International Journal of Modern Agriculture, Volume 10, No.2, 2021
ISSN: 2305-7246

Food safety indicators of yogurt with vegetable supplements

Farida Smolnikova[1], Maksim Rebezov[2,3,4], Mars Khayrullin[4], Irina Dolmatova[5], Tatiana Zaitseva[5], Azat Nigmatjanov[6], Svetlana Kanareikina[7], Vladimir Kanareikin[6]

[1]Shakarim University of Semey, Semey, Kazakhstan
[2]V.M. Gorbatov Federal Research Center for Food Systems of Russian Academy of Sciences, Moscow, Russia;
[3]Prokhorov General Physics Institute, Russian Academy of Sciences, Moscow, Russian Federation
[4]K.G. Razumovsky Moscow State University of technologies and management (the First Cossack University)109004, Moscow, Russian Federation
[5]Nosov Magnitogorsk State Technical University, Magnitogorsk, Russia
[6]Ufa State Petroleum Technological University, Ufa, Russia
[7]Bashkir State Agrarian University, Ufa, Russia

Abstract

This paper studies the food safety indicators of yoghurt comprising additionally Vitamin C and vegetable supplements (pumpkin pureeand oat flour). The technological process of yogurt production includes milk fermentation with *Thermophilik Yoghurt Culture YC–X 16* ferment. Storing for 7 days does not significantly change pH and density of yoghurt. Toxic elements, mycotoxins, antibiotics and pesticides are not detected. The mineral composition shows that developed yoghurt enriched with potassium, sodium, magnesium and calcium comparing with control yoghurt sample. Thus, developing yoghurt with combination of vitamin C and vegetable components satisfies the requirements of food safety.

Keywords: yoghurt, pumpkin puree, oat flour, vitamin C, food safety, toxic elements

Introduction

There are various types of fermented milk products for human nutrition. Yoghurts are fermented milk products with a broken or undisturbed clot, obtained by ripening of skimmed or normalized milk with a starter culture and with or without the addition of various food supplements. Depending on the flavoring and aromatic species used, yoghurt may has unsweetened, sweet, with vanilla, fruit and berry, etc. taste [1].

The starter cultures play great importance in production of quality yogurt. Microorganisms, including probiotic, used in monocultures or as part of starters for the production of milk products, must be specified, non-pathogenic, non-toxigenic [2, 3]. Thus, yoghurt products are quite a popular food product. Its assortment is constantly expanding due to new types of food supplements, fillers, manufacturing techniques, and brands of manufacturers.

There are high requirements for compliance with quality factors, as they determine the level of nutritional value, usefulness and safety of yogurt for the consumer. The use of natural plant components in the formulation of combined milk products will also reduce the consumption of easily digestible carbohydrates, which has increased dramatically in recent years, and reduce the risk of cardiovascular, endocrine, and gastrointestinal diseases [4, 5].

In recent years, vegetable crops such as beets and carrots have become widespread as fillers in the production of milk products [6, 7]. Pumpkin, beets and carrots are one of the most common root crops, rich in vitamins, minerals, and most importantly, contain pectin substances that contribute not only to improving the nutritional value of the product, but also to remove from the human body heavy metals, toxins, radioactive elements [8].

The goal of this study is to evaluate the food safety indicators and mineral composition of the yoghurt comprising pumpkin puree and oat flour.

Materials and methods

The quality of yogurt is determined according to standard GOST R 51331–99 "Yoghurt: general specifications" by following characteristics:

- organoleptic: appearance and texture, taste and smell, color;
- physico-chemical: mass fraction of fat, milk protein, dry skim milk, sucrose and total sugar in terms of invert sugar, vitamins; acidity, phosphatase.
- microbiological: the number of lactic acid microorganisms in 1 g of product at the end of the shelf life, CFU.

Technological process of yogurt production

The following ingredients are used for the production of yoghurt:

- cow milk;
- bacterial starter cultures and bacterial concentrates for yoghurt;
- granulated sugar;
- Oat flour;
- pumpkin puree;
- Vitamin C.

1. Preparation of ingredients. Milk of the 1st grade is used for production, with acidity not higher than 20 T, without any mechanical contamination.

2. Milk normalization. For most yogurts, the fat content should be at least 6%. The calculation of skimmed milk or cream required for normalization is carried out according to the material balance formulas if the normalization is carried out by mixing whole milk with skimmed milk or cream.

3. Heat treatment. Pasteurization of milk is carried out at a temperature of 85-87 °C holding for 5-10 minutes or at 90-92 ° C holding for 2-3 minutes.

4. Milk homogenization. Heat treatment of milk is usually combined with homogenization. Homogenization process is performed at temperature not lower than 55 °C and a pressure of 17.5 MPa which improves the consistency and prevents the separation of whey.

5. Milk cooling. Pasteurized and homogenized milk is immediately cooled in the regenerative section of the pasteurization unit up to 50-55 °C, fermentation temperature with pure cultures of lactic acid bacteria: using thermophilic cultures -.

6. Milk fermentation. The milk and ferments are poured into the milk tank with mixer. After filling the tank, the entire mixture is additionally stirred for 15 minutes. Ferment can be added before filling the tank with milk. The ferment should be immediately added to the cooled milk. Type of ferment depends on the milk product. The ferment is thoroughly mixed to obtain a homogeneous liquid consistency, then poured into the milk with constant stirring. The ferments used in youghurt production were YC – X 16, Thermophilik Yoghurt Culture at the rate of 1 packet of ferment per 500 liters of the fermented mixture. The end of fermentation is determined by the formation of a strong clot with an acidity of 95-100 ° T. The clot is cooled for 10-30 minutes and stirred in order to obtain a uniform consistency of the milk clot and to avoid separation of the whey.

7. Cooling. Upon reaching the required acidity and the formation of a clot, the yoghurt is immediately cooled in plate coolers to a temperature not higher than 8 ° C, and then bottled.

At the end of the fermentation sugar and vitamin C, diluted in a small amount of water are added. Ascorbic acid (vitamin C or sodium ascorbate) is added to the normalized mixture before 30-40 minutes of souring. Then it stirred for 10-15 minutes and incubated for 30 minutes. The amount of vitamin C is 180 g per 1000 kg, sodium ascorbate - 210 g per 1000 kg of product. Aromatic and flavoring fillers are added to the normalized mixture before fermentation. The pumpkin puree is injected into the fermented mixture and fermentation is carried out at a temperature of 40-42 ° C for 4-6 hours until the acidity of the clot is 70 °T.

Obtained yoghurt is cooled to 16-20 °C and sent for bottling, packaging, labeling, and storing in refrigerated chambers to a temperature of 4 ± 2 ° C. The storage time of the product at 6 °C is not more than 4 days.

The formulation of yoghurt is presented in Table 1.

Table 1 – Yoghurt formulation

Ingredient	Content, %
Milk with fat 2,5 %	73
Pumpkin puree	15
Oat flour	2
Ferment	0,03
Sugar	10
Vitamin C	0,039

Pumpkin puree was prepared in the laboratory. The pumpkin was washed, peeled, cut into large cubes and steamed. Then the boiled pumpkin was ground to a puree mass.

Results and discussion

Yoghurt quality is determined by a set of properties that determine its suitability to meet certain human needs. Sensory, or organoleptic, methods based on the analysis of sensations of the human sense organs are widely used to assess the consumer advantages of food products. Organoleptic properties of pumpkin puree are presented in table 2.

Table 2 - Sensorial aspects of pumpkin puree

Indicator	Characteristic
Appearance	Homogeneous puree finely chopped mass. Mashed, homogeneous puree mass with few dot blotches of dark-colored skin
Consistency	When spreading puree on a flat surface, a hilly or slightly spreading mass should be formed.
Taste and flavor	Natural, well pronounced, characteristic of the given fruit, or a mixture of used components after heat treatment. No off-flavor and odor allowed.

Color	Uniform on the whole mass, peculiar to the color of the pumpkin or mixture of the used components.

Studying the quality indicators of yogurt during storage

The quality of any food product determines, first of all, the quality of the ingredients and the technological process. Not least important is to ensure the stability of the quality indicators of the product during the storage.

Active acidity is one of the main quality indicators of milk and milk products. The pH value has a significant effect to the colloidal state of milk proteins, the growth of beneficial and harmful microflora, the thermal stability of milk, and the activity of enzymes [9, 10]. Table 3 presents the results of physical-chemical parameters of yoghurt.

Table 3 - Physical-chemical parameters of yoghurt depending on storage time

Storage time, days	pH	Density, kg/m^3	Organoleptic parameters
0	4,42	1117	Taste and flavor - fermented milk with a taste of milk, oat grains. It has homogeneous consistency with cereal filler, viscous. The color is milky white with cream shade.
3	4,43	1115	Taste and flavor - fermented milk with a taste of milk, oat grains. It has homogeneous consistency with cereal filler, viscous. The color is milky white with cream shade.
7	4,40	1116	Taste and flavor - fermented milk with a taste of milk, oat grains. It has homogeneous consistency with cereal filler, viscous. The color is milky white with cream shade.

According to the table 3 the change in active acidity and organoleptic characteristics of the yoghurt stored for 7 days, is insignificant. The storage period of yogurt is extended due to the introduction of vitamin C and aseptic filling into the containers. The optimal shelf life of yogurt in terms of density and viscosity is also 7 days. After this time, the lactic acid microflora gradually begins to die off, the thixotropic bonds of the lactic acid clot are destroyed, due to the decrease in the conditional viscosity, syneresis, and appearing the liquid consistency after 7 days of storage [12].

With all the quality indicators, the shelf life of milk-vegetable yogurt can be taken no more than 7 days. The developed technology of yoghurt will improve the beneficial properties of this product, by the unique biological value of cow's milk, and enriching it with vegetable-cereal components. Moreover, new type of yoghurt will expand the range of fermented milk products.

The study of food safety yogurt

In terms of microbiological safety indicators, yogurt should comply with the "Hygienic requirements for the quality and safety of food raw materials and food products" as applied to fermented milk drinks. The content of toxic elements, mycotoxins, antibiotics, pesticides and radionuclides in the product should not exceed the permissible levels established by SanPiN 2.3.2.1078. Microbiological indicators of the product must comply with the requirements of SanPiN 2.3.2.1078.

Table 4 - Food safety indicators of the yoghurt

Indicator	Permissible level	Detected value
Toxic elements, mg/kg, no more:		
Lead	0,1	Not detected
Arsenic	0,05	Not detected
Cadmium	0,03	Not detected
Mercury	0,005	Not detected
Mycotoxins, mg/kg, no more:		
Aflatoxin M1	0,0005	Not detected
Antibiotics:		
Levomycetin	Not allowed	Not detected
Tetracycline group	Not allowed	Not detected
Pesticides, mg/kg, no more:		
hexachlorocyclohexane (α-, β-, γ-isomers)	0,05	Not detected
Dichlorodiphenyltrichloroethane and its metabolites	0,05	Not detected
Radionuclides, Bq/kg:		

Caesium-137	no more 100	less 10
Strontium-90	no more 25	less 5,1

The mineral composition of developed yoghurt characterized by higher content comparing with control sample of potassium, sodium, magnesium and calcium (Table 5).

Table 5 - Mineral composition of the yoghurt, mg/100g

Mineral	Concentration in yoghurt sample	
	Control sample	Experimental sample
Phosphorus	96.0	95.0
Potassium	147.0	252.0
Sodium	52.0	250.0
Magnesium	15.0	45.0
calcium	122.0	124.0
Selenium	2.0	2.5
Manganese	0.6	0.06
Copper	10.0	10.0
Iodine	9.0	9.0
Zinc	0.4	0.4
Iron	0.09	0.4

All minerals are divided into 2 groups: macroelements with concentration of minerals in human body more than 0.01% and microelements with concentration of minerals in human body between 0.00001% up to 0.01% [13].

Traditionally, milk products are rich in calcium. In developed yogurt the concentration of calcium is 124.0 mg/100g, which highly satisfies the daily requirement.

The amount of calcium in human body takes 5th place after the four main elements - carbon, oxygen, hydrogen and nitrogen. This is one of the important macroelements for the human body. Calcium performs an important role in forming strong compounds with proteins, phospholipids and organic acids, and has an effect to the physiological and biochemical processes occurring in the body. Calcium plays a major role in building bone tissue [14].

The content of magnesium is 3 times higher in experimental sample comparing with control one. This macronutrient essential for human, as it participates in a number of enzymatic processes and biosynthesis of proteins and amino acids in human body. Magnesium is widely used for the treatment and prevention of many nervous and cardiovascular diseases [15]. About 60% of all magnesium is concentrated in bone tissue, about 34% in soft tissue, and about 5% in the extracellular space of human body.

The level of potassium and sodium (252.0mg/100g and 250.0mg/100g) are much higher in developed yoghurt rather than in control sample (147.0 mg/100g and 52.0 mg/100g).

Same amount of copper, iodine and zinc was observed as in control as in experimental yoghurt. Small quantity of the manganese was detected in experimental sample (0.06 mg/100g), whereas in contrast large amount (0.6 mg/100g) was concentrated in control sample of yoghurt.

Conclusion

Ensuring food safety of milk products is the most important priority in the field of healthy nutrition. Produced yoghurt with active cultures and vegetable supplements (pumpkin puree and oat flour) complies with the food safety regulations. Consumption of developed yogurt increases more intake of minerals, such as calcium, magnesium, phosphorous et.c., by human.

References:

1. Kakimov A, Jilkisheva A, Mayorov A, Zharykbasova K, Kakimova Z, Mirasheva G, Zharykbasov Y, Zolotov A, Yessimbekov Z (2019) Developing the process parameters of milk pasteurization for reducing the concentration of toxic elements and radionuclides. ARPN Journal of Engineering and Applied Sciences, 14 (13), pp. 2443-2447.
2. Kakimov A, Kakimova Z, Mirasheva G, Bepeyeva A, Toleubekova S, Jumazhanova M, Zhumadilova G, Yessimbekov Z (2017), Amino acid composition of sour-milk drink with encapsulated probiotics. Annual Research and Review in Biology, 17, 18(1). DOI:10.9734/ARRB/2017/36079.
3. Gavrilova, N., Chernopolskaya, N., Molyboga, E., Shipkova, K., Dolmatova, I., Demidova, V., Rebezov, M., Kuznetsova, E., Ponomareva, L., 2019. Biotechnology application in production of specialized dairy products using probiotic cultures immobilization. International Journal of Innovative Technology and Exploring Engineering, 8(6), pp. 642-648.
4. Gorelik O, Shatskikh Y, Rebezov M, Kanareikina S, Kanareikin V, Lihodeyevskaya O, Andrushechkina N, Harlap S, Te-merbayeva M, Dolmatova I, Okuskhanova E (2017), Study of chemical and mineral

composition of new sour milk bio-product with sapropel powder. Annual Research and Review in Biology, 18(4). DOI: 10.9734/ARRB/2017/36937.

5. He, J., Gu, S., Wu, Y., Li, S., Zhai, X., Yang, J. A preparation of health yoghurt with anti-distortion (2013) Journal of Chinese Institute of Food Science and Technology, 13 (1), pp. 73-79.
6. Nazarenko J.V., Kitchenko L.N., Okunevska S.O., Tsyhura V.V. The influence of oatmeal on technological characteristics of yogurt. Scientific Messenger of Lviv National University of Veterinary Medicine and Biotechnologies, 2017, 19(75):120-123.
7. Smolnikova, F., Moldabayeva, Z., Klychkova, M., Gorelik, O., Khaybrakhmanov, R., Mironova, I., Kalimullin, A., Latypova, G., 2019. Sour milk production technology and its nutritive value. International Journal of Innovative Technology and Exploring Engineering, 8(7), pp. 670-672.
8. Roshchupkina O.E. The prospect of using vegetable components in the developing of fermented milk products. European Research, 2017, 1(24): 27-28.
9. Ibrahim M.N.1, Selezneva I.S. Functional Yoghurt Production Using Oat B- Glucan. Actual Science, 2017, 3(3): 80-85.
10. 8. Gorbatova K.K., Gun'kova P.I. Milk and Dairy Products Biochemistry. 4th ed. St. Petersburg, 2010. 336 p.
11. Temerbayeva M., Rebezov M., Okuskhanova E., Zinina O., Gorelik O., Vagapova O., Beginer T., Gritsenko S., Serikova A., Yessimbekov Zh. Development of Yoghurt from Combination of Goat and Cow Milk. Annual Research & Review in Biology 23(6): 1–7, 2018.
12. Tultabayeva, T., Chomanov, U., Zhumaliyeva, G., Tultabayev, B., Shoman, A. Methods for optimizing the composition and properties of milk and dairy products fat bases (2017) Journal of Engineering and Applied Sciences, 12 (12), pp. 3247-3251.
13. Skalny A.V., Rudakov I.A. Bioelements in medicine. Moscow: "ONIKS 21st Century" Publishing House, 2004.
14. Rylova N.V., Samoilov A.S., Troyegubova N.A. Special characteristics of the mineral status of athletes http://www.rusnauka.com/22_PNR_2013/Medecine/4_143355.doc.htm
15. Kontani M, Hara A, Ohta S, Ikeda T. Hypermagnesemia induced by massive cathartic ingestion in an elderly woman without pre-existing renal dysfunction. Intern Med. 2005;22:448–452. doi: 10.2169/internalmedicine.44.448.