloids, such as pectin and starch that favors the increase of the number of viable cells of bifidobacteria, provides the necessary viscosity and certain humidity, prevents stratification at using fruit-berry prebiotics. The optimal storage term of sour-milk desserts at temperature (3±1) ^{o}C is no more than 15 days.

Keywords: bifidobacteria, sour-milk bacteria, fruit-berry prebiotics, probiotics, synbiotics, sour-milk desserts.

DOI: 10.21303/2504-5695.2019.00862

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1. Introduction

Humans are continuously influenced by the whole complex of unfavorable factors, including the mass uncontrolled use of chemotherapeutic preparations that change the normal functioning of main life activity systems of the organism.

In this connection there appeared a question about renewal methods of the optimal intestinal microflora, inherited for the healthy human organism.

The continuous growth of consumption of sour-milk products is observed at the international level, both in Ukraine and abroad. Their popularity is conditioned by a pleasant taste and medical properties. The special attention is paid to bifidobacteria [1], dominating in the intestinal microflora of children and adults. In this connection the special attention is acquired by the question, connected with supporting the microbial balance in the gastrointestinal tract as a protecting factor of the human life activity. The most effective way of normalizing the imbalance of the intestinal microbiocenosis is in using synbiotics that are the complex of probiotics [2] and prebiotics, and preparation of products on their base, that allows to stimulate the own microflora of the human intestine. The problem, connected with the development of

production technologies of fermented sour-milk desserts of the functional destination, based on synbiotics, enriched with bifidobacteria [3] and biologically active substances of the vegetable origin, is topical.

The aim of the work is to develop the technology of sour-milk fermented desserts, enriched with bifidobacteria and processing products of vegetable raw materials that allow to support the microbiological balance in the gastro-intestinal tract as a protective function of the human organism.

2. Materials and Methods

There were used in the work: raw cow milk – by SSU 3662:2018[7]; dry skimmed milk – by SSU 4273:2003; starch – by SSU 4380:2005; apple pectin – by SSU 6088:2009; vanilin – by SS 16599-71; lactulose syrup "Lactusan", permitted for the usage in food industry by MHP of Ukraine (P № 011717/02); fructose – by TC 9111-011-359-37677-02; the most spread strains of lactobacteria *S. Thermophilus CT-14, Lactobacillus acidophilus* and strains of bifidobacteria *Bifidobacterium longum subsp. longum B379 M, Bifidobacterium adolescentis B-1, Bifidobacterium bifidum 791,* inherent to the human organism.

The studies were conducted both by standard and original research methods, including microbiological, biochemical, physical-chemical and technological ones.

Instructions for taking samples of milk and milk products [4] were determined according to the conventional method.

For analyzing milk by physical-chemical and organoleptic parameters, milk was accurately mixed, then heated to temperature (20±2) °C.

A sample with an infused layer of cream was heated on the water bath before the study to temperature (35±5) °C and cooled to temperature (20 ±2) °C. Milk and liquid milk semi-products were accurately mixed, and samples were taken immediately for conducting the analyses. Fermented desserts with stiffeners and vegetable improvers were mixed by a spatula during 1 min, and samples for the analysis were taken immediately [4].

Dry skimmed milk was selected, observing precautionary arrangements for preventing penetration of atmosphere moisture in a container with the product.

2. 1. Experimental procedures

For creating functional fermented products, it is necessary to determine the composition of high-effective cultures of microorganisms with the high and diverse biochemical activity together with the high productivity [4]. The correct choice of biologically active strains of bifido- and lacto-cultures for making fermented milk products allows to get the quality that corresponds to requirements of the normative documents of Ukraine, SSU 2212:2003 change 2013 and ones of foreign countries ISO 27205/IDF 149 [5, 6] by organoleptic and physical-chemical parameters.

One of promising directions of the creation of sour-milk fermented products is the development of complex leavens, based on consortiums of probiotic bacteria of different taxonomic groups, most stable to unfavorable environmental factors, with the higher activity, comparing with leavens, produced using pure monocultures [7]. Selection criteria of strains of lacto- and bifidobacteria are their biological activity that is the ability to provide the prognosticated functional influence on the human organism and also technological parameters that allow to get dessert sour-milk products with certain physical-chemical and rheological properties.

For creating consortiums, seven types of sour-milk bacteria were screened. They were assessed by the ability to ferment lactose, acid-creating level, proteolytic activity. The authors of the article have established, that the high consumption level of lactose is observed in thermophilic cultures of *Lactobacillus acidophilus* and *S. Thermophilus* types. The highest proteolytic activity by the increment of the amount of free amino acids and high acid-creating ability are inherent to *L. Acidophilus* lactobacteria. At the same time acidophilic bacilli are able to produce antibiotics, such as lactocydin and acidophilin, which effect is intensified at the presence of milk acid.

The creation of consortiums of separate strains of bifidobacteria allows to improve technological properties of microorganisms essentially. The number of viable cells increases in average in 3–4 times that indicates the presence of mutual inhibition of used strains of bifidobacteria in the consortium. At the joint use of selected consortiums of strains of lacto- and bifidobacteria, the antagonistic activity of the used compositions of microorganisms grows. All studied strains of lacto- and bifidobacteria are stable to development inhibitors [8].

Fructose and lactulose that stimulate bifidobacteria growth and development were used in the composition of sour-milk products that accelerate the process of acid creation [9]. At fermentation of sterilized skimmed milk by the consortium of bifidobacteria during 6 hours, the active acidity at fructose is pH 4,64, lactulose – pH 4,6, without bifidostimulators – 4,7, whereas the titrated acidity reaches 68, 72 and 52 %, respectively. The less active acidity and essentially higher titrated acidity of the samples at bifidostimulators may be explained by the increased activity of bifidobacteria and creation of acetic acid (together with milk acid) that is a stronger electrolyte than milk one in the fermentation process.

For providing a structure, inherent to dessert sour-milk products, hydrocolloids were used. Pectin activates the development of bifidobacteria in the process of fermentation. The use of 0,3 % of pectin favors the development of the number of viable cells of bifidobacteria in dessert products from $1 \cdot 10^4$ CFU/cm^3 to $2{,}5 \cdot 10^8$ CFU/cm^3, comparing with the control, in which the number of bifidobacteria increases to $1{,}2 \cdot 10^7$ CFU/cm^3. Starch allows to get the daggle-like structure with a gloss surface, inherent to pastes and puddings [10]. The use of hydrocolloids allows to get the necessary structure, to provide the certain humidity, to prevent stratification of bifidogenic sour-milk products at using fruit-berry prebiotics. The process of homogenization, directed on disintegrating casein myceles to submyceles, and milk fat – to balls with the diameter less than 1,0 mcm. Homogenization of the milk mixture by the regime: pressure 15 MPa and t=65 ^{o}C, favors creation and preservation of thin-dispersed milk-fat emulsion, and pasteurization regime (90±2) ^{o}C, τ=2 min, provides the necessary sterility of symbiotic products.

An important component of any product is taste fillers that not only form organoleptic properties, but also enrich products with biologically active ingredients – vitamins, polyphenols, mineral substances, increase the resistance of the organism to unfavorable environmental conditions.

The recipe of fermented dessert products of the functional destination with fat mass share 2,5 % is presented in **Table 1.**

Table 1

Recipe of fermented dessert products on the milk base

Raw material	Raw material mass share, kg
Skimmed milk F=0,05 %	709,0
Dry skimmed milk F=1 %	61,8
Cream F=35 %	34,4
Fructose	50,0
Jelly-like starch	40,0
Gelatin	10,0
Syrup “Lactusan”	20,0
Apple pectin	3,0
Vanilin	0,1
Lemon-acid sodium	1,2
Leaven	50.0
Fruit-berry juice	20,5
Totally:	1000,0

Semi-products of fruit-berry juices without flesh were subjected to the thermal processing at temperature 70...80 °C during 20 min and cooled to temperature (37±1) °C before introducing in a fermented product. At using juices with flesh, its semi-products were rubbed, homogenized at pressure P=(15–17) MPa, pasteurized at temperature 80–85 °C during 20 min, cooled to temperature (37±1) °C and used as improvers at making dessert fermented products.

Pectin was used in a special container with the dry powder of fructose, dissolved in a little amount of skimmed milk, heated at continuous mixing to temperature (90±2) °C, kept during 5 min, cooled to temperature (55±2) °C and put in a container for mixing.

Starch was poured by the fourfold amount of skimmed milk, heated to temperature 30 °C, accurately mixed and left for 1 hour for swelling. The obtained mixture was heated at mixing to temperature (85±2) °C for solving starch completely, cooled to temperature (55±2) °C and directed to a container for mixing.

The obtained mixture of normalized milk with bifidostimulators and stabilizers was mixed during 5...10 min and put to the separator-cleaner. The accurately mixed material was heated to temperature (65±2) °C, homogenized at pressure P=(15±2) MPa and pasteurized at temperature (90±2) °C, keeping for 2 min.

The pasteurized mixture was cooled to temperature (37±1) °C and leavened by the composition of adapted microorganisms, consisted of bifidobacteria consortiums (B. bifidum + B. longum + B. adolescentis) and lactobacteria ones (Lb. acidophilus + Str. thermophilus) in ratio 2:1, in amount 5,0 %, that contains $1 \cdot 10^4$ CFU/cm^3 of lacto- and bifidobacteria, mixed during 20...30 min, gradually adding strawberry juice a fruit-berry filler, packed in a hermetic container, marked, leavened during (5,5±0,5) as hours to active acidity (pH) 4,6–4,7 and cooled to temperature (3,0±1) °C. The ready dessert product was stored during 15 days at temperature (3,0±1) °C.

It has been established by the experimental way, that storage of dessert fermented products at temperature (3±1) °C provides preservation of the developed desserts during 18 days without whey separation. Probiotic properties of desserts remain at level $1 \cdot 10^9$ CFU/cm^3 during 20 days, but from 10-th day there is observed the gradual disintegration of the structure with separation of some drops of moisture. The optimal storage term of dessert products was limited to 15 days.

3. Research results

The dessert fermented products were studied by organoleptic (**Table 2**), physical-chemical and microbiological (**Table 3**) parameters immediately after producing and after 15 days of storage at (3,0±1) °C.

Table 2

Organoleptic parameters of dessert fermented products

Parameters	Dessert fermented products	
	After package	In 15 days of storage
Taste and smell	Pure, sour-milk, moderately sweet, with a fragrance and smack of a filler	
Color	From light-pink to pink, homogenous, even along the whole mass	
Consistence and outlook	Homogenous, delicate, jelly-like mass, without separation of fat and whey, with the gloss surface	

The products correspond to the requirements, set according to normative documents [11] for dessert fermented products with the prolonged storage term, by organoleptic, physical-chemical and microbiological parameters.

Table 3
Physical-chemical and microbiological parameters of dessert products

Parameters	Dessert fermented products	
	After package	In 15 days of storage
Mass share of dry substances, %	25,25	25,25
Mass share of moisture, %	74,75	74,75
Mass share of fat, %	2,5	2,5
Mass share of protein, %	5,56	5,56
Mass share of carbohydrates, % including food fibers	9,123,68	9,123,68
Active acidity (pH)	4,6	4,55
Titrated acidity, °T	77	82
Viscosity, $\eta \cdot 10^3$, Pa·s	1,75±0,2	1,75±0,2
Mass share of polyphenol substances, mg/100 g	98	95
Mass share of vitamin C, mg/100 g	5	2,2
Number of viable cells of bifidobacteria, Lg CFU/cm^3	9,8	9,6
Number of viable cells of lactobacteria, Lg CFU/cm^3	8,8	8,7
BCBG in 0,1 cm^3	Absent	absent
Energetic value, cal/kJ	83/339	83/339

3. Conclusions

The biological value of the developed fermented sour-milk products is mainly conditioned by properties of the used specially selected consortiums of strains of probiotics of lacto- and bifidobacteria and processing products of vegetable raw materials.

The use of bifidobacteria in the composition of milk products needs to select strains, able to develop under unfavorable production conditions and ones of the gastro-intestinal tract.

Bifidostimulators fructose and lactulose increase the activity, growth and development of bifidobacteria, accelerate the process of acid creation.

The use of hydrocolods allows to get the necessary structure, to provide the certain humidity, to prevent stratification of sour-milk products at using fruit-berry improvers.

The developed dessert fermented products have the high food and biological value, are characterized with the high content of lacto- and bifidobacteria that allows to relate them to functional products of the healing-prophylactic destination, stored during 15 days.

It is necessary to create new consortiums of microorganisms, which composition allows to realize the physiological, biochemical and technological potential of used microorganisms maximally, to improve structural-mechanical properties. The formation of new consortiums of separate bifidobacteria strains allows to increase the number of viable cells of bifidobacteria and to raise their antagonistic activity. At creating probiotic products, there must be selected strains, tested for the symbiotic ability, in such a way that probiotic cultures add each other by the biological activity, revealing the synergism effect in a product. It is necessary to enrich sour-milk fermented products with processing products of raw materials that allow to enrich them with insoluble polysaccharides, vitamins, polyphenol and mineral substances, to stimulate the development of bifidobacteria.

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