Slovak Journal of Food Sciences

Potravinarstvo Slovak Journal of Food Sciences
vol. 15, 2021, p. 970-981
https://doi.org/10.5219/1688
Received: 31 July 2021. Accepted: 27 September 2021.
Available online: 28 October 2021 at www.potravinarstvo.com

ISSN 1337-0960 (online)

INNOVATIVE APPROACHES TO THE DEVELOPMENT OF A NEW SOUR MILK PRODUCT

Irina Vlasenko, Valentyna Bandura, Tetyana Semko, Larisa Fialkovska, Olga Ivanishcheva, Vladyslav Palamarchuk

ABSTRACT
The topic provides an analysis of the current approach to healthy nutrition and represents a new functional fermented milk drink based on buttermilk containing natural prebiotics - a biologically valuable complex Spirulina platensis. The main tasks of the industry as a holistic system for the management and production of food ingredients and products are outlined. The work highlights the requirements for the quality and context of the functional product manufacture, the main criteria for the consumer choice, and positioning of products in the healthy lifestyle system. The topic covers the most common pro- and prebiotics, including strains. The unique food green microalgae Spirulina platensis as a source of biologically valuable components is proposed for industrial application. A technique for the production of the fermented milk drink based on buttermilk and spirulina as prebiotic was developed and scientifically substantiated. The protein contained in buttermilk is characterized by high nutritional value, exhibits functional properties and can significantly affect the quality of the drink. To confirm this, the possibility of using buttermilk with different protein content from 2.9 to 3.2 to improve the structure of the clot in the composition of the drink and the content of spirulina from 10 to 20% was studied. As single criteria for optimizing the prescription composition of the drink at the different protein content of buttermilk used indicators of product quality - acidity, degree of syneresis, organoleptic parameters. The optimal values of the individual criteria are obtained in different ranges of protein content 3 times 1-2-2; sample 2-3.0; sample 3-3.2%, which allows you to get recommendations for the formulation of a new type of drink.

Keywords: buttermilk; prebiotics; probiotics; spirulina; technology; model food composition.

INTRODUCTION
Nowadays, the regulatory requirements for raw milk are described in the EU Food Code and the regulations of the European Parliament, which provide a detailed explanation of the traceability of raw milk. Regulation (EU) No. 178/2002 of the European Parliament and of the Council of 28 January 2002 describes the general principles and requirements of food law concerning food safety, as well as a package of so-called "hygiene regulations" governing the requirements for milk producers. raw materials, food producers, entities. It should be noted that according to the data, the protein content in milk harvested by processing enterprises is below 3.0% not only from March to May but even in the summer months. The requirements for the control of the qualitative and quantitative composition of the microflora contained in milk are becoming very important. Milk is a good nutrient medium for the development of most microorganisms **(Vlasenko, et al., 2020)**. Specialists divide all microorganisms found in milk into three groups: technically important, pathogenic, and sanitary-indicative microorganisms. Sanitary-indicative microorganisms indicate the degree of contamination of milk and non-compliance with sanitary and hygienic production regimes. Thus, the quality of raw milk supplied to enterprises is one of the main problems that need to be addressed to improve quality and safety, increase yield and reduce the cost of finished products **(Semko, Kolianovska, and Ivanishcheva, 2018)**.
The concept of functional foods as a source of protein, carbohydrates, and microelements consists of consuming products that offer various benefits that go beyond basic nutritional needs **(Martirosyan, Singh, 2015)**.
Functional foods are designed to improve metabolic functions and biochemical parameters of the human body and help prevent non-communicable diseases such as cardiovascular disease (CVD), cancer, type 2 diabetes mellitus, and osteoporosis. Functional dairy products are the main suppliers of probiotic microorganisms, help to restore the gastrointestinal microflora. Strains of bifidobacteria and some lactobacillus species, such as

Lactobacillus acidophilus, Lactobacillus casei subsp. *casei, Bifidobacterium SPP. (B. adolescentis, B. animalis, B. bifidum, B. longum, B. breve*), belong to probiotic cultures. They exert a positive effect on the human body and normalize the composition and functions of the bacterial flora in the gastrointestinal tract. **(Breus et al., 2019)**.

The world's leading manufacturers and researchers of functional foods are France, Japan, Mexico, while the United Kingdom, the Netherlands, Germany, and Spain are among the European leaders. **(Vicentini, Liberatore and Mastrocola, 2016)**. About 50% of healthy functional products are dairy products and about 30% are cereals.

Tackling the healthy nutrition issue is the most challenging and urgent task for the society and contemporary public health system. In the XXI century, a strategic line of the food industry consists in the attribution of special-purpose foods to the "healthy" diet.

One of the important components of any fermented milk drink is spirulina, which is widely used to improve the taste and protein content. A new technique for the manufacture of products using spirulina extract will become a new trend in the enrichment of traditional fermented milk drinks that heralds the innovative development of the dairy industry aimed at expanding the range of functional products.

In recent years, Ukrainian scientists have developed several products containing spirulina, although the assortment is still limited and does not meet the demand for such products. Raising consumer awareness of nutrient health benefits and nutritional value of components for potential disease prevention and health improvement will play the most significant role in the global food and nutraceutical market.

Functional products are considered medicinal products that are not only a source of energy and important nutrients but also good for health. Many studies, including some funded by the European Commission (EC), have led to an understanding of the potential mechanisms of biologically active food ingredients able to improve health and possibly reduce the risk of disease while improving overall well-being. Functional foods and nutraceuticals help improve health, reduce healthcare costs and promote economic development in rural areas. The demand for functional foods, especially in developed economies, is soaring now due to better awareness of the health benefits of functional foods and the growing gross income of households. The United States is the world's largest market for functional foods expecting to grow. This growth is mainly driven by the ever-increasing demand for energy drinks and enriched dairy products. Meanwhile, national rules and justifications for claims of no harm to health are among the most challenging problems that the functional foods and nutraceuticals market continues to face **(Daliri and Lee, 2015)**.

Probiotics are considered single or mixed cultures of living microorganisms, which can change the intestinal microbiota and benefit the health of a host once ingested in sufficient quantities **(Tiihonen, Ouwehand and Rautonen, 2010)**. Probiotic products contain live microorganisms over a dose recommended as good for health (5 × 109 CFU/day for 5 days) **(Gupta and Garg, R., 2009)**.

Prebiotics are considered food components intended to selectively stimulate the growth and/or activity of intestinal bacterial strains capable of fermenting, for example, undigested starch, oligosaccharides, and non-starch polysaccharides **(Upadhyay and Moudgal, 2012)**. Synbiotics contain both probiotics and prebiotics and exert beneficial health activity as a result of the synergistic action of the two components **(Scholz-Ahrens, et al., 2016)**.

Products that contain probiotics, including *Lactobacillus* strains and/or *Bifidobacterium* and less often *Escherichia*, *Enterococcus,* or *Bacillus*, include yogurt, kefir, buttermilk, acidophilus milk, sauerkraut, pickled cucumbers, tempeh, miso, and tea fungus **(Zawistowska-Rojek, et al., 2016)**. Prebiotics are considered oligosaccharides such as fructooligosaccharides (inulin), galactooligosaccharides, xylooligosaccharides, cyclodextrins, and lactulose. Significant sources of oligosaccharides are chicory root, topinambur, raw garlic, onions, and whole grains **(Al-Sherajiae et al., 2013)**.

The use of probiotics has been associated with improving immune function. Probiotics have been used for the treatment of gastrointestinal disorders such as constipation, diarrhea, Crohn's disease, irritable bowel syndrome (IBS), and diverticular disease. The health benefits of probiotics are closely associated with a proper balance of microflora in the digestive system **(Clements and Carding, 2018)**.

Probiotics are considered useful once supported by prebiotics in a diet since they can stimulate the growth of bifidobacteria, which numbers are significantly reduced in humans within 55 to 60 years of age **(Stavropoulou, and Bezirtzoglou, 2019)**. The health benefits of prebiotics consist in their ability to stimulate useful digestive activity, including bifidobacterial growth. Some prebiotics, not hydrolyzing in the human gastrointestinal tract, yet having other beneficial properties, such as inulin, which replace fat. Other prebiotics, such as fructans, contribute to the absorption of calcium, magnesium, iron, zinc, copper, and phosphorus. The dosage of fructans that exert the prebiotic effect ranges from 4 to 8 g per day **(Gibson, et al., 2010)**.

The combination of pro- and prebiotics in the diet of elderly people is considered advantageous in terms of the ability to intensify the intestinal growth of bifidobacteria. The increased number of bifidobacteria contributes to the higher concentration of bacterial folic acid, vitamins B 1, B 2, B 6, and nicotinic acid. Therefore, bifidobacteria can be a source of essential nutrients and support the preventive measures and management of gastrointestinal diseases **(Shoaib et al., 2016)**.

The most important group of products containing probiotics are fermented milk products (yogurt, kefir, buttermilk, etc.), cheeses, and tea fungus. Probiotic bacteria are present in some other foods, such as ice-cream, frozen desserts, fermented fruits, vegetable juices, and fermented meat **(Zaręba and Ziarno, 2011)**. Probiotic bacteria are added to sweets, such as jelly candies, in combination with yogurt or chocolate, as well as to chocolate products in combination with lyophilized microorganisms, to grain juices, frozen yogurt, chocolate bars, cookies, and cereals **(Semko, Vlasenko and Palamarchuk, 2020)**. Some probiotics are sold in the form of tablets or capsules. The new products are beverages containing probiotic bacteria in bottle caps, which run in the bottle contents once the bottle is opened **(Kregiel, 2015)**. Traditional unrefined sources of prebiotics in the diet are soybeans, shelled wheat and barley, and raw oats. The food market also offers a variety of products with the addition of prebiotics and synbiotics, such as fermented dairy drinks, yogurts, fruit drinks, fatty spreads, meat products, mayonnaise, margarine, and pasta **(Liutkevičius et al., 2016)**.

The use of probiotics and their positive effect on the digestive system have been substantiated by scientific data and approved by EU health regulators **(Van Loveren, Sanz, and Salminen, 2012)**.

The purpose of the work is the development of a new functional fermented milk drink based on buttermilk using a complex of biologically valuable natural pro- and prebiotics originating from *Spirulina platensis*.

Scientific Hypothesis

Development of innovative technology for combining secondary raw materials of the dairy industry with a unique food green algae prebiotic Spirulina platensis. Fermentation with selected strains of probiotic cultures was carried out in the work. The proposed product can complement the range of functional fermented milk drinks in the system of healthy nutrition.

The peculiarity of our proposed application of bacterial leavens is that after high-temperature treatment of buttermilk in the mode (100 ±5ºC) with a holding time of 25 s was cooled to 30 ±2ºC.

One of the important components of our sour milk drink is spirulina, which is widely used to improve the taste and enrich it with protein.

The resulting fermented milk drink is a polydisperse colloidal system in which the buttermilk is a dispersion medium, and the proteins of buttermilk and spirulina - the dispersed phase. The research results show that under the same conditions of the coagulation process with the increasing amount of spirulina added from 10 to 25% changes the acidity of the finished product.

MATERIAL AND METHODOLOGY

Samples

The object of the study is the quality indicators of the fermented milk product obtained by acid coagulation of buttermilk proteins using spirulina.

Subjects of research: buttermilk, spirulina, organoleptic, physicochemical parameters (mass fraction of protein, acidity, degree of syneresis).

For the study were prepared 4 samples of the drink with a mass fraction of protein of 2.9-3.2% with different doses of buttermilk and combinations of spirulina in different mass fractions. Spirulina (TM "Food Factor") was used to enrich the drink and form a characteristic thick consistency. TM is registered with the FDA (Food and Drug Administration - US Federal Food and Drug Administration). Doses of leaven (1.8% of the main (manufacturer Center for the Development of Microbiology and Biochemistry "Biochem") and 0.2% additional (manufacturer State Research Enterprise of Bacterial Ferments TIMM, Ukraine). Bacterial cultures are produced by the Center for Development of Microbiology and Biochemistry "Bioc1hem" and ANV produced by the State Research Enterprise of Bacterial Ferments TIMM Kyiv (manufacturer of pro- and prebiotics Ukraine). The bacterial leaven of mesophilic lactic acid bacteria and the additional leaven of thermophilic lactic acid bacteria were used as the main raw materials. The main bacterial leaven includes Lactococcus lactis subsp. lactis, Lactococcus lactis subsp cremoris, Lactococcus lactis subsp diacetilactis, Lenconostoc lactis.

Samples of the drink were prepared in the laboratory of food production VITE KNUTE certified quality management system (certificate No. UA.80050.063 QMS-21 recertified from 21.06.2021) following the classical technological scheme of production of fermented milk product.

Chemicals

Buttermilk was used as raw material for the production of the drink. Buttermilk is a cream plasma obtained during the separation of butter from cream. The nutritional and dietary value of buttermilk preconditions its complete collection and use for food production whenever possible.

It is formed at the stages of whipping or separation of cream.

The chemical composition of buttermilk depends on the cream fat content, its acidity, temperature, and mechanical treatment. Protein substances of buttermilk are rich in cystine, lysine, methionine, and other essential amino acids. Buttermilk is characterized by a high content of fat-soluble vitamins. The chemical composition of buttermilk is presented in Table 1.

Table 1 Chemical composition of buttermilk

Description	Buttermilk (sweet butter)
Dry matter content, %	9.1 (8.3-9.5)
Lactose content, %	4.8 (4.7–4.8
Protein content, %	3.1 (2.9 – 3.2)
Milk fat content, %	0.4 (0.4 – 0.7)
Acidity, °T, after CHFC	20 (20 – 21)
Density, kg/m^3 (temperature (20 ± 2) °C)	1030 (1027 – 1029)

Pro- and prebiotic starters for production of the fermented milk drink based on buttermilk were selected from concentrates provided by manufacturers of bacterial cultures: Biochem Center for the Development of Microbiology and Biochemistry – a manufacturer of probiotics since 1978 located in an ecologically clean region of Italy, and ANV producer TIMM State Research Enterprise of Bacterial Starters, the Ukrainian (Kyiv) manufacturer of pro- and prebiotics.

Table 2 Characteristics of lactobacilli used in the work

Starter name	Manufacturing company	Starter content	Starter type
Basic complex	Biochem Center for the Development of Microbiology and Biochemistry. Department of Biochemistry of Microorganisms Institute of Microbiology and Virology. D.K. Zabolotny NAS of Ukraine, Kyiv, Ukraine.	*Lactococcus lactis subsp. lactis, Lactococcus lactis subsp Lactococcus lactis subsp diacetilactis, Lenconostoc lactis*	Gout-Foud - diplococci, chains of cocci of different length
Additional	TIMM State Research Enterprise of Bacterial Ferments TIMM, Kyiv, Ukraine. www.ddpdz.com.ua	*Lactobacillus acidophilus* (inviscid medium)	ANV – cocci, sticks of different length

Bacterial starter of mesophilic lactic acid bacteria was used as the main raw material, while thermophilic lactic acid bacteria were used as the additional one.

Animals and Biological Material:

The main bacterial starter included *Lactococcus lactis subsp. lactis, Lactococcus lactis subsp cremoris, Lactococcus lactis subsp diacetilactis,* and *Lenconostoc lactis.*

The description of lactobacilli starters is presented in Table 2.

One of the unique natural food sources is spirulina, a blue-green microalgae *Spirulina platensis*, which can be successfully used in everyday diet as a source of biologically valuable components. Spirulina is a product with a high concentration of protein (65 - 72%) by weight of algae. Algae contain several essential amino acids. Carbohydrates containing in the amount of 10-15% of the total spirulina weight are well digested and do not exert a negative effect on the pancreas. Spirulina contains almost all vitamins but C and D. It is the richest known source of vitamins A, B12, E, and F. Spirulina has five times more iron than brewer's yeast or dill. The algae contain trace elements featuring antioxidant activity, such as selenium, manganese, zinc, copper, iron, and chromium.

Spirulina is one of the richest sources of carotenoids. It contains about ten different types of carotenoids, including alpha-, beta- and gamma-carotenoids, half of the yellow xanthophylls.

Spirulina contains an average of 40-150 times more B vitamins (B1, B2, B3, B5, B6, B9, B12) than milk, cheese, meat, eggs, and butter.

The chemical composition of spirulina suggests the possibility of producing a wide range of prophylactic dairy products of various forms. This trend in the production of combined dairy products is promising and socially significant. According to marketing research, people choose dairy products containing plant components being guided by three criteria - taste, health, and culture. Once these criteria are met, the foods are considered fit for the main diet. And of course, they must be safe, meet the demand of essential nutrients, as well as contain biologically active components exerting a preventive effect on the human body **(Lange et al., 2020)**.

Producer:

United States Pharmacopeia (USP) Reference Standard (Sigma Aldrich).

This product is provided as delivered and specified by the issuing Pharmacopoeia. All information provided in support of this product, including MSDS and any product information leaflets, have been developed and issued under the Authority of the issuing Pharmacopoeia.

For further information and support please go to the website of the issuing Pharmacopoeia.

Instruments

The peculiarity of the introduction of bacterial leavens is that after high-temperature treatment of buttermilk in the mode (100 ±5) oC with a holding time of 25 s and cooled to 30 ±2 oC. The sourdough was prepared on chilled milk, stirred for 5 min to evenly distribute the components of the sourdough cultures **(Semko, Vlasenko and Palamarchuk, 2020)**. Made a different ratio of basic and additional leaven: 1.8% of the main and 0.2% of the additional. Fermentation was performed to a titratable acidity of at least 75-80 ºT (pH = 4.7). Then added fresh-frozen spirulina (1up = 20 grams) (1 sample-10g, 2 sample-15g, 3sample -20g, 4-25g). Samples of sour milk drink were cooled and stored in a refrigerator at a temperature of (4 ± 2) ° C for at least 8 days. After these technological operations, tests were performed. Mixing was performed with a mixer.

Pasteurization of buttermilk in a cheese boiler brand FJ 15 (Figure 1). Samples of the mixture No. 1, 2, 3 and 4.

The acidity of the fermented milk drink expressed in degrees Turner (ºT), and determined by the titrimetric method.

To modify the method of acid coagulation and rationalize the dose of spirulina, a range from 5% to 25% was determined with a step of variation of 5.

Functional and technological characteristics - acidity, the degree of syneresis was determined in the laboratory of VITE. Acidity was determined on a Bunsen apparatus (Figure 1). The titrated acidity of the fermented milk mixture was determined according to GOST 3624-92 and measured in degrees Turner (ºT). Turner degrees mean the number of millimeters of alkali solution 0.1 mol·dm^3 spent on neutralizing the concentrate **(Grek et al., 2015)**. The mass fraction of buttermilk protein was determined on an Ecomilk Bond milk analyzer (determination time – 120 sec with printer).

Laboratory Methods

Biochemical and physicochemical parameters of buttermilk as raw material and semi-finished products in the process of manufacture of fermented milk drink were studied by conventional methods of analysis set out in the relevant standards and guidelines for microbiological and technical-and-chemical control of fermented milk, as well as methods described in special literature.

The research methods are presented in Table 3.

Figure 1 Mini pasteurizer cheese factory FJ 15.

Figure 3 "Ecomilk Bond" to determine in buttermilk and drinks.

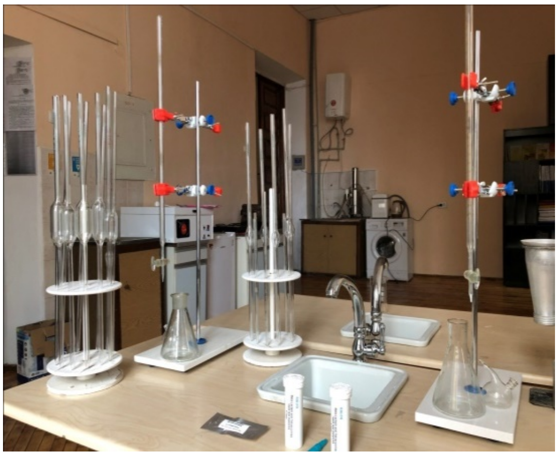

Figure 2 Apparatus for Bunsen titration.

Figure 4 Laboratory centrifuge "Orbit".

Table 3 Research methods.

Description	The principle of the research method
Raw buttermilk sampling and preparation for tests	According to GOST 26809-86
Mass fraction of fat, %	Gerber acid centrifugation method and "Ekomilk Bond" milk analyzer according to GOST 5867-90
Mass fraction of protein, %	Using a milk analyzer "Ekomilk Bond" according to GOST 2579-90 i GOST 23327-78
Active acidity (pH), (units)	Potentiometric method according to GOST 26781-85
Titrated acidity, ◦T	Titrometric method according to GOST 3624-92
Density, g/cm^3	Areometric method according to GOST 3625-84
Milk purity grade, group	Filtering
Sampling for microbiological tests	According to GOST 26668-85
The amount of acidophilic bacillus, %	By the method of limiting dilution of sterile skim milk at a temperature of 43°C
NMAFAnM, CFU/sm^3	According to GOST 9225-84 and GOST 10444.12-88
Mass fraction of nitrogenous compounds in the fermented milk product, %	By Kjeldahl method modified by ASRIBCM
The composition of free amino acids, %	Using amino analyzer Bio-Tronik LC 2000 following treatment with a solution of sulfosalicylic acid
Fractional composition of proteins in the fermented milk product, %	Polyacrylamide gel electrophoresis method (Lemley method modified by introduction of urea gel)

Table 4 The model food composition of the drink, kg.

Description	Receipts			
	No. 1	No. 2	No. 3	No. 4
Buttermilk	920.0	910.0	900.0	890
Sugar	50.0	55.0	60.0	65
Spirulina	10.0	15.0	20.0	25
Starter (1.8 % - basic and 0.2 % - additional)	20.0	20.0	20.0	20,0
Finisher product output	1000	1000	1000	1000

Table 5 Organoleptic properties of the fermented milk drink enriched with pro- and prebiotic cultures.

Description	Model product			
	No. 1	No. 2	No. 3	No. 4
1. Appearance and consistency	Uniform thickening	Uniform thickening, minor buttermilk separation	Uniform thickening, granular consistency	Heterogeneous clot with separation of serum drops
2. Taste and odor	Pleasant well-expressed sour milk, without foreign taste and smell	Sour milk, without foreign taste and smell	Specific sour milk, some foreign taste and smell	The specific sour-milk has a foreign herbal taste
3. Color		White, greenish tinge		Greenish-gray with spirulina

Description of the Experiment
Sample preparation:
While developing the recipe, we set the fo following tasks: to study the technological properties of spirulina intended for the manufacture of fermented milk drinks based on buttermilk; to develop the recipe and technological scheme for the manufacture of finished products; to choose the ratio of microorganisms that would enhance the taste of the product; to study the organoleptic, physical-and-chemical, microbiological properties of the fermented milk drink [8].
The model food composition of the drink is presented in Table 4.

The next stage of the study was to create a technological scheme presented in Figure 5.

The degree of syneresis was not more than 15 cm³ per 100 g of product, and not less than 10 points in the organoleptic evaluation were achieved at different doses.

Therefore, as criteria for optimizing the prescription composition of sour milk drink used characteristics:

- degree of syneresis (C, cm³ / 100 g);
- acidity of the product (Degrees T);
- organoleptic parameters (OP, points).

Limit indicators of criteria are characteristic of the control sample:

- degree of syneresis - no more than 15 cm ³ / 100 g;
- acidity - not more than 100

Buttermilk quality assessment (acidity, °T – 1027-1029; density, kg/m³ – 1027-1029; dry matter content, % – 8.3-9.5)

↓

Pasteurization (t= 100±5 ⁰C, τ=25 s)

↓

Cooling to fermentation temperature (t= 30±2 ⁰C)

↓

Fermentation (t= 30±2 ⁰C, direct starter introduction)

↓

Fermentation in tanks (t= 30±2 ⁰C, τ=6-8 hours, until thickening)

↓

Adding frozen spirulina and sugar to the fermented product

↓

Stirring and cooling (t= 20 ⁰C, τ=15-40 min)

↓

Bottling and packaging of the finished product (t= 20 ⁰C)

↓

Maturation and cooling (t= 0-8 ⁰C, τ=24 hours)

↓

Storage (t= 0-8 ⁰C, no more than 14 days)

Figure 5 Process flow diagram for production of the fermented milk product from buttermilk

- organoleptic indicators - from 0 to 10 points.

Independent variables determine the mass fraction of buttermilk fat (F, %) in the range from 0 to 3% and the mass fraction of spirulina application (C, %) in the range from 0 to 40 g.

Number of samples analyzed:

As a result of the study, three model products were obtained.

Table 5 contains the results of the organoleptic study of finished product enriched with prebiotic *Spirulina platensis* and probiotic (basic – *Lactococcus lactis subsp. lactis, Lactococcus lactis subsp cremoris, Lactococcus lactis subsp diacetilactis, Lenconostoc lactis;* additional – *Lactobacillus acidophilus).*

Organoleptic characteristics of the drink were determined on a 10-point scale in accordance with the requirements of table. 1.

Statistical analysis

Mathematical modeling is used in the work. The experiment was repeated three times and mathematically processed using Microsoft Exel 2007 indicators: acidity, degree of syneresis, organoleptic characteristics **(Kolyanovska et al., 2019)**.

The research was performed according to the matrix of experimental planning in accordance with the plan of small factorial experiment SFE-2^{4-1}.

The experiments were performed in triplicate. When processing the experimental data, a statistically significant indicator was considered to be the value (n = 3, p ≥0.05).

RESULTS AND DISCUSSION

The authors developed a functional sour milk drink **(Bultosa, 2016)**. The expediency and relevance of the use of secondary raw materials for the production of oil using specialized strains of the microorganism in the production of food products with a functional focus are described. **(Bal'-Prilipko et al., 2016)**.

We present the development **(Guneser, Hosoglu, Guneser and Yuceer, 2020)** of a new functional sour milk drink from buttermilk with the use of natural pro- and prebiotics - with a biologically valuable complex *Spirulina platensis* **(Kavimandan, 2015)**. The chemical composition of sour milk drink enriched with pro- and prebiotic cultures was studied **(Fakhry et al., 2021)**. The main most common pro- and prebiotics, including strains, are specified Lactobacillus acidophilus, Lactobacillus casei subsp. casei, bifidobacterium SPP. (B. Adolescentis, B. animalis, B. bifidum, B. longum, B. breve) bacteria of starting cultures **(Katla, et al., 2001)**. Lactobacilli are used from several different sources **(Klein et al., 2000)** have broad antimicrobial activity. Lactobacilli were used as probiotics in experiments to make the drink. Experiments on the development of fermented milk product according to the approved quality management system ISO 9001 and the developed procedure for tasting the drink contain organoleptic characteristics and a score (from 1 to 10) **(Dal Bello, et al., 2017)**. To assess the basic chemical composition in the literature, different types of products were analyzed **(Hayaloglu et al., 2008)**. Our studies have shown that with increasing administration of spirulina, the acidity of the drink increases disproportionately. With a spirulina content of 10 to 20%, the acidity of the finished product is acceptable. At introduction - 25% acidity for 5 hours makes 87 – 90 °T that testifies to the overestimated acidity of a product. Using the MIR technique, the average fat content of the beverage, which is 0.4%, the content of dry nonfat milk residue - 8.0, the acidity of the beverage 75 – 87 ˚T **(Manuelian et al., 2017)**. Comparisons of proteolysis products obtained with different proteolytic drugs were studied **(Yukalo, Datsyshyn and Storozh, 2019)**. The results of the studies corresponded to the chemical parameters for determining the degree of syneresis (C, cm^3/100 g); product acidity (degrees T) and organoleptic parameters (OP, points) **(Madalozzo, Sauer and Nagata, 2015)**. Samples No. 1, 2 and 3 in the work **(Breus et al., 2019)** similar in characteristics and meet the requirements for fermented milk drinks. The composition of buttermilk shows that its use for the production of fermented milk drinks is relevant. In this context, the problem of full and rational use of buttermilk is considered relevant **(Manuelian et al., 2017)**. For the manufacture of sour milk drink **(Polischuk et al., 2020)** the degree of syneresis (serum isolation from the beverage clot) was investigated by centrifugation using a laboratory centrifuge Orbita (Ukraine). Rotation speed 1000 rpm, centrifuge tubes with a volume of 25 cm^3 for 5 – 25 min and in terms of serum volume in cm^3 per 100 g of product **(Lange et al., 2020)**.

The synergistic properties of beverage clots were evaluated by the amount of whey released during protein coagulation **(Atallaha, Morsyb and Gemiela, 2020)**. The dependence of the syneretic properties of buttermilk on the density of the clot and the duration of centrifugation of sour milk drink was determined. Analyzing the obtained data, it should be noted that the glossy clot with spirulina impairs the syneretic properties of the clot. After centrifugation for 5 – 25 min rennet clots obtained from buttermilk, which underwent two-stage pasteurization at different doses of spirulina, the amount of serum for centrifugation was: variant 1 sample - 77%, 2 samples - 74%, 3 samples - 71%, 4- sample - 68%. The lowest amount of serum was obtained in the sample with the highest dose of spirulina-25 **(Patel et al., 2019)**. In the fourth sample, it was noted that the appearance and consistency have a heterogeneous structure, a clot with the release of serum drops, the taste and smell of grassy, greenish-gray color with spirulina. The overall score of the fourth sample is overestimated. Due to the deterioration of organoleptic parameters, the study of sample №4 was stopped.

Food manufacturers around the world are tasked with improving the quality, biological value, safety, taste, and range of certain foods, including functional foods **(Türkmen, Akal and Ozer, 2019)**. Therefore, the development of the latest technologies for the production of fermented milk drinks based on buttermilk, suitable for all functional groups using the natural prebiotic spirulina, is considered a very promising task **(Bultosa, 2016)**. In particular, on the basis of dairy products you can produce a wide range of health, medical and dietary products.

Table 6 Chemical composition of the fermented milk drink enriched with pro- and prebiotic cultures.

Description	Model product			
	No. 1	No. 2	No. 3	No. 4
Fat content, %	0.4	0.4	0.4	0.4
The content of dry skim milk residue, %	8.0	8.0	8.0	8.0
Acidity, ˚T	75	78	80	87
Temperature, ˚C	8	8	8	8

Table 7 Microbiological properties of fermented milk drink enriched with pro- and prebiotic cultures.

Description	Model product		
	No. 1	No. 2	No. 3
Escherichia coli bacteria (coliforms), per 0.1 cm^3 of the fermented milk drink		Not found	
Molds, CFU per 1 cm^3		Not found	
Pathogenic microorganisms, including Salmonella bacteria, per 25 cm^3		Not found	
The number of viable lactic acid bacteria, CFU per 1 cm^3	$1.0x10^7$	$1.0x10^7$	$1.0x10^7$

Note: Having analyzed the resulted organoleptic, physical-chemical and microbiological parameters, we found model product No.1 the best one.

Table 8 Recipes for sour milk drink with different doses of spirulina.

Name of the component	Recipes			
	No. 1	No. 2	No. 3	No. 4
buttermilk	920,0	910,0	900,0	895
Sugar	50,0	55,0	60,0	60,0
Spirulina	10,0	15,0	20,0	25
Sourdought (1.8% of the main and 0.2% of the additional)	20,0	20,0	20,0	20,0
The yield of the finished product	1000	1000	1000	1000

Table 9 Estimation of quality of samples of drink on organoleptic indicators (the maximum possible points are specified).

Indicator	Characteristics
Consistency, appearance (3 points)	Homogeneous, tender, with a broken clot, moderately dense, without gas formation, with the replacement of the included threads of spirulina.
Taste and smell (6 points)	Pure, sour milk, with a taste of green algae-spirulina, odorless.
Color (1 point)	Green, for fermented milk drink caused by spirulina

Therefore, research related to the processing of buttermilk and the search for alternative ways to use it as a raw material for the production of fermented milk drinks, supplemented with prebiotics, deserves to be introduced into production.

In our work, we present a recipe for a sour milk drink based on buttermilk and spirulina **(Atallaha, Morsyb and Gemiela, 2020)**. We have developed a recipe for a functional milk drink based on buttermilk enriched with prebiotic spirulina **(Leiss et al., 2008)**, can be used by dairy companies **(Guneser et al., 2001)**.

Table 6 contains the chemical composition of the fermented milk drink enriched with pro- and prebiotic cultures.

Table 7 contains microbiological properties of fermented milk drink enriched with pro- and prebiotic cultures.

The degree of syneresis (serum isolation from the beverage clot) was studied by centrifugation using a laboratory centrifuge Orbita (Ukraine). Rotation speed 1000 rpm, centrifuge tubes with a volume of 25 cm^3 for 5 – 25 min and in terms of serum volume in cm^3 per 100 g of product.

The synergistic properties of the beverage clots were evaluated by the amount of serum released during protein coagulation. The dependence of the syneretic properties of the fermented milk clot on the density of the clot and the duration of centrifugation of the fermented milk drink is shown in Figure 6. Analyzing the data obtained, it should

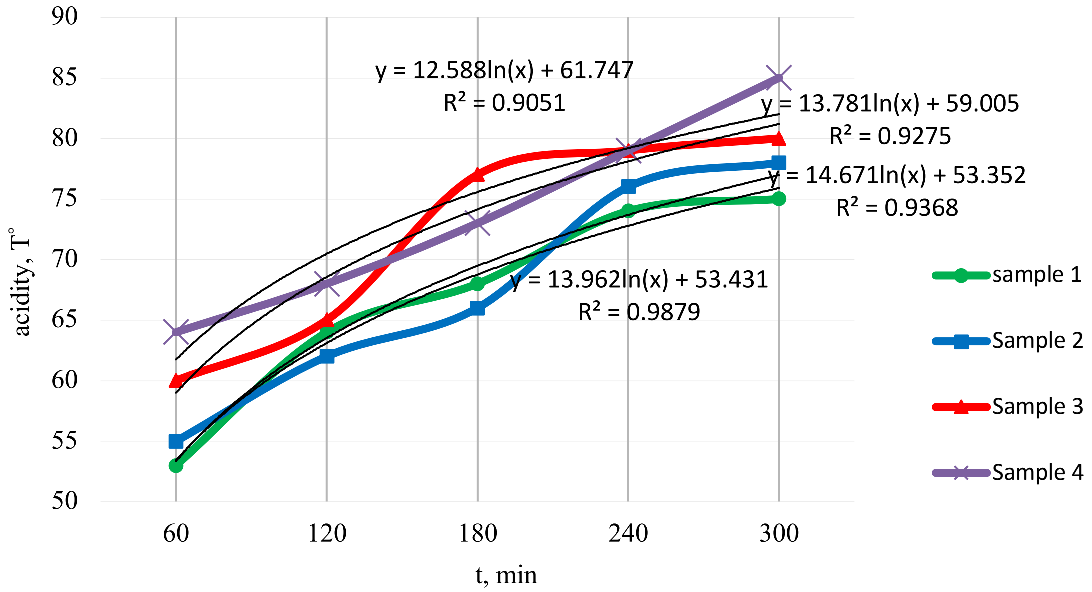

Figure 7 Dynamics of change in acidity of buttermilk with spirulina.

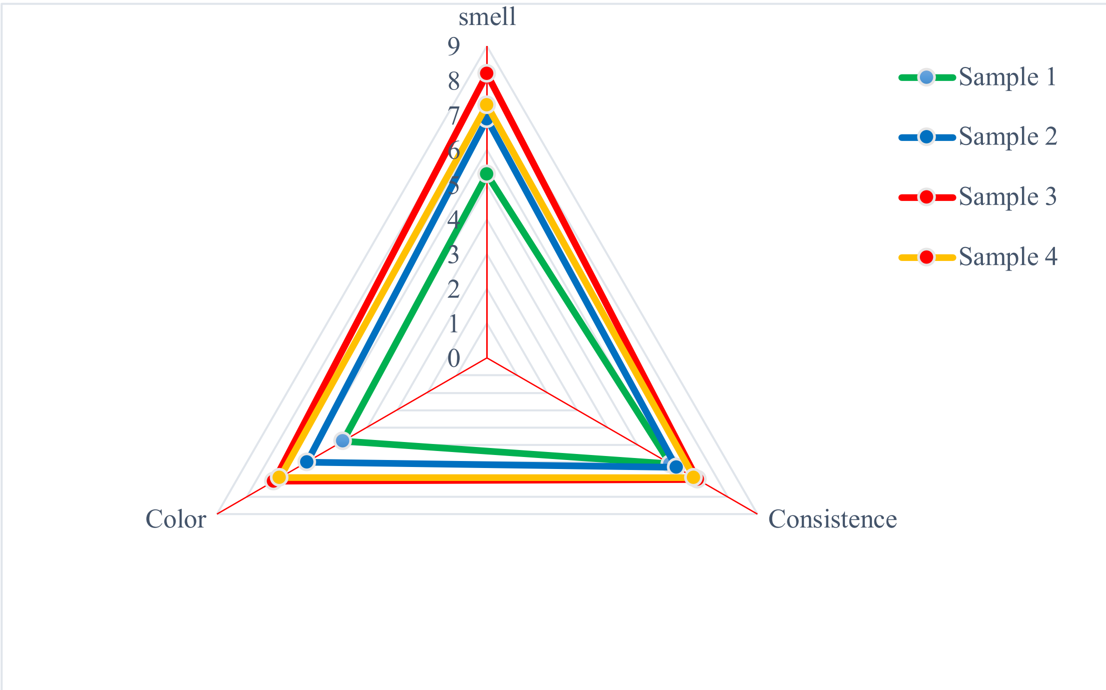

Figure 8 Comparison of organoleptic characteristics of samples.

be noted that a loose clot with spirulina impairs the syneretic properties of the clot. After centrifugation for 5-25 min rennet clots obtained from buttermilk, which underwent 2-stage pasteurization at different doses of spirulina, the amount of centrifugation serum was: option 1 sample - 77%, 2 sample - 74%, 3 sample - 71%, 4-sample-68%. The lowest amount of serum was obtained in the sample with the highest dose of spirulina-25.

Studies show that with the increasing introduction of spirulina, the acidity of the drink increases disproportionately (Figure 7). When the content of spirulina is from 10 to 20%, the acidity of the finished product is acceptable. At introduction - 25% acidity in 5 hours makes 87-90 °T that indicates the overestimated acidity of a product.

According to the approved quality management system ISO 9001, we created a tasting commission, which conducted a point evaluation (from 1 to 10) of the developed sour milk drink (Fig. 8). Samples No. 1, 2 and 3 are similar in characteristics and meet the requirements for fermented milk drinks. In the fourth sample it was noted that the appearance and consistency have a heterogeneous structure, a clot with the release of serum drops, the taste and smell are herbaceous, greenish-gray color with spirulina. The overall score of the fourth sample is inflated. Due to the deterioration of organoleptic parameters, the study of sample №4 was suspended.

Food producers around the world are challenged with the task of improving the quality, biological value, safety, taste, and the assortment of certain types of food, including functional products.

Analysis of buttermilk processing technologies shows that its use for the production of sour milk drinks is relevant. In this context, the problem of full and rational use of buttermilk is considered topical. Therefore, the development of the latest techniques for the manufacture of fermented milk drinks based on buttermilk suitable for all functional population groups using natural prebiotic spirulina is considered quite a promising task. In particular, it is possible to produce a wide range of health, medical and dietary products based on dairy products.

Having analyzed buttermilk processing techniques, we concluded that the issue of full and rational use of the material is still actual. Therefore, the study related to the processing of buttermilk and the search for alternative ways of using it as a raw material for the manufacture of fermented milk drinks supplemented with prebiotics is worth the whistle.

The recipe of fermented milk drink developed by us based on buttermilk enriched with prebiotic spirulina can be used by dairy establishments.

Table 10 contains the recipe of the fermented milk drink based on buttermilk.

Table 10 – The recipe of the fermented milk drink based on buttermilk enriched with pro- and prebiotic cultures

Description	Used raw material, kg
Buttermilk	920.0
Granulated sugar	50
Starter	20.0
Spirulina	10
Total	1000

The research results have shown that the subject drink is characterized by improved nutritional value and fit for human consumption.

CONCLUSION

Functional dairy products are the main suppliers of probiotic microorganisms, help to restore the microflora of the human gastrointestinal tract. Strains of bifidobacteria and certain species of lactobacilli, such as *Lactobacillus acidophilus, Lactobacillus casei subsp. casei, Bifidobacterium* spp. (*B. adolescentis, B. animalis, B. bifidum, B. longum, B. breve*), belong to probiotic cultures. The peculiarity of our proposed application of bacterial leavens is that after high-temperature treatment of buttermilk in the mode (100 ±5 °C) with a holding time of 25 s was cooled to 30 ±2 °C.

One of the important components of our sour milk drink is spirulina, which is widely used to improve the taste and enrich it with protein. We have developed an innovative technology for combining the unique food green algae Spirulina platensis with secondary raw materials fermented by selected strains of probiotic crops. Experimental studies have shown that a loose clot with spirulina impairs the syneretic properties of the clot, as evidenced by centrifugation for 5 – 25 min clots obtained from buttermilk, which has undergone 2-stage pasteurization. The lowest amount of whey was obtained in the sample with the highest dose of spirulina – 25. The optimal ratios of components (buttermilk, sourdough, sugar and spirulina) for the preparation of the food composition were determined. The parameters of the technological process of product preparation are established (fermentation in tanks $t = 30 \pm 2$°C, $\tau = 6 – 8$ h before clot formation).

The resulting fermented milk drink is a polydisperse colloidal system in which the buttermilk is a dispersion medium, and the proteins of buttermilk and spirulina are the dispersed phase. The results showed that under the same conditions of the coagulation process with increasing amount of spirulina added from 10 to 25% changes the acidity of the finished product. According to research, in our opinion, the most rational is the content of spirulina 10% for all defined indicators.

In the innovative development of the dairy industry, the technology of products using the plant extract of spirulina will be a new direction of enrichment of traditional fermented milk drinks to expand the range of functional products. The developed product can take the place of a functional sour milk drink in the system of healthy nutrition of the population.

The proposed technology for the production of sour milk drink from buttermilk and spirulina content allows to obtain a drink with improved technological properties and increased biological value.

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Funds:
This research received no external funding.

Conflict of Interest:
The authors declare no conflict of interest.

Ethical Statement:
This article does not contain any studies that would require an ethical statement.

Contact Address:

Irina Vlasenko, Institute of Trade and Economics, Faculty of Trade, Marketing and Services, Department of Commodity Science, Expertise and Commercial Business, Soborna, 87, 21050, Vinnytsia, Ukraine, Tel.:+380975714171,
E-mail: i.vlasenko@vtei.edu.ua
ORCID: https://orcid.org/0000-0001-9995-2025

Valentyna Bandura, National University of Life and Environmental Sciences of Ukraine, Heroiv Oborony street, 15, 03041, Kyiv, Ukraine, Tel.:+380677477093,
E-mail: bandura_3@ukr.net
ORCID: https://orcid.org/0000-0001-8074-3020

*Tetyana Semko, Vinnitsia Institute of Trade and Economics, Faculty of Trade, Marketing and Services, Department of Tourism, Hotel and Restaurant Business, Soborna, 87, 21050, Vinnytsia, Ukraine, Tel.: +380679625468,
E-mail: semko1965@ukr.net
ORCID: https://orcid.org/0000-0002-1951-5384

Larisa Fialkovska, Institute of Trade and Economics, Faculty of Trade, Marketing and Services, Department of Tourism, Hotel and Restaurant Business, Soborna, 87, 21050, Vinnytsia, Ukraine, Tel.:+380677477093,
E-mail: larisa_fialkova@ukr.net
ORCID: https://orcid.org/0000-0002-4353-0963

Olga Ivanishcheva, Institute of Trade and Economics, Faculty of Trade, Marketing and Services, Department of Tourism, Hotel and Restaurant Business, Soborna, 87, 21050, Vinnytsia, Ukraine, Tel.:+380933460220,
E-mail: olya.ivanisheva@gmail.com
ORCID: https://orcid.org/0000-0002-0500-3652

Vladyslav Palamarchuk, Vinnitsia Institute of Trade and Economics, Faculty of Trade, Marketing and Services, Department of Commodity Science, Expertise and Commercial Business, Soborna, 87, 21050, Vinnytsia, Ukraine, Tel.: +380935257378,
E-mail: kupc1989@gmail.com
ORCID: https://orcid.org/0000-0002-4906-1299

Corresponding author: *