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Optimization of the recipe of yoghurt with additives and control of some quality attributes of new yoghurt recipe

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Abstract. According to the data and the results of clinical trials received in Nutrition Institute of 'Russian Academy of Medical Sciences', it was found that 80% of Russians suffer from lack of selenium. Saint-Petersburg University Innovation Company 'Littoral' has developed a biologically active food supplement 'Selenium Alga plus'. The aim of this research was to investigate the possibility of using dietary supplement 'Selenium Alga Plus' in yoghurt manufacture. Almost all groups of the population consume such fermented milk drink as yogurt, so that it is considered that this method increasing selenium as the most effective. People suffering from diabetes may have lack of selenium in the organism, as well as healthy people. Since traditional yogurt contains 11% of sucrose, it is necessary to choose sweetening components with vegetable origin. Selecting sweetening components of vegetable origin we pursued the dual purpose. Firstly, we created a sweet product, which would be a source of organic selenium. Therefore the sucrose was replaced with the plant origin sweeteners such as syrup of Jerusalem artichoke and stevioside. Secondly, it was the development of technology and composition of functional food product, intended not only for mass consumption, but also for people suffer from diabetes. It becomes possible due to the absence of sucrose, the presence of selenium and Jerusalem artichoke, which are able to reduce the blood sugar level.

Key words: nutrition, yogurt, selenium, stevioside, Jerusalem artichoke.

INTRODUCTION

Recent years in Russia and abroad functional food is used widely. New promising food industry trend improves the structure of nutrition and the human health maintenance. Research and development of functional foods enriched with dietary fiber, antioxidants, vitamins and minerals, are relevant.

According to the Institute of Nutrition 'RAMN' scientists, data approximately 80% of Russia's population suffers from a deficiency of selenium. Particularly severe selenium deficiency is observed in elderly people aged 45–55 years and after 70 ('*selenium pit*'), pregnant women and children fed infants food. (Volkotrub et al., 2001)

The main route of selenium in the body is alimentary. 90% of selenium intake is driven into human organism with nourishment and 10% with water. Assimilation of soluble forms of selenium (most part of selenium is absorbed in the duodenum and other sections of the intestine) is determined by the nature of the food.

Retention indices (inclusion metabolism) and potential toxicity play important role. Available data confirms the advantage of organic forms of selenium (selenomethionine, selenocystein) as dietary sources of selenium. Selenomethionine is absorbed five to ten times better than other chemical compounds (Volkotrub et al., 2001).

Organic form (selenomethionine, selenocystein) is the most preferable for the body to digest as 95–98%, whereas the animal form is absorbed at 30%, and nonorganic form is absorbed only at 10% (however, just mineral form of selenium requires the greatest prudence since its excess leads to producing and accumulating of the '*gidroselenidanion'* toxin in the body (Gmoshinsky et al., 2006).

Humans need a little quantity of selenium to maintain health. The World Health Organization believes that women need about 55 micrograms, man – 70 micrograms, and children – 15 micrograms of the substance per day.

Saint-Petersburg University innovative company 'Litoral' developed a biologically active food supplement 'Selenium Alga plus'.

Dietary supplement 'Selenium Alga Plus' contains an organic form of selenium (sources – selenium yeast, garlic, wheat bran). The selenium is included in the composition more than 200 hormones and enzymes and thus it regulates work of all organs and systems of our body. Selenium is incorporated into proteins to make selenoproteins, which are important antioxidant enzymes. Selenium is found in glutathione peroxidase, thioredoxins, and selenoprotein P (Fraga, 2005). Selenium plays an important role in many biological functions: antioxidant defense, formation of thyroid hormones, DNA synthesis, fertility and reproduction. Some, like methylselenol, play a role in cancer prevention (Mehdi et al., 2013).

Brown algae one part of selenium supplement contains more iodine than any other maintaining product. Iodine and selenium are the most important trace elements for the health of the thyroid gland and normal production of the hormone. Numerous medical researches about the role of trace elements in the development of iodine deficiency disorders confirmed close metabolic relationship of iodine and selenium in the body, as well as experiments on rats have shown that the saturation of the selenium in a lack of iodine leads to the aggravation of iodine deficiency diseases (Gromova, 2004). The composition of the supplement also includes garlic, wheat bran, brewer's yeast, artichoke, E, C, B vitamins. Vitamin C improves the absorption of selenium, promotes the stabilization and recovery of vitamin E. Selenium is required for the action of vitamin E. Together, they create a full-fledged *'trap'* for the fat–soluble oxidants. Selenium and Vitamin E can work only in conjunction, so that ingestion of one substance requires supplementation with another substance. Moreover, the lack of these vitamins can prevent the body to assimilate selenium (Thomson, 2004).

Jerusalem artichoke, which is a part of supplement 'Selenium Alga Plus', lowers blood sugar level, that beneficially affects the efficiency of the complex. Wheat bran promote the formation of the nutritive bolus, thus nutrients pass through the gastrointestinal tract with optimal speed that promotes assimilation by the body (Kochnev et al., 2002).

It should be noted that there is another no less important problem in Russia. People suffering from this disease, may suffer from selenium deficiency in an organism as well as healthy people. In addition, because of diabetes is often accompanied by intestinal dysbiosis, such people need of daily use of dairy products. Therefore, at the Department of Technology of milk and food biotechnology, it was decided to develop a fermented

milk product, available not only for general populations, but also for people with diabetes (Wotkins, 1997).

In recent years, there was a trend towards the production of functional foods (Gmoshinsky et al., 2006). They differ in various compositions, but the unity of the assortment based on the purposeful usage of milk and non-dairy origin raw-stuff imparting protein, lipid, carbohydrate, vitamin or mineral orientation of new products. Based on the above, the purpose of this study was to develop a composition of yogurt, using supplement 'Selenium Alga Plus' containing selenium in organic form, with the addition of sugar substitutes – syrup of Jerusalem artichoke and stevia.

MATERIALS AND METHODS

Dry skim milk was obtained from a local market. One party dry skim milk was used to provide reliability of the experimental results. Technological process was performed by the known traditional technology, thermostatic method. Required quantity of selected according to GOST 52791–2007 dry skim milk was dissolved in water (SanPin 2.1.4.1074–01) heated to a temperature 40–45°C until complete dissolution, and held at this temperature for 1 hour to intumescence proteins. Then milk was pasteurized at the temperature 90–95°C having been delayed 2–8 min, was cooled to 45°C, added starter culture, were stirred and thermostated during 4 hours.

Standard starter culture was used to ferment yogurt (*Lactobacillus delbrueckii subsp. Bulgaricus* and *Streptococcus thermophilus*) Termophilic Yoghurt Culture by firm Yo–FlexR CHR HANSEN party YF–L811 was used.

Same batch dietary supplement 'Selenium Alga Plus' from Company 'Litoral' was used. Supplement was added in dry form, after pasteurization. Dietary supplement was packaged in a vacuum packaging, thus additional heat treatment was not required to provide product safety.

Stevioside powder (31834003920000; manufactured by 'Rudolf Wild GmbH & Co/KG') was scaled and added in dry form.

Syrup of Jerusalem artichoke was manufactured by LLC 'Terra' (Specification – 9185-003-56857055-05). The required amount of syrup was measured by laboratory pipette according to GOST 29227–91.

In the first stage of researching, the effect of the concentration of the studied supplement on quality yogurt and dynamics of accumulation of acidity was determined. Supplement was added in an amount of from 0.1 to 0.8%, which is from 13 to 100% of the daily requirement for selenium for adult human by eating 200 g of the product. Supplement concentration was ranged from 0.1% to 0.8% with the increments of 0.1%. Control pattern was a sample without supplement. Based on literature data, selenium has a property to be destroyed by heat treatment of over 50°C. Therefore the moment of addition supplement after pasteurization before fermentation and in the finished product before bottling was investigated.

To determine the dosage of stevioside in the product it was added from 0.01 to 0.1% in increments of 0.01%. The sample that was produced from reconstituted skim milk with a sucrose content of 11%, served as control. Organoleptic evaluation of samples was conducted. To determine the effect of Jerusalem artichoke syrup concentration in the product it was added from 1 to 5% of the dose of syrup of Jerusalem artichoke in increments of 1%.

In the second stage research the moment of entering of sweetener was determined. To determine the moment of entering the sweeteners two samples were prepared. In the first case, the stevioside and syrup of Jerusalem artichoke were introduced into normalized mixture before pasteurize but in the second case, they were added after pasteurization with starter culture. The control sample was generated by the addition 11% of sucrose. The technological process was performed in the traditional way. Dynamic of accumulation of titratable acidity was investigated, titratable and active acidity were estimated.

Samples were evaluated for organoleptic properties by a taste panel of the 11 staff members and students of the Technology of Milk and Food Biotechnology Department. The participants were selected and trained in accordance with the ISO 8586-1 standard (1993). Requirements for the work of the group of assessors were according to ISO 8589 standard (2007).Sensory evaluation of the yogurt samples was carried out using quantitative descriptive (profile) method of analytical evaluation of foods modified for yogurt, containing in its composition Supplements 'Selenium Alga Plus'. Each indicator was evaluated on a 5-point scale (Table 1).

Table 1. Evaluation of samples

Characteristics					Score
Taste	Odour	Consistency	Colour	Appearance	
sweet enough, off-flavour	feebly marked strange odour	insufficiently precipitate	not CCF	separation serum, precipitate	2
TTF, excessive or inadequate sweet	insufficiently pronounced, FF	insufficiently HVD	CCF	separation serum	3
TTF, moderately sweet	moderate, FF	insufficiently HVD	CCF	glossy surface, separation serum not more that 3%	4
TPF, sweet	brightly-expressed FF	HVD	CCF	glossy surface, without separating the serum	5

TPF – taste pure, fermented, without foreign flavour;
FF – fermented flavour;
HVD – homogeneous, viscous, dense consistency;
CCF – the corresponding colour filler.

pH was measured using a pH meter (pH–410 with a glass combination electrode).

Titratable acidity determination was carried out by titrimetric method using phenolphthalein indicator according to GOST 3624–92.

The value of the relative viscosity was determined using a viscometer VZ 246 GOST 9070–75 (see Fig. 1).

Figure 1. The viscometer VZ–246.

Investigation of qualitative indexes of the experiment pattern finished product was performed in comparison with the control. In the control and experimental samples was determined organoleptic characteristics, titratable and active acidity, relative viscosity, water holding capacity of the bunch. Microscopic sample was prepared.

RESULTS AND DISCUSSIONS

Influence of the concentration of Supplement 'Selenium Alga Plus' on organoleptic properties of yogurt is shown in Table 2. As seen from the data presented in Table 2, increasing the dose over 0.4% Supplement being felt specific taste with a pronounced odour of algae, which prevents increase the concentration Supplements over 0.4%.

Table 2. Effect of the supplement concentration on the yoghurt organoleptic quality

Concentration of supplement	Quality indicators	
	Taste and smell	Consistency
Control sample	pure fermented milk	homogeneous, viscous
0.1%	pure fermented milk	homogeneous, viscous, there are small particles of brown colour
0.2%	pure fermented milk, typical filler tabled	homogeneous, viscous, there are small particles of brown colour
0.3%	pure fermented milk, typical filler tabled	homogeneous, viscous, there are particles of brown colour
0.4 %	pure fermented milk, typical filler tabled	homogeneous, viscous, there are particles of brown colour
0.5%	fermented milk, taste with a specific taste and smell of algae	homogeneous, viscous, there are particles of brown colour
0.6%	fermented milk, taste with a pronounced taste and smell of algae	homogeneous, viscous, there are particles of brown colour
0.7%	fermented milk, specific taste, with a pronounced taste and smell of algae	homogeneous, viscous, there are particles of brown colour
0.8%	fermented milk, unpleasant specific	homogeneous, viscous, there are particles of brown colour

Thus, based on organoleptic features – the taste and smell – sample at a concentration of 0.4% supplement was selected, which corresponds to 50% of the normal intake of selenium per day by eating 200 g of product. Influence of concentration of stevioside on quality findings of yogurt are shown in Table 3.

Table 3. Effect of the concentration of stevioside on quality yogurt

Concentration of stevioside	Taste and smell
Control sample	pure fermented milk, moderately sweet
0.01	Pure fermented milk
0.02	Pure fermented milk
0.03	pure fermented milk, not sweet enough
0.04	pure fermented milk, not sweet enough
0.05	pure fermented milk, not sweet enough
0.06	pure fermented milk, not sweet enough with a specific flavour
0.07	pure fermented milk, not sweet enough with a specific flavour
0.08	pure fermented milk, not sweet enough with a specific flavour
0.09	fermented milk, overly sweet with a specific flavour
0.10	fermented milk, overly sweet with a specific flavour

As seen from the data presented in Table 3, a sample with a stevioside concentration of 0.05% has insufficient sweetness, but increasing concentration gives explicit presence of a specific after-taste. Therefore, to increase the sweetness of the product the syrup of Jerusalem artichoke was chosen. Therefore, it was decided to make further Jerusalem artichoke syrup. Findings of quality yogurt with stevioside and syrup of Jerusalem artichoke are shown in Table 4.

Table 4. Effect of concentration of syrup of Jerusalem artichoke on quality yogurt

Concentration of stevioside	oncentration of yrup of Jerusalem rtichoke	oncentration of Selenium upplements Alga Plus	Taste and smell
0	0	0	Pure fermented moderately sweet
0.05	0	0.4	fermented milk, not sweet enough
0.05	1.0	0.4	fermented milk, not sweet enough
0.05	2.0	0.4	fermented milk, not sweet enough
0.05	3.0	0.4	fermented milk, moderately sweet, pleasant
0.05	4.0	0.4	fermented milk, unpleasantly sweet
0.04	3.0	0.4	fermented milk, not sweet enough
0.04	4.0	0.4	fermented milk, not sweet enough
0.04	5.0	0.4	Fermented milk, unpleasantly sweet

As can be seen from the data presented in Table 4, experiment sample with syrup of Jerusalem artichoke doses 0.05% had fermented sweet taste without foreign tastes and odours. Thus the following concentrations of sweeteners were selected: stevioside – 0.05% and Syrup of Jerusalem artichoke – 3%.The effect of Supplement concentration on the dynamic of accumulation acidity presented in Fig. 2.

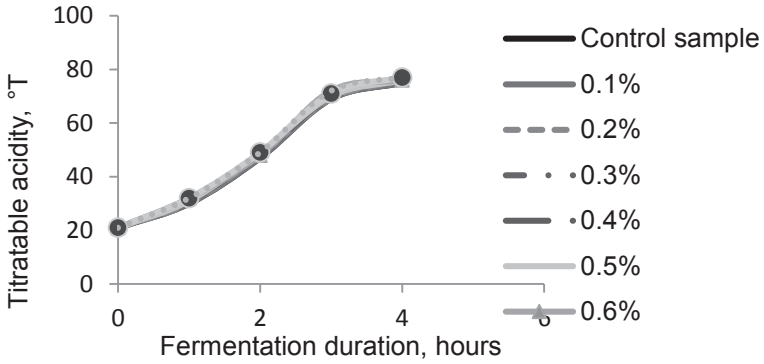

Figure 2. The influence of the concentration of supplement on the dynamic of the accumulation of acidity.

As seen from the data presented in Fig. 2, supplement, regardless of the application dose, no effect on titratable and active acidity. Dynamic accumulation of acidity in the experimental and control samples was similar. During 4 hours ripening titratable acidity and active pH reached 76 ± 2°T, 4.62 ± 0.05, respectively.

Supplement 'Selenium Alga plus' must be added, together with the starter culture in the pasteurized milk as during heat treatment over 50°C, are losing 50% of selenium.

Dietary supplement 'Selenium Plus Alga' packaged in a vacuum packaging, thus it does not require additional treatment to provide the product safety.

Influence of addition moment of sweeteners on the acidity accumulation dynamic is presented in Fig. 3.

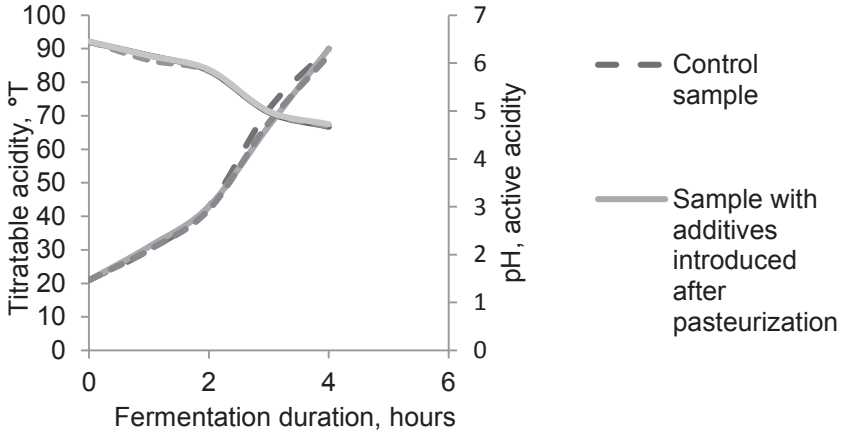

Figure 3. Acidity accumulation dynamics in yogurt depending on the insertion of additives.

As could be seen from the data presented in Fig. 1 significant differences between dynamics accumulation titratable acidity, test samples with additives and control sample was not observed. Next, sensory evaluation of yogurt samples was realized. These organoleptic characteristics of yogurt samples and control sample are displayed in Fig. 4.

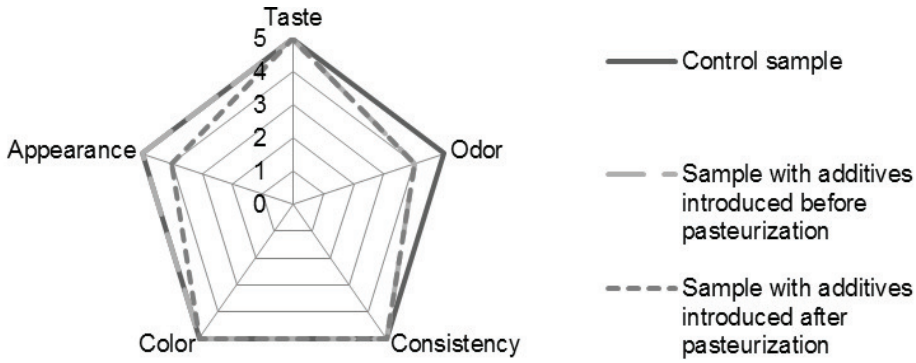

Figure 4. Sensory evaluation of samples.

Test samples with additives introduced before and after pasteurization, did not have significant differences from the organoleptic quality of control sample. Additionally, there was no difference between dynamics of the acidity accumulation. Thus both sweeteners may be applied before and after pasteurization. However, in terms of the product microbiological safety, sweeteners should be added in the standardized milk before pasteurization. Microscopic control and experiment yogurt samples are presented in Fig. 5.

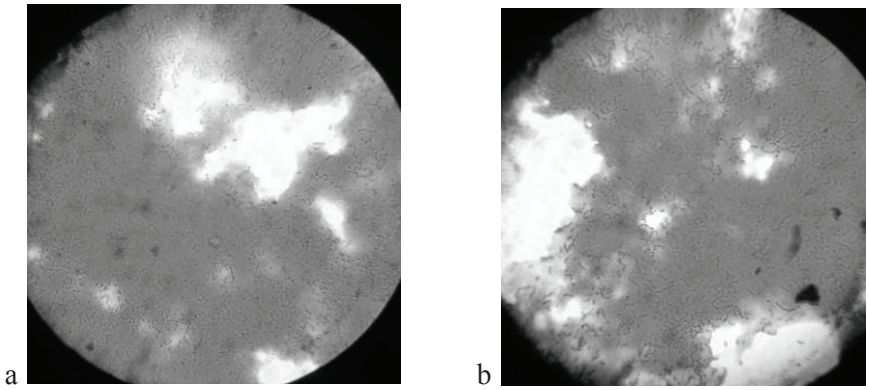

Figure 5. Microscopic samples of yogurt: a) without supplement; b) with supplement.

At the time of visual estimation of microscopic sample of yogurt, lactic streptococcus and rods were discovered. The presence of foreign microorganisms (*Oidiumlactis, thermotolerant yeast* and *lactic acid bacillus*) was not observed. Characteristics of the finished product are presented in Table 5.

Table 5. Quality characteristic of yogurt enriched Supplements 'Selenium Alga Plus'

Indicator	Characteristic	
	Control sample	Product
Taste	pure fermented milk	pure fermented milk, with a smack of filler, sweet
Flavour	pronounced aroma of fermented milk	pronounced aroma of fermented milk, characteristic tabled filler
Colour	white	corresponding to the colour of the filler, homogeneous throughout the mass
Consistence	homogeneous, moderately viscous, moderately dense	homogeneous, moderately viscous, moderately dense
Appearance	a glazy surface without whey separation	a glazy surface without whey separation, there are inclusions of supplement, evenly distributed throughout the mass
Acidity, °T	78 ± 2	79 ± 2
Active acidity, pH	4.62 ± 0.05	4.58 ± 0.05
Relative viscosity, seconds	41 ± 2	43 ± 2

CONCLUSIONS

1. The study concluded that the supplement 'Selenium Alga Plus' company Litoral can be used for the production of yogurt.
2. The dose entering of 0.4% of supplement 'Selenium Alga Plus' by weight of the mixture was established, that corresponds to 50% of normal selenium consumption per a day by eating 200g of the product. Based on these studies it can be concluded that the enrichment of the yogurt allows to obtain a product, which is a source of organic selenium.
3. Yogurt has a sweet flavour without foreign tastes and odours and it contains 0.05% stevioside and 3% artichoke syrup. Based on these studies it can be concluded that yogurt, enriched with selenium and sweeteners, is available for people suffering from diabetes.
4. It has revealed that the stage of the sweeteners entering before pasteurization in normalized mixture and after pasteurization with starter culture has not any effect on the quality of the finished product. Choosing the moment of the sweeteners entering before pasteurization provides safe product manufacturing.

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REFERENCES

Donskaya, G. & Zaharova, E. 2010. Milk drink with Jerusalem artichoke. *Dairy industry* **10**, 69–70 (in Russian).

Fraga, C.G. 2005. Relevance, essentiality and toxicity of trace elements in human health. *Molecular Aspects of Medicine* **26**, 235–244.

Gapparov, M. 2003. Functional Foods. *Food processing industry* **3**, 6–7 (in Russian).
Gmoshinsky, I. & Mazo, V. 2006. Minerals in human nutrition. *Nutrition* **75** (5), 15–21 (in Russian).
Gromova, O. 2004. Attention–selenium. *Propitanie* **7** (in Russian).
Grunskaya, V. & Gabrielyan, D. 2012. Enriched milk drinks using whey. *Dairy industry* **10**, 56 (in Russian).
ISO 8586–1: 1993. Sensory analysis. General guidance to the selection, training and monitoring of assessors, Part 1. Selected assessors.
ISO 8589: 2007. Sensory analysis – General guidance for the design of test rooms.
Kim, V. 2001.Dairy products – prebiotics. *Dairy industry* **2**, 31–32 (in Russian).
Kochnev, N.K. & Kalinichev, M.V. 2002. Jerusalem artichoke–bioenergy crops XXI century. Ares, Moscow, 76 pp.
Lipatov, N. 1994.The dairy industry in the XXI century. *Nutrition* **6**, 39–42 (in Russian).
Lisitsin, V. & Kovalev, I. 2000. Stevia–a source of health and longevity of the nation. *Dairy Industry* **5**, 38–39 (in Russian).
Mehdi, Y., Hornick, J., Istasse, L., & Dufrasne, I. 2013. Selenium in the Environment, Metabolism and Involvement in Body Functions. *Molecules* **18**, 3292-3311.
Sheveleva, S. 1999. Probiotics, prebiotics and probiotic products. *Nutrition* **2**, 32–39 (in Russian).
Thomson, C.D. 2004. Assessment of requirements for selenium and adequacy of selenium status: a review. *European Journal of Clinical Nutrition* **58**, 391–402.
Volkotrub, L. & Andropova, T. 2001. *Hygiene and sanitation* **3**, 57–61 (in Russian).
Wotkins, P. D. 1997. Diabetes mellitus. Binom, Moscow, 96pp. (in Russian).