Innovative whey based tonic drink with the plant components

M I Slozhenkina¹², D A Skachkov¹, O P Serova¹, D N Pilipenko²³, L F Obrushnikova² and N I Mosolova²

¹ Volgograd State Technical University, Volgograd, Russia
² Volga Region Research Institute of Manufacture and Processing of Meat-And-Milk Production, Volgograd, Russia
³ E-mail: pilden@yandex.ru

Abstract. The article discusses the relevance of the development of fermented whey beverages with the addition of plant components. The relevance of the study is confirmed by literature sources that indicate the possibility of obtaining such beverages with high consumer properties and high nutritional value from secondary raw materials of the dairy industry. At the first stage of determining the effectiveness of fermentation, the production of prototypes was carried out using lactobraying yeast in various quantities: prototype 1 contained 0.1% lactobraying yeast, prototype 2 – 0.5%, and prototype 3 – 0.9%. At the second stage, for further formation of the optimal taste and functional formulation, experimental samples were made with the addition of various amounts of plant functional components – currant syrup. During the experiment, the following prototypes were developed: sample 4 – with the addition of currant syrup in an amount of 1%; sample 5 – with 3%, sample 6 – with 5%. The data obtained as a result of the experiment confirm the adequacy of the developed formulation and technology of fermented whey based tonic with the addition of plant components and prove its functionality. The developed whey based tonic is a good addition to the diet, has a low calorie content, high nutritional value, has a positive effect on the gastrointestinal tract, and therefore its use will have a positive impact on human health.

1. Introduction

The article discusses the relevance of the development of fermented whey beverages with the addition of plant components. The relevance of the study is confirmed by literature sources that indicate the possibility of obtaining such beverages from secondary raw materials of the dairy industry with good consumer properties and high nutritional value.[1]

The research is devoted to assessing the compatibility of the components of the created drink during its production and consumption. The results of evaluating the balance of the formulation and nutritional value of the developed finished drink, depending on the components that make up its composition, are shown.[2, 3]

It is known, that fermented milk products are essential components of a full-fledged healthy diet, which is due to the small efforts of the human body to digest and assimilate them, especially if it’s a drink. It should be noted the role of fermented milk products as the best means to normalize the composition of the intestinal microflora.

Whey is a raw material, and accordingly products based on it, can play an important role in specialized nutrition, as they have a lot of positive properties in terms of nutritional value, and plant
ingredients that are used in whey drinks not only expand the range, but also give the product a certain functionality.

However, whey is not deservedly given insufficient attention by both processors and consumers. In addition, an important and urgent problem is the rational use of milk and its full 100% industrial processing, that is, waste-free production. This is also significant from the point of view of ecology. The majority of milk processing enterprises discharge the whey produced during the production of dairy products into the sewer as production waste, which is negative both from an environmental and economic point of view. And given the problem associated with the shortage of dairy raw materials, the question of its rational use is becoming increasingly relevant. At the same time, this product – drink is quite easy to enrich with non-dairy functional ingredients and give it new properties, which allows it to relate to functional food products. Functional products are aimed at providing the human body with useful nutrients and have a deterministic relationship with therapeutic and preventive goals. Therefore, the study of the possibility of using vegetable raw materials in the formulations of fermented milk whey drinks is in demand and promising and deserves comprehensive support. [4]

Dairy products are unique in their ability to provide the human body with essential nutritional components, and adding various plant-based food raw materials to the formula compositions of dairy products, including beverages, is promising and adds specific functionality to them. The following are often used as vegetable food ingredients (raw materials) for the enrichment of dairy raw materials in dairy product formulations: cereals, legumes and their processed products (flour, cake, meal, extrudates), various oilseeds, etc., and in dairy drinks – fruits and berries. One of the criteria for choosing plant raw materials is its ability to expand the range of the existing product line due to consumer properties (increasing nutritional value, including improving organoleptic properties) and reducing the cost in comparison with analogues (prototypes) without plant components. [5]

Drinks based on whey can have a positive effect on the emotional state of a person and play an important role in therapeutic nutrition, especially for the elderly, pregnant women and those who have problems with excess weight. [6, 7]

The aim of the work is to develop a tonic fermented whey drink with vegetable ingredients and study the nutritional value of the resulting drink. For this purpose, the influence of the fermenting component and vegetable raw materials on the consumer properties and nutritional value of the developed whey-based drink was experimentally evaluated.

2. Materials and methods
The object of research is a whey based tonic with the addition of plant components. The research was conducted at the Department of food production technology of the Volgograd state technical University and in the Volga Region Research Institute of Manufacture and Processing of Meat-And-Milk Production.

The experiment to optimize the formulation and adapt the technology of the whey tonic was carried out in two stages. At the first stage, the concentration of the fermenting component was selected. At the second stage, the optimal amount of vegetable flavor and functional component was selected. Upon completion of the experimental studies, technical documentation was developed.

As the main raw material for the production of a tonic, whey obtained during the production of cottage cheese and yeast is used. To improve the taste characteristics and give functional properties, auxiliary vegetable raw materials are used – fruit and berry syrups and spices to enrich the drink with nutrients and give a pleasant taste. The developed product range, as fillers, includes: currant syrup, strawberry syrup, pear syrup.

At the first stage of determining the effectiveness of serum fermentation, the production of prototypes was carried out using a fermenting substance – lactobraying yeast, in various quantities: prototype 1 contained 0.1% lactobraying yeast, prototype 2 - 0.5% lactobraying yeast, prototype 3 - 0.9% lactobraying yeast.

At the second stage, for further formation of the optimal taste and functional formulation, experimental samples were made with the addition of various amounts of plant functional components.
The product with currant syrup was taken as a model sample. During the experiment, the following prototypes were developed: sample 4 – with the addition of currant syrup in an amount of 1%; sample 5 – with the addition of currant syrup in an amount of 3%; sample 6 – with the addition of currant syrup in an amount of 5%. [8]

Organoleptic quality assessment was carried out according Russian standard 34352-2017 by tasting, Commission. To assess organoleptic indicators, a 20-point rating scale was used, according to which the maximum score of the sample is 20 points, for each of the 4 indicators, a maximum of five points. The evaluation was carried out by a tasting Committee of 5 experts.

Physical and chemical parameters were studied: the acidity of fermented whey, the mass fraction of protein, mass fraction of carbohydrates.

In addition, the study was conducted using methods of statistical data analysis, comparison, analogy, and systematization.

3. Results and discussion

Whey is a product obtained in the manufacture of cheese, cottage cheese and casein, intended for further processing. Depending on the quality of milk, production technology, and starter cultures used, the whey may have a different composition and taste. Serum is ideal for dietary nutrition - the fat content does not exceed 0.2 %, protein about 1 %, lactose (a special type of carbohydrates that is completely absorbed by the body, is not deposited as fat mass and normalizes the intestinal microflora) up to 4 %.

Whey is rich in vitamins (PP, C, B2, B1, beta-carotene, etc.) and minerals (1 liter of whey provides the body with potassium 130 mg ~ 40 % of the daily norm, calcium 80 mg ~ 75 % of the daily norm, phosphorus 78 mg, sodium 40 mg, magnesium 8 mg, iron 0.1 mg). Table 1 shows the nutritional content in 100 g of the product.

Table 1. Chemical composition and nutritional value of whey.

| Nutrient          | Content |
|-------------------|---------|
| Fat, g           | 0.1     |
| Carbohydrates, g  | 4.0     |
| Protein, g       | 1.0     |
| Nutritional value, kcal (kJ) | 20.9 (87.5) |

Vitamins, mg

| Vitamin |          |
|---------|----------|
| A       | -        |
| B₁      | 0.03     |
| B₂      | 0.11     |
| PP      | 0.14     |
| C       | 0.50     |

Minerals, mg

| Mineral  |  |
|----------|---|
| Sodium   | 40.0 |
| Potassium| 125.0|
| Calcium  | 60.0 |
| Magnesium| 6.0  |
| Phosphorus| 71.0 |
| Iron     | 0.1  |

Currant is a source of biologically active substances, especially macro- and microelements, vitamins and organic acids, which are in an easily digestible form and in optimal proportions for the human body. The composition of currant berries is diverse in biologically functional trace elements and minerals. Black currant syrup is rich in vitamins C - 115.4 mg%, B₆ - 6.494 mg%, H – 3.117 mg%, E – 0.909 mg%, B₃ – 0.519 mg%, β-carotene – 0.118 mg%; macro - and microelements: potassium - 17.7 mg%, calcium - 46.4 mg%, magnesium – 39mg%, cobalt – 5.2 mcg%, manganese - 11.7 mcg%, copper - 168.8 mcg%, molybdenum - 44.5 mcg%, etc.
Vitamins, macro- and microelements in currant syrup give the whey tonic functional properties when they are added to the formulation of the created drink in an amount sufficient to create its optimal organoleptic properties. In addition, currant syrup improves organoleptic parameters, thereby improving the consumer performance of the finished product.

The technological method for the production of fermented whey tonic is the fermentation of lactose with lactobraying yeast. The method is based on the enzymatic hydrolysis of serum lactose into monosaccharides, followed by fermentation of glucose by industrial races of yeast.

In order to select the optimal amount of the lactobraying component, the prepared prototypes (1-3) of the whey tonic were evaluated by the tasting Commission. The results of organoleptic evaluation of experimental samples are presented at the table 2.

| Indicator and consistency | Sample 1 | Sample 2 | Sample 3 |
|---------------------------|----------|----------|----------|
| Appearance and consistency | liquid consistency, no gas formation | liquid consistency, gas formation is slightly present | liquid consistency, bright gas formation |
| Taste | the taste of curd whey | the taste of curd whey, barely noticeable yeast aftertaste | pronounced taste of yeast, yeast aftertaste |
| Points: | 3 | 5 | 2 |
| Smell | curd whey smell | curd whey smell | whey and yeast smell |
| Points: | 4 | 5 | 1 |
| Color | pale yellow | pale yellow | pale yellow |
| Points: | 5 | 5 | 5 |
| Total | 16 | 20 | 9 |

The best was sample 2, which scored a maximum score of 20. According to the results of the organoleptic assessment, given in table 2, it can be concluded that the best organoleptic properties have sample 2, which scored the maximum number of points (20), and the worst is recognized as sample 3 – 9 points. When adding a lactic fermentation agent in the amount of 0.1% (sample 1) – there is no gas formation, when adding 0.9% (sample 3) – a pronounced yeast taste, yeast aftertaste.

The profilogram based on the results of the point evaluation of prototypes is shown in figure 1.

![Profilogram of organoleptic evaluation of experimental samples with different amounts of the lactobacilli component (stage 1).](image-url)
In order to determine the amount of acid formation in the fermentation process, the acidity of the experimental samples of the whey tonic was determined by the end of the technological process. The results of determining the acidity of the test samples are presented in table 3.

Table 3. The acidity of samples of the fermentation stage.

| Samples   | Acidity, °T |
|-----------|-------------|
| Sample 1  | 76          |
| Sample 2  | 80          |
| Sample 3  | 104         |

As a result of the conducted studies, table 3 shows that the amount of lactic fermentation yeast introduced affects the acidity of the finished whey beverage. As the yeast dosage increases, the titrated acidity of the drink also increases. Thus, it was found that, including from the point of view of organoleptic indicators, the optimal concentration for fermentation of curd whey is the concentration of lactobraying yeast in the amount of 0.5% at which the acidity of the drink (sample 2) is 80 °T, which is proved by the best organoleptic properties of the finished product.

Further, at the next stage of the experiment, to determine the optimal amount of flavor, functional filler, experimental samples (4-6) of a whey tonic were developed, which had a different dosage of currant syrup. For a comparative assessment of organoleptic parameters of the studied samples, a Commission score was used. The results of the evaluation of prototypes are presented in table 4.

Table 4. Organoleptic parameters of samples with taste components.

| Indicator              | Characteristics                                      | Sample 1                        | Sample 2                        | Sample 3                        |
|------------------------|------------------------------------------------------|--------------------------------|--------------------------------|--------------------------------|
| Appearance and consistency | liquid consistency, gas formation is slightly present | liquid consistency, gas formation is slightly present | liquid consistency, gas formation is present |
| Points:                | 5                                                   | 5                              | 5                              |
| Taste                  | the taste of curd whey, faint currant flavor         | the taste of curd whey, strong currant flavor    | the taste of curd whey, too strong currant flavor   |
| Points:                | 4                                                   | 5                              | 4                              |
| Smell                  | curd whey smell, currant is almost not felt          | curd whey smell, bright tone of currant            | curd whey smell, too strong smell of currant         |
| Points:                | 4                                                   | 5                              | 3                              |
| Color                  | pale pink                                           | pink                            | purple                          |
| Points:                | 5                                                   | 5                              | 5                              |
| Total                  | 18                                                  | 20                             | 17                             |

The results of the organoleptic evaluation of experimental samples table 4 show that the maximum score was received by sample 5 – 20 points, and the worst was sample 6 (17 points). The obtained data indicate that the addition of a vegetable flavor, functional component - currant syrup in an amount of 3% will be optimal. When adding syrup in a smaller amount, the taste of the filler is weakly expressed, and in a larger amount, the taste of currant interrupts the taste of whey.

The profilogram based on the results of the point evaluation of prototypes is shown in figure 2.
Figure 2. Profilogram of organoleptic evaluation of experimental samples, when selecting the taste component.

The profilogram clearly shows the shortcomings of samples 4 and 6 identified by the tasting Commission.

The work carried out on the development of the recipe and technology of a tonic drink based on whey with the addition of plant components revealed the optimal recipe. At the same time, it also includes a functional ingredient that enriches the main product with vitamins, as well as macro and microelements, increasing its nutritional value. To assess the nutritional value, its main indicators were determined, including energy value, table 5.

Table 5. Nutritional value of whey tonic, per 100 g.

| Nutrient               | Content |
|------------------------|---------|
| Fat, g                 | 0.1     |
| Carbohydrates, g       | 5.5     |
| Protein, g             | 1.0     |
| Nutritional value, kcal (kJ) | 26.9 |

The data obtained indicate a fairly high nutritional value of the developed fermented whey drink. It was found that the nutritional value and chemical composition of the raw material (whey) significantly improved due to the use of lactobraying yeast and currant syrup.

4. Conclusion
Summarizing the above, we can conclude that an adequate formulation of fermented whey tonic with the addition of plant components has been developed. It can be argued that the proposed technology is effective, because it provides high quality products and methods for processing raw materials of various quality. One of the advantages of production is the use (utilization) of secondary raw materials, which also increases the importance of the developed technology in relation to the environment.

The use of this type of fermentation improves the organoleptic properties of the product.

To date, an effective way to solve the problem of vitamin and mineral deficiency is to add components of plant raw materials with an increased content of the necessary ingredients. Adding currants to the created fermented whey tonic in the form of syrup in the optimal dosage for creating...
organoleptic properties provides about half of the daily human need for vitamins and macro - microelements when consuming one serving of the drink.

To improve the taste characteristics, you can use fruit and berry components. Currant berries are a source of biologically active substances, especially macro - and microelements, vitamins and organic acids, which are contained in them in an easily digestible form and in optimal proportions for the human body. They can provide about half of a person's daily need for vitamins and trace elements.

The developed fermented whey tonic is a good addition to the diet, has a low calorie content, high nutritional value, has a positive effect on the gastrointestinal tract, and therefore its use will have a positive impact on human health. designed for the General public.

Thus, the data obtained as a result of the experiment confirm the adequacy of the developed formulation and technology of fermented whey tonic with the addition of plant components and prove its functionality. The developed whey tonic is a good addition to the diet, has a low calorie content, high nutritional value, has a positive effect on the gastrointestinal tract, and therefore its use will have a positive impact on human health.

Acknowledgments
This work was performed under the grant of the President of the Russian Federation to support leading scientific schools HIII-2542.2020.11. Grant sponsors were not directly involved in the development, analysis, or writing of this article.

References
[1] Khramtsov A G, Brykalov A B and Pilipenko N Yu 2012 Whey drinks with herbal ingredients Dairy industry 7 64-6
[2] Gorlov I F, Slozhenkina M I, Skachkov D A et al. 2019 Quality of kefir product enriched with plant-based food ingredients Food industry 11 20-4
[3] Viljanen K, Halmos A L, Sinclair A, Heinonen M 2005 Effect of blackberry and raspberry juice on whey protein emulsion stability European Food Research and Technology 221(5) 602-9
[4] Vu T, Mgebrishvili I, Hramova V, Korotkova A and Gorlov I 2017 The analysis of the using efficiency Japanese matcha tea in the fermented milk products production Journal of Hygienic Engineering and Design 20 86-91
[5] Zavorokhina N V et al. 2019 IOP Conf. Ser.: Earth Environ. Sci. 315 062008
[6] Agric J 2005 Food Chem 53(6) 2022-7
[7] A A Korotkova et al. 2020 IOP Conf. Ser.: Earth Environ. Sci. 548 082078
[8] Velichkina A V, Skachkov D A and Grebennikova O V 2018 Investigation of the influence of the amount of fillers on the physical and chemical properties of fermented milk products New approaches to the development of technologies for the production and processing of agricultural products (Volgograd: VRRIMP, VSTU) p 263-5