Research of technological features of production of functional fermented milk products

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Abstract. The most important factor determining human health is nutrition. Functional products containing many valuable ingredients contribute to the strengthening and maintenance of human health. In this regard, over the years, the development of technology for the production of such products does not lose its relevance. The authors selected the composition and ratio of probiotic microflora in the composition of a complex starter culture for the production of a functional fermented milk product. Two variants of complex starter culture were selected containing Streptococcus salivarius subsp. thermophilus, Bifidobacterium subsp. lactis (BB-12) and Lactobacillus casei subsp. casei in a ratio of 4: 1: 1 and Streptococcus salivarius subsp. thermophilus, Bifidobacterium bifidum and Lactobacillus acidophilus in a 4: 1: 1 ratio. The paper considers the influence of individual technological factors on the quality formation of the finished product, such as the dose of the prebiotic galactooligosaccharides (GOS), the dose of the concentrate of whey protein (CWP) and the fermentation temperature of the milk mixture. The following technological factors of production have been established: doses of introduced components (GOS - (1 ± 0.1) %, CWP (2.0 ± 0.5) % and the fermentation temperature of the mixture (38 ± 2 °C). The results of the study will be used further in the development of technology for a functional fermented milk product.

1. Introduction
The main human value is a person health. It is determined by many factors, but is more dependent on nutrition. Eating disorders become the main reasons for the development of some diseases such as cardiovascular, allergic and gastrointestinal diseases, obesity, diabetes, etc. The studies of many scientists prove the fact that food products are not only a source of essential nutrients, but they also participate in various biochemical processes in the human body [1].

Functional food products are a valuable source of nutritional ingredients that help maintain and improve human health. These ingredients include probiotic microflora, prebiotics, vitamins, minerals, fat-like substances, carotenoids, polyphenolic compounds.

Functional food products are recommended for use by various age groups of the population and are aimed at replenishing nutritional deficiencies, as well as reducing the risk of diseases associated with malnutrition [2, 3].

In modern conditions, many adverse factors affect the human body, such as environmental degradation, constant stress, uncontrolled intake of antimicrobial medical preparations, violation of the diet, etc. As a result, one of the most frequent consequences of the influence of these factors is an imbalance of the beneficial intestinal microflora and, as a result, a dysfunction of the gastrointestinal tract, a decrease in natural immunity, a deficiency of B-group vitamins. Regular consumption of foods
containing probiotic microorganisms, as well as prebiotics, can help restore and maintain the required level of normal microflora in the human body [4, 5].

In this paper, the technological features of a functional fermented milk product are considered, such as: types of starter cultures and their various ratios, the possibility of using a prebiotic supplement of galactooligosaccharides (GOS) and concentrate of whey protein (CWP), as well as their dosage and fermentation temperature of the milk mixture in the production of a functional fermented milk product.

2. Materials and methods

The first stage of the research is devoted to the selection of the main types of microorganisms and their ratios in a complex ferment for the production of a functional fermented milk product.

We considered such types of microorganisms as *Streptococcus salivaris subsp. thermophilus*, *Lactobacillus acidophilus*, *Bifidobacterium subsp. lactic* (BB-12), *Lactobacterium casei subsp. casei* in different ratios. The researchers investigated the acidity increase in forming clots in the process of fermentation with complex starter cultures, as well as the increase in number of viable cells of the starter microflora.

At the second stage, the complex influence of such factors as: a) dose of prebiotic GOS, b) dose of CWP and c) fermentation temperature on the formation of the finished product were investigated. The following parameters were taken as determining the quality of the finished product: the number of cells of probiotic microorganisms (bifidobacteria) in the finished clots and the organoleptic characteristics of the finished product.

Dose of GOS was set no more than 2 g per day, taking into account the analysis of literature data. The dose of CWP was selected basing on the formulation of such fermented milk product as yoghurt in order to normalize milk by the content of nonfat milk solids in an amount of 8.2-8.6 g/100g.

The objects of research were reconstituted skimmed milk powder, reconstituted skimmed milk powder with the addition of GOS and CWP, as well as samples of a functional fermented milk product made from reconstituted skim powder milk without and with GOS added.

Sampling and preparation for further analysis was carried out in accordance with GOST 26809.1-2014.

The titratable acidity of the fermented milk product samples was determined by the titrimetric method using the phenolphthalein indicator in accordance with GOST R 54669-2011.

The number of viable cells of lactic acid microflora was determined according to GOST 33951-2016, bifidobacteria - according to GOST 33924-2016.

The organoleptic characteristics of the test samples of the functional fermented milk product were determined in accordance with GOST R ISO 22935-2-2011.

To process the experimental data, the STATISTICA software package was used.

3. Results

During the research, two variants of the species composition of complex starter cultures were used: 1 - *Streptococcus salivaris subsp. thermophilus*, *Bifidobacterium subsp. lactis* (BB-12) and *Lactobacterium casei subsp. casei*.; 2 - *Streptococcus salivaris subsp. thermophilus*, *Bifidobacterium bifidum*, and *Lactobacillus acidophilus*.

In experimental samples of clots, developed using the above complex starter cultures at different ratios of microorganisms, the increase in acidity, the duration of fermentation and the total number of viable cells of microorganisms were determined.

The results of the experiment using two variants of starter cultures at different ratios of cultures of microorganisms are shown in Figure 1.
Figure 1. Influence of the microorganism type and ratio on the fermentation process and the growth of microorganism biomass.

When analyzing the data obtained, it can be seen that in the samples of clots formed with a complex starter cultures of both variants with a ratio of microorganisms of 4:1:1, the most active process of acidity increase was noted in comparison with other variants of microorganism ratios. This may be explained by the predominant amount and the highest biochemical activity of *Streptococcus salivaris subsp. thermophilus* compared to other microorganisms in complex starter cultures.

In addition, with the indicated ratio of microorganisms, the most uniform growth of lactic acid microflora and bifidobacteria was noted.

Decrease in the number of *Streptococcus salivaris subsp. thermophilus* in complex starter cultures of both variants (1:1:1 and 2:1:1 ratios) reduced the rate of acid formation and led to an increase in the duration of clot fermentation. In this regard, the inexpediency of using the indicated ratios of microorganisms in both versions of ferments has been established.

In order to study the complex effect of the dose of GOS, the dose of CWP, as well as the temperature of the mixture fermentation on the formation of the finished product, the influence of these factors on the number of viable cells of microorganisms and the organoleptic indicators of the produced clots was studied.

The following intervals of technological factors were selected: GOS dose from 0.5 to 2.0% with a step of 0.5%; dose of CWP - from 0.5 to 8.0% with a step of 1.5%; fermentation temperature - from 32 to 42 °C with a step of 6 °C.

The specified range of the investigated factors of production of a functional fermented milk product was selected on the basis of analysis of literature data, as well as our own research.

The regression equation and graphs based on the obtained data from this equation describe the effect of the GOS dose ($X_1$), the CWP dose ($X_2$) and the fermentation temperature of the mixture ($X_3$) on the number of bifidoflora cells in the finished product, resulting data are shown in Figure 2.
Analysis of the dependence obtained shows that the dose of the prebiotic has the greatest effect on the number of bifidobacterium cells. In addition, the optimal values of the fermentation temperature of the mixture, as well as the dose of the introduced components, have been determined.

Figure 2. Influence of the dose of GOS ($X_1$) and of CWP ($X_2$) on the number of bifidobacterial cells in testing samples of clots at a fixed fermentation temperature: a) (32±2) °C, b) (36±2) °C, c) (42±2) °C.

The effect of the dose of the introduced components (GOS ($X_1$) and concentrate of whey protein ($X_2$)), along with the fermentation temperature ($X_3$) on the organoleptic indicators of the produced clots are described by the corresponding regression equation and graphs built on its basis, resulting data are shown in Figure 3.

Analysis of the data obtained allows us to conclude that the organoleptic characteristics of the finished product are most influenced by the prebiotic dose and the fermentation temperature of the mixture.

Figure 3. Influence of the dose of GOS ($X_1$) and of CWP ($X_2$) on organoleptic indicators of the finished products depending on the fermentation temperature: a) (32±2) °C, b) (36±2) °C, c) (42±2) °C.

4. Conclusion
Based on the obtained dependencies, the most optimal parameters for the production of a functional fermented milk product were determined, namely they are doses of the introduced components (GOS - (1±0.1) %, CWP - (2.0 ± 0.5) %), as well as the fermentation mixture temperature (38±2) °C.

The results obtained will allow in the future developing a production technology of a functional product enriched with probiotic microflora and prebiotics.
References

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