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THE USAGE OF CHIA SEEDS IN THE PRODUCTION OF YOGURT DESSERTS FOR ATHLETES

Abstract

A healthy lifestyle today is inextricably linked to proper nutrition. At the forefront of the struggle for beauty, health and youth are superfoods - products with unique biological characteristics, which include chia seeds. The paper provides an analysis of the chemical composition, properties, nutritional and biological value of chia seeds. It is shown that chia seeds are indispensable in the nutrition of athletes: due to their rare gel-forming properties, rich chemical composition and low calorie content, chia seeds are able to turn any drink (including yogurt) into a biologically active product that replenishes energy expenditure, gives strength and endurance, is able to build muscle mass, get rid of excess fat if whole grains are used in the product or help maintain current weight if crushed seeds are used in the product. The microflora of chia seeds before heat treatment and after infusing its grains in milk at temperatures of +66±1,+76±1 and +86±1ºC for 31±1 min was studied. It is recommended to infuse chia seeds in the prepared yogurt base at a temperature of +86±1ºC for 31±1 min for the preparation of yogurt desserts for athletes intended for weight loss (ratio of chia seeds: yogurt base during infusing – 1:4), cool to the fermentation temperature – +40±1ºC, and then mix with the yogurt base prepared for fermentation at a ratio of yogurt base: infused chia seeds of 3:1. The efficiency of pasteurization was determined in samples of yogurt base enriched with crushed chia seeds, prepared from milk of extra and higher grades. It is shown that high pasteurization efficiency (>99.98%) is achieved by pasteurizing a yogurt base enriched with crushed chia seeds at a temperature of +90…95ºC for 10…20 min. It is recommended to add crushed chia seeds (particle size 0.5 mm) to the yogurt base during the process of normalization by mass fraction of DSMR together with KSB-UF-75 for the preparation of a yogurt base with crushed chia seeds for the production of yogurt desserts for athletes intended for weight loss and for maintaining current weight, respectively. Technological schemes for the preparation of a yogurt base with whole and crushed chia seeds for the production of yogurt desserts for athletes intended for weight loss and for maintaining current weight, respectively, are presented.

Keywords: chia seeds; chemical composition; yogurt base; yogurt dessert for athletes; infusion; pasteurization; temperature; duration; number of mesophilic aerobic and facultative anaerobic microorganisms; efficiency of pasteurization.

Introduction

A healthy lifestyle is in trend today and is inextricably linked to proper nutrition. At the forefront of the struggle for beauty, health and youth are superfoods - products with unique biological characteristics. Due to the high concentration of nutraceuticals: vitamins, trace elements, amino acids and antioxidants, such food is something between food and medicine, for which it was defined as "feel better", "looks younger", "live longer" and "superfood".

In the list of the most famous superfoods, the leading place today is occupied by chia seeds, which are called a panacea and a dietary miracle for their unusually useful properties. In the modern world, the use of this product for food purposes is quite wide. The maximum production volumes of dietary supplements, breakfast cereals, confectionery products based on it are observed in the USA, Canada, Australia and New Zealand. In recent years, there has been a growing interest in chia seeds in Europe: since 2005, chia has been included in the list of the most promising food products in the European Union countries [1, 2]. This is explained by their unique chemical composition. Therefore, the development of recipes and technologies for innovative food products with chia seeds, including for special nutrition: sports, gerodietic, children's, is a promising direction for domestic scientists and manufacturers.

Literary review

The Salvia hispanica plant is native to South America and belongs to the mint family. During the time of the ancient Aztecs and Incas, chia seeds were incredibly valued, as evidenced by the name itself, which in the ancient Mayan language sounds like "strength". They were eaten by warriors during long campaigns, used in religious ceremonies, paying tribute to the clergy, and given to newlyweds for weddings. Modern studies confirm the high biological value of chia seeds, which are recognized as one of the most useful foods on the planet. This is a unique concentrated cocktail of many nutrients: vitamins, trace elements, fiber, vegetable protein, omega-3 acids and antioxidants, which give strength and endurance to the body, are of paramount importance for brain health, and give youthfulness and beauty to the skin [1, 2]. In addition, chia seeds are a whole grain food, organically grown, GMO-free and gluten-free. It provides the body with a huge amount of nutrients with a very small portion of calories (465–486 kcal) [2]. The nutritional value of chia seeds is given in Table 1, the amino acid composition in Table 2, and the content of vitamins and minerals in Table 3. [1, 2].

A comparison of the chemical composition of chia seeds with other generally recognized beneficial seeds – flax – shows a higher content in the former of all nutrients, including omega-3 (Table 1) and the natural antiox-

Table 1 – Nutritional value of chia seeds (per 100 g of product) [2]

Component names	Component content per 100g of chia seeds
Protein, g	16.50–21.00
Fats, g	30.70–31.00
incl. cholesterol, g	0.0
trans-fats, g	0.0
saturated fatty acids (SFA), g	3.30
monounsaturated fatty acids (MUFA), g	2.30
polyunsaturated fatty acids (PUFAs),g	24.00
incl. omega-3 fatty acids, g	17.83
omega-6 fatty acids, g	5.84
Carbs, g	42.10–42.12
incl. fiber, g	34.40
Minerals, g	4.70–4.80
Water, g	5.80–5.90

Table 2 – Amino acid composition of proteins in chia seeds [2]

Amino acid	Content, g/100 g	Amino acid	Content, g/100 g
Lysine	0.970	Tryptophan	0.436
Histidine	0.531	Cystine	0.407
Arginine	2.143	Tyrosine	0.563
Threonine	0.709	Alanine	1.044
Valin	0.950	Aspartic acid	1.689
Methionine	0.588	Glutamic acid	3.500
Isoleucine	0.801	Glycine	0.943
Phenylalanine	1.016	Proline	0.776
Leucine	1.371	Serine	1.049

Table 3 – The content of vitamins and minerals in chia seeds [2]

Vitamin	Content, mg/100 g	Minerals	Content, mg/100 g
		Calcium	631.00
Vitamin C	1.60	Copper	0.92
Vitamin E	0.50	Iron	7.72
Vitamin B_9	110.00	Magnesium	335.00
Vitamin PP	6.13	Manganese	2.72
Vitamin B_2	0.17	Potassium	407.00
Vitamin B_1	0.62	Sodium	16.00
Vitamin B_3	8.83	Phosphorus	860.00
Vitamin B_6	0.10	Zinc	4.58
Vitamin A	0.016	Selenium	55.20

idant tocopherol (Table 3), which fights free radicals that cause aging and disease. Due to its antibacterial properties, this plant is widely used in medicine to combat infections and viruses as a natural antibiotic [1, 2].

Adding chia seeds to yogurts (10% seed weight) contributes to significant ($p \leq 0.05$) changes in fatty acid content, i.e. a significant decrease in saturated fatty acids (SFA) and short-chain fatty acids (SCFA) and a significant increase in polyunsaturated fatty acids (PUFA): yogurts with chia seeds are characterized by a significant increase in polyunsaturated fatty acids (PUFA), including omega-3 acids, and a more favorable omega-6/omega-3 ratio [3]. Yogurts with chia seeds are also characterized by significantly ($p \leq 0.05$) lower atherogenicity (AI) and thrombogenicity (TI) indices and a higher ratio of hypocholesterolemia to hypercholesterolemia [3].

100 g of chia seeds contain 22% of the daily protein intake, 37% of fat and 14% of carbohydrates [1, 2]. Chia seeds have a high mass fraction of protein (Table 1) and a balanced complex of essential amino acids (Table 2), which makes them a universal food for vegetarians and vegans. The protein in the seeds is the most useful dietary component for people who are losing weight: it reduces appetite, eliminates obsessive thoughts about food and the desire to snack at night. It is believed that eating chia seeds for breakfast increases satiety and reduces food intake in the short term [1, 2, 4, 5]. The content of digestible carbohydrates is only 3.57%, which refers them to low-carb foods [1, 2, 4]. The superfood is recommended for people with gluten intolerance and those with egg allergies: just one tablespoon of chia mixed with three tablespoons of water is equivalent in nutritional value to one egg. Given that chia seeds are rich in fiber, protein, and omega-3, they prevent the risk of heart disease, increase “good” cholesterol, normalize blood pressure, and thin the blood, preventing blood clots. Studies show that this product prevents blood sugar from rising after eating a high-carb meal, which may be beneficial for people with type 2 diabetes [4]. Chia is an excellent source of calcium for those who do not consume dairy products. They contain calcium and phosphorus (in a ratio of 1.00 : 1.36, which is close to the recommended physiological nutritional standards of 1.0 : 1.5), magnesium and protein, which are important for the health of teeth and bones, so they are recommended for people with musculoskeletal problems. Phosphorus contained in chia improves performance, has a positive effect on memory and mood, and iron increases hemoglobin, so it should be included in the diet during high mental loads, for example, during a session or exams, as well as for those who suffer from anemia [1, 2].

The high content of soluble fiber in chia seeds – 2.40-5.16% – defines it as a product for weight loss. It is able to absorb liquid up to 10-12 times its weight, becoming gel-like and expanding in the stomach. This gives a feeling of satiety, slows down the digestion of food and automatically reduces the number of calories absorbed [4–6].

However, studies on the effectiveness of chia seeds for weight loss have yielded mixed results. In a study of overweight people, 50 grams of chia seeds per day for 12 weeks did not change body weight or health indicators. Another 10-week study showed that in 62

women, this product did not affect body weight, but increased the amount of omega-3 in the blood. At the same time, a 6-month analysis of people with obesity and type 2 diabetes on a low-calorie diet showed that daily consumption of chia seeds led to significantly greater weight loss compared to a placebo. Thus, many nutritionists have concluded that adding chia seeds to the diet is not the main, but an important addition to a weight loss diet, along with a healthy lifestyle, exercise and good sleep. Only in this case can chia seeds significantly contribute to weight loss [4–6].

Insoluble fiber 29.24-32.00%, which is rich in chia seeds, nourishes beneficial intestinal bacteria, and when combined with fermented milk products, metabolism is accelerated and microflora is significantly improved, which is very important for health and immunity. A diet with sufficient fiber prevents constipation, eliminates toxins and promotes the healing of the digestive tract [4–9].

Chia seeds are a godsend for athletes. Due to their rare gel-forming properties, rich chemical composition and low calorie content, they can instantly turn any drink into a biologically active product that replenishes energy expenditure, gives strength and endurance, can build muscle mass and get rid of excess fat [3–9].

Chia seeds are a beauty superfood because they have a positive effect on the skin, help with weight loss, reduce the frequency and intensity of hot flashes during menopause, and have a rejuvenating effect [1, 2].

Chia is recommended for anyone who often gets colds and viral diseases, suffers from indigestion, or suffers from joint and muscle pain. Thanks to its fiber and a large complex of nutraceuticals, consuming this superfood improves digestion and restores the body's immune and nervous systems. This is especially important for the elderly and children, who can be given it from the age of eight. In addition, recent studies have shown that chia seeds contain substances that prevent the development of breast, colon, and prostate cancer [1, 2, 3, 6].

Today, chia is grown in Mexico, Ecuador, Australia, Guatemala, and Bolivia. The plant reaches a height of up to 1 meter, the seeds are small, come in black, white and grayish. No particular difference between the chemical composition of white and black grains has yet been established. Both varieties are edible, very useful and have an equally neutral taste. The color of the seeds, determined by the place of growth, depends on the climate and soil. White seeds (narrow-leaved sage) are produced by a plant grown in Mexico and South America. Locals believe that this variety helps better with allergies, anemia and hormonal disorders. Black seeds (sage) are collected in Guatemala, where they are used to combat diabetes, high cholesterol and fever. However, contrary to popular belief, it has been established that the difference between the types of chia is purely aesthetic: black seeds add a contrasting color to dishes, while white ones are more often used in light ones, for example, with vanilla, coconut and banana puddings. In addition, white seeds are also used for oil extraction [1, 2].

Chia seeds are common foods without strict restrictions on consumption. For a modern megalopolis resident, 1 to 3 tablespoons of the product per day are enough for health and activity, which can be eaten at once or divided into several doses. Chia seeds are consumed raw, mixed with water, milk, and fermented milk products. They can be added to smoothies, porridges, soups, salads, and cocktails, and as flour – to bread, pancakes, and sauce. The simplest home recipe is berries, chia, cottage cheese, kefir, or yogurt [7–9].

Chia seeds can be prepared in two ways: soaked before use, pouring liquid, or ground in a coffee grinder. The first option is suitable for weight loss, which is explained by the presence of a shell that covers each grain. When soaked, it envelops the mucous membrane of the digestive tract, protecting it from harmful and aggressive products, satisfying hunger, and having a detox effect. At the same time, this mucus does not release valuable trace elements of the "vitamin nucleolus" into the gastrointestinal tract. To maximize the benefits of superfood, it should be consumed ground, which allows you to extract as many nutrients as possible from the seeds [1, 2, 7, 8]. Most often, the seeds are soaked overnight in milk or yogurt, mixed with juice, and chia puddings are prepared. It should be borne in mind that dairy products reduce the absorption of nutrients from other foods, so combining chia with milk will bring less benefit to the body, but it will cleanse the intestines well and give a feeling of satiety. To get a thick drink, you need to mix milk with chia seeds in a ratio of 1 : 4 and infuse for 30 minutes. A variant of a wonderful dessert can be obtained by infusing 0.5 tsp of chia seeds in 150 g of yogurt (infusing time – from 3 to 8 hours) [7–9]. The crushed seeds can be added to porridge, sprinkled on salads, etc. [1, 2].

Contraindications to the use of chia are: individual intolerance; allergic reaction to the product; gastrointestinal diseases in the acute stage; poisoning; diarrhea; hypotension; taking anticoagulants that thin the blood. Despite the extremely rare phenomenon of allergy to the product, it is worth starting its intake with a small dose – 1 tablespoon during the first 4 days. With good dynamics, the daily norm can be increased to the optimal dose – 3 tablespoons [1, 2, 6]. Pregnant women should discuss this with their doctor before taking the product [1, 2].

Formulation of the problem

Ensuring the microbiological safety of yogurt products/desserts when using any additional raw ingredients is a key aspect of the technological process of their production.

Chia seeds, like most plant products, have a natural microflora that depends on the conditions of cultivation, storage and processing. Adding chia to yogurt products/desserts creates additional challenges in ensuring microbiological safety. Chia can be a source of contamination due to its complex structure, ability to retain microorganisms and increased nutritional value for their development. The main groups of microorganisms that can be present in chia seeds [1, 2, 10]:

– natural microflora: these are microorganisms that are present as a result of contact of seeds with air and water – bacteria of the genus Pseudomonas, Micrococcus, nitrogen-fixing bacteria (depending on the growing conditions); possible presence of molds and yeasts – mold fungi of the Aspergillus, Penicillium families (may be present in minimal quantities in the natural environment), yeasts of the Saccharomyces or Candida genus;

– contaminants (contaminating microflora): during collection, transportation or storage, seeds may be contaminated with pathogenic or conditionally pathogenic microorganisms – Salmonella – dangerous to health, often occurs in cases of violation of sanitary conditions; Escherichia coli (coliforms) – indicates possible fecal contamination; Clostridium perfringens – under poor storage conditions; fungi – Aspergillus flavus – can produce aflatoxins, especially under high humidity conditions, Fusarium, Rhizopus – with prolonged improper storage.

Contamination of chia seeds can occur through contact with dirty water, equipment or poor storage conditions. Chia seed processing (washing, drying, heat treatment) significantly reduces the level of microorganisms, but some bacterial or fungal spores may remain. To prevent unwanted microflora in sesame seeds, the following methods are used [10]: humidity control: seeds should be stored at low humidity (<10%) to prevent mold growth; heat treatment: roasting, pasteurization or sterilization destroy pathogenic microorganisms; sanitation: ensuring the cleanliness of equipment and compliance with hygiene standards during processing and storage prevent the ingress of secondary contamination microflora; laboratory control: testing sesame seeds for the presence of aflatoxins, Salmonella, KMAFAnM, *Escherichia coli* (coliforms) and other dangerous microorganisms contributes to obtaining a safe product with the addition of this raw ingredient.

The aim of the presented work was to develop methods for preparing chia seeds for the production of yogurt desserts for athletes.

Research objectives:

– to substantiate the method of infusing chia seeds in milk for the production of yogurt desserts for athletes intended for weight loss;

– to substantiate the method of preparing crushed chia seeds for the production of yogurt desserts for athletes intended for maintaining current weight.

Materials and methods

For experimental studies, whole milk of extra and superior grade according to DSTU 3662-2018 was used; skimmed milk with an acidity of up to 19ºT, obtained by separating whole milk of extra and superior grade according to DSTU 3662-2018; KSB-UF-75 – whey protein concentrate obtained by ultrafiltration, according to TU U 15-5-35293993-002:2011 (manufacturer – LLC "Techmolprom"); black chia seeds Targroch (manufacturer – Paraguay). For the preparation of the yogurt base, whole milk, skimmed milk and KSB-UF-75 were used in the proportions recommended in [11], which provide a mass fraction of fat and dry skimmed milk residue in the yogurt base of 1.5% and 13.0%, respectively.

When performing experimental studies, a complex of physicochemical, organoleptic and microbiological research methods used in the dairy industry to determine milk quality indicators was used: the mass fraction of dry matter, fat and protein (%) was determined by the arbitration method according to DSTU 8552:2015, by the Gerber acid method according to DSTU ISO1211, by the refractometric method according to DSTU ISO 8968-1:2005, respectively; titrated and active acidity (°T and pH units) was determined by the titrometric method according to GOST 3624-92 and by the potentiometric method according to DSTU 8550:2015, respectively; the number of mesophilic aerobic and facultative anaerobic microorganisms (KMAFAnM) was determined according to DSTU 7357:2013; *Escherichia coli* group bacteria (BGKP) were determined according to DSTU 7357:2013; the number of molds and yeasts was determined according to DSTU ISO 6611/IDF 94:2007; pathogenic bacteria, including *Salmonella*, were determined according to DSTU IDF 93A:2003.

Results of the study and their discussion

For experimental studies, chia seeds were used that had undergone preliminary heat treatment with steam. According to the manufacturer, chia seeds should be free of pathogenic microorganisms, including *Salmonella*, molds, yeasts and *Escherichia coli* (coliforms), and the number of MAFAnM should not exceed 50 thousand CFU/g.

The first stage of experimental studies consisted in developing the parameters of heat treatment of chia seeds in milk for the production of yogurt desserts for athletes intended for weight loss.

Microbiological indicators of chia seeds used in the studies are given in Table 4. To reduce the number of MAFAnM in chia seeds, its heat treatment (infusion) in milk with a mass fraction of fat of 1.5% was used at temperatures of +66±1, +76±1 and +86±1ºC for 31±1 min.

Table 4 – Effect of temperature and duration of heat treatment (soaking) of chia seeds in milk on microbiological parameters (n = 3; p ≥ 95)

Indicator name	Indicator value fin			
	chia seeds before heat treatment	chia seed/milk mixture after heat treatment (infusion) in milk using parameters		
		t = +66±1ºC, τ = 31±1 min.	t = +76±1ºC, τ = 31±1 min.	t = +86±1ºC, τ = 31±1 min.
KMAFAmN, CFU/g	36000 ± 2450	4500 ± 320	1500 ± 84	1200 ± 98
Escherichia coli (coliforms) in 0.01 g of product	Absent	Absent	Absent	Absent
Molds, CFU/g	Absent	Absent	Absent	Absent
Yeast, CFU/g	Absent	Absent	Absent	Absent
Pathogenic microorganisms, including *Salmonella*, in 25 g of product	Absent	Absent	Absent	Absent

(the ratio of chia seeds: milk, according to the recommendations of literary sources [1, 2], was set at 1:4).

The results of microbiological studies (Table 4) demonstrate a significant effect of heat treatment of chia seeds on microbiological indicators, in particular on the number of mesophilic aerobic and facultative anaerobic microorganisms (MAFAmN): in raw chia seeds, the number of MAFAmN is 36000±2450 CFU/g, which meets the established requirements [10]; heat treatment (infusion) of chia seeds in milk at a temperature of +66±1ºC for 31±1 min. reduces the number of MAFAmN in it to 4500±320 CFU/g; when the temperature of heat treatment (infusion) of chia seeds in milk is increased to +76±1ºC and +86±1ºC for 31±1 min. the level of KMAFAmN decreases to 1500±84 CFU/g and 1200±98 CFU/g, respectively, which indicates a progressive improvement in microbiological purity.

Regarding the absence of *Escherichia coli* in 0.01 g of seeds and the absence of pathogenic microorganisms, including *Salmonella*, in 25 g of the product, as well as the absence of molds and yeasts (Table 4), it should be noted that none of the samples (raw or processed chia seeds) were found to contain the specified groups of microorganisms, which confirms compliance with sanitary and hygienic standards during the production of chia seeds, as well as during the experimental study.

The results obtained indicate that heat treatment (infusion) of sesame seeds in milk at a temperature of +86±1ºC for 31±1 min. provides the most effective reduction of the level of KMAFAmN, which increases its microbiological safety, and the absence of *E. coli*, pathogenic bacteria, molds and yeasts in all samples confirms that the product meets the basic requirements for quality and safety. Therefore, it is these parameters of heat treatment of chia seeds in milk that are recommended for use in the technology of yogurt desserts for athletes intended for weight loss. Considering the developed recommendations on the optimal composition of yogurt desserts for athletes [11], the mass fraction of chia seeds in them should be 4.3%. Since the ratio of chia seeds: milk during infusion was 1:4, it is recommended to feed 4.3 kg of prepared chia seeds into a long-term pasteurization bath (LTPB) with 17.2 kg of prepared yogurt base heated to a temperature of +86±1ºC, then to keep the mixture of chia seeds with yogurt base at the specified temperature for 31±1 minutes, cool it to the fermentation temperature of +40±1ºC by feeding tap water into the LTPB jacket, after which the mixture of chia seeds with yogurt base is fed by a pump for viscous products into a tank with yogurt base prepared for fermentation at a temperature of +40±1ºC. The resulting mixture of yogurt base and infused chia seeds is subsequently fermented with a starter composition of yogurt cultures and bifidobacteria. The technology of preparing a yogurt mixture with chia seeds for the production of yogurt desserts for athletes intended for weight loss is shown in Fig.1.

The second stage of experimental research consisted in developing the parameters of heat treatment of a yogurt base enriched with crushed chia seeds for the production of yogurt desserts for athletes intended for maintaining current weight.

Chia seeds were ground in a laboratory mill to a particle size of no more than 0.5 mm, and the ground chia seeds were added to the yogurt base in the process of normalization by mass fraction of dry non-fat milk residue (DSMR) together with whey protein concentrate obtained by ultrafiltration (KSB-UF-75) according to the developed recommendations [11]. Yogurt bases were prepared from cow's milk of extra and superior grades. The obtained yogurt bases enriched with crushed chia seeds were filtered, samples were taken for the determination of KMAFAnM, heated to a temperature of +65±1ºC, emulsifies at a speed of 4000 min^{-1}, heated to the pasteurization temperature of +90…95ºC and kept for 5; 10; 15 and 20 min., after which they were cooled to a temperature of +20±1ºC and KMAFAnM was determined in them. According to the obtained experimental data, the pasteurization efficiency (%) was calculated in all samples of yogurt bases enriched with crushed chia seeds, the results of the studies are given in Table 5.

The results obtained indicate that high pasteurization efficiency (>99.98%) is achieved when pasteurizing a yogurt base enriched with crushed chia seeds at a temperature of +90…95ºC for 10…20 minutes.

Table 5 – Efficiency of the heat treatment regime of yogurt base enriched with crushed chia seeds

(n = 3; p ≥ 95)

Indicator name	The value of the indicator for a yogurt base enriched with crushed chia seeds, pasteurized at a temperature of +90…95ºC and withheld for							
	5 min.		10 min.		15 min.		20 min.	
	when using milk of the following grade as raw material							
	extra	superior	extra	superior	extra	superior	extra	superior
KMAFAnM before pasteurization, CFU/cm^3	76733 ± 1120	153993 ± 2870	76733 ± 1120	153993 ± 2870	76733 ± 1120	153993 ± 2870	76733 ± 1120	153993 ± 2870
KMAFAnM after pasteurization, CFU/cm^3	< 20	< 30	< 10	< 20	< 10	< 15	< 10	< 15
Pasteurization efficiency, %	99,97	99,98	99,99	99,99	99,99	99,99	99,99	99,99

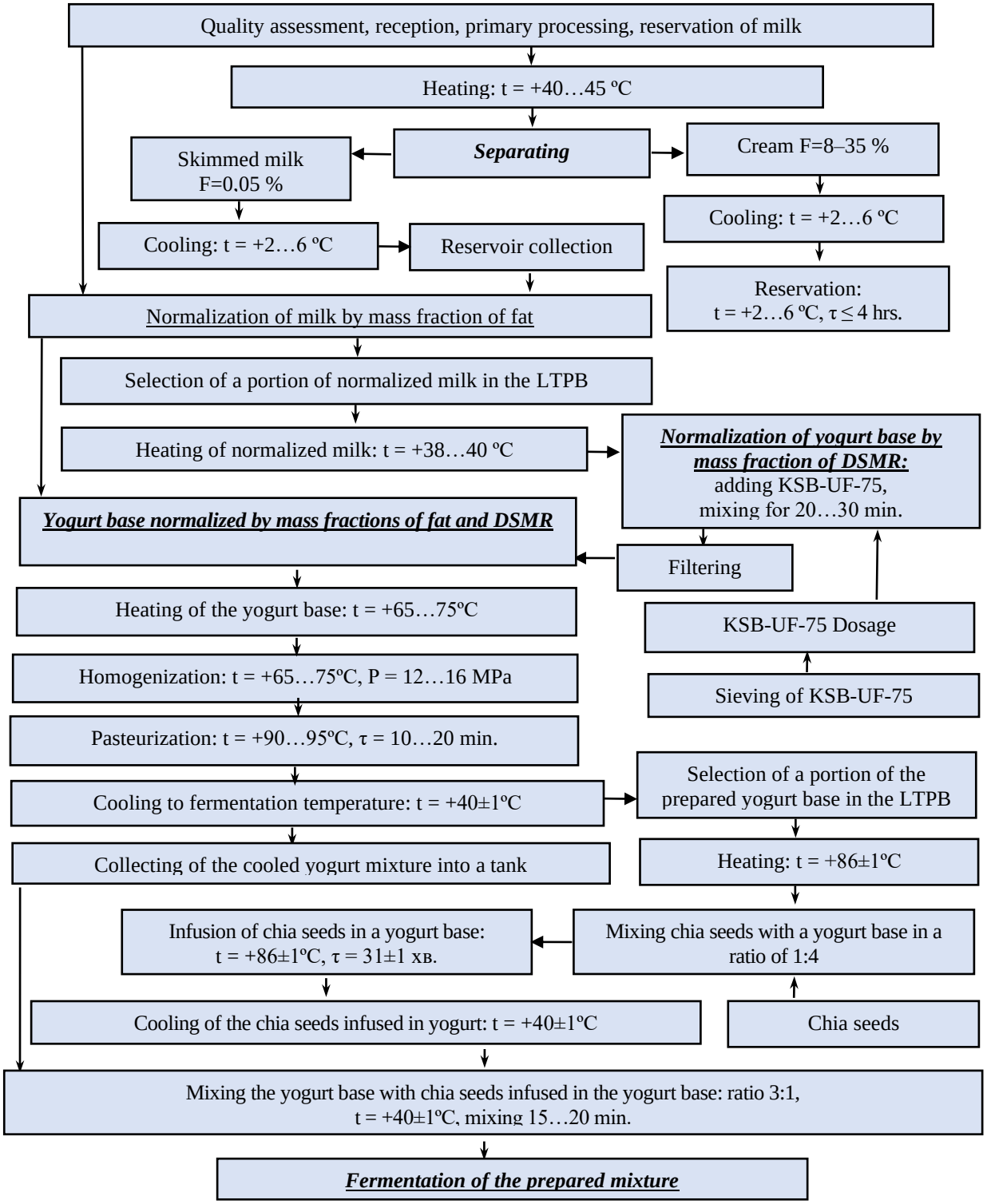

Fig. 1 – Technology for preparing a yogurt base with chia seeds for the production of yogurt desserts for athletes intended for weight loss

This pasteurization mode is recommended for use in the technology of yogurt desserts for athletes intended to maintain current weight. The technology of preparing a yogurt mixture with crushed chia seeds for the production of yogurt desserts for athletes intended to maintain current weight is shown in Fig. 2.

Conclusions

1. To prepare a yogurt base with chia seeds for the production of yogurt desserts for athletes intended for weight loss, it is recommended to infuse chia seeds in the prepared yogurt base at a temperature of +86±1ºC for 31±1 min. in a LTPB (the ratio of chia seeds: yogurt base during infusion is 1:4), cool to the fermentation temperature of +40±1ºC, and then feed it with a viscous product

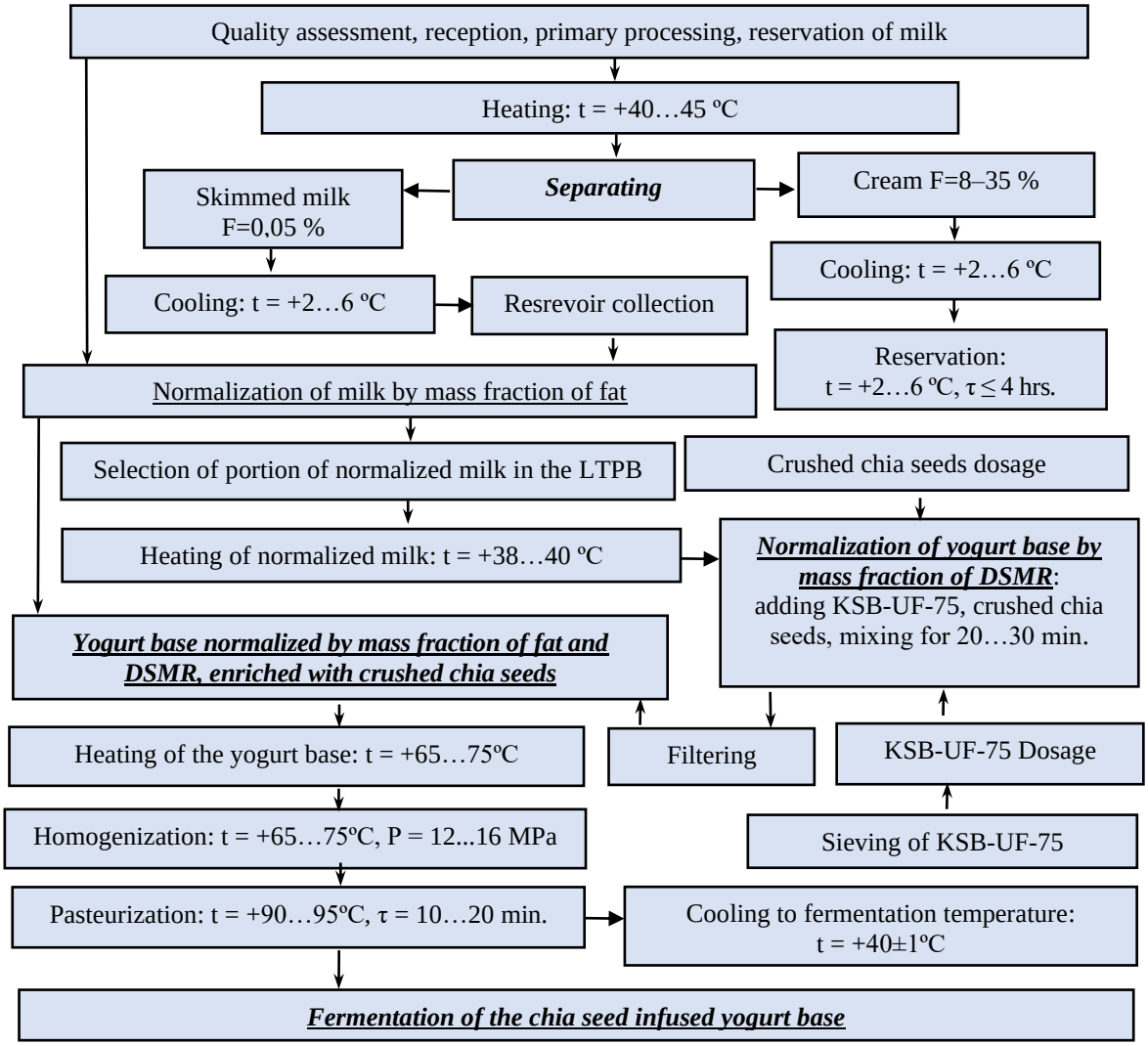

Fig. 2 – Technology for preparing yogurt base with crushed chia seeds for the production of yogurt desserts for athletes intended to maintain current weight

pump into a tank with a yogurt base prepared for fermentation at a ratio of yogurt base: infused chia seeds of 3:1.

2. To prepare a yogurt base with crushed chia seeds for the production of yogurt desserts for athletes intended for maintaining current weight, it is recommended to add crushed chia seeds (particle size 0.5 mm) to the yogurt base during the process of normalization by mass fraction of DSMR together with KSB-UF-75. Pasteurization of yogurt base with crushed chia seeds is recommended to be carried out at a temperature of +90…95ºC with a holding time of 10…20 minutes.

REFERENSES

1. Motyka, S., Koc, K., Ekiert. H., Blicharska, E., Czarnek, K., Szopa, A. (2022). The Current State of Knowledge on Salvia hispanica and Salviae hispanicae Semen (Chia Seeds). Review. Molecules. 27(4), 1207. DOI: 10.3390/molecules27041207
2. Knez Hrnčič, M., Ivanovski, M., Cör, D., Knez, Ž. (2019). Chia Seeds (Salvia hispanica L.): An Overview—Phytochemical Profile, Isolation Methods, and Application. Molecules. 25(1), 11. DOI: 10.3390/molecules25010011
3. Paszczyk, B., Tońska, E. (2025). Influence of Plant Additives on Changes in the Composition of Fatty Acids, Lipid Quality Indices and Minerals of Fermented Dairy Products from Cow's Milk. Molecules. 30(2), 235. https://doi.org/10.3390/molecules30020235
4. Capitani, M. I., Spotorno, V., Nolasco, S. M., & Tomás, M. C. (2016). Chemical characteristics and functional properties of chia seed (Salvia hispanica L.) gum. Journal of Food Science and Technology. 53(2), 175–181. DOI: 10.1155/2014/241053
5. Ayaz, A., Akyol, A., Inan-Eroglu, E., Kabasakal, C-A., Samur, G., Akbiyik, F. (2017). Chia seed (Salvia Hispanica L.) added yogurt reduces short-term food intake and increases satiety: randomised controlled trial. Nutr Res Pract. 11(5), 412-418. DOI: 10.4162/nrp.2017.11.5.412
6. Gularte, M. A., Rosell, C. M., Gómez, M. (2019). Impact of chia (Salvia hispanica L.) as a functional ingredient on dairy product properties. Food Hydrocolloids. 87, 802–810. DOI:10.1017/S0029665108006216
7. Dostálová, J., Rysová, J., & Pokorný, J. (2018). Effect of chia seed supplementation on yogurt properties and consumer acceptance. International Dairy Journal. 86, 65–72. DOI:10.35219/foodtechnology.2023.1.08

8. Moghadam, M.Z., Yazdi, F.T., & Eskandari, M.H. (2019). Effect of chia seed flour on physicochemical and sensory properties of probiotic yogurt. Journal of Functional Foods. 57, 306–313. https://doi.org/10.3390/fermentation10080431
9. Nakov, G., Ninova-Nikolova, N., Ivanova, N., Raykova, V., Trajkovska B., Luˇcan Coli´c, M., Lukinac, J., Juki´c, M. (2024). Yogurt Enriched with Chia Seeds: Physicochemical, Microbiological, and Sensory Changes during Storage. Fermentation. 10(8), 431. DOI:10.3390/fermentation10080431
10. Slozhenkina, M., Gorlov, I., Kryuchkova, V., Serkova, A., Ryaskova, A., Belik, S. (2019). Vegetable ingredient in cheese product. Potravinarstvo Slovak Journal of Food Sciences. 13(1), 1018–1025. DOI: 10.5219/1207
11. Tkachenko, N., Chagarovs`ky`j, O., Podolyan, Z. (2022). Matematy`chne modelyuvannya skladu jogurtovogo desertu dlya xarchuvannya divchat-sportsmeniv. Zbirny`k tez dopovidej 82-yi naukovoyi konferenciyi vy`kladachiv universy`tetu, Odesa, 26–29 kvit. 2022 r./Odes. nacz. texnol. un-t; pid zag. red. B.V. Yegorova. Odesa: ONTU. 104–106.

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ВИКОРИСТАННЯ НАСІННЯ ЧІА У ВИРОБНИЦТВІ ЙОГУРТОВИХ ДЕСЕРТІВ ДЛЯ СПОРТСМЕНІВ

Анотація

Здоровий спосіб життя сьогодні невід'ємно пов'язаний з правильним харчуванням. В авангарді боротьби за красу, здоров'я і молодість знаходяться суперфуди – продукти, що володіють унікальними біологічними характеристиками, до яких відносять насіння чіа. В роботі наведено аналіз хімічного склад, властивостей, харчової та біологічної цінності насіння чіа. Показано, що насіння чіа є незамінним у харчуванні спортсменів: завдяки рідкісній желеутворювальній властивості, багатому хімічному складу і низькій калорійності, насіння чіа здатні перетворити будь-який напій (у т.ч. йогуртовий) у біологічно активний продукт, який поповнює енергетичні витрати, дає силу і витривалість, здатний наростити м'язову масу, позбавити від зайвого жиру за умови використання у продукті цілих зернят або сприяти підтриманню поточної ваги за умови використання у продукті подрібненого насіння. Досліджено мікрофлору насіння чіа до теплового оброблення та після настоювання його зернят у молоці за температури +66±1,+76±1 та +86±1°С протягом 31±1 хв. Рекомендовано для приготування йогуртової основи з насінням чіа для виробництва йогуртових десертів для спортсменів, призначених для схуднення, настоювати насіння чіа у підготовленій йогуртовій основі за температури +86±1°С протягом 31±1 хв. (співвідношення насіння чіа : йогуртова основа при настоюванні – 1 : 4), охолоджувати до температури ферментації – +40±1°С, після чого змішувати з підготовленою для ферментації йогуртовою основою при співвідношенні йогуртової основи : настояного насіння чіа 3 : 1. Визначено ефективність пастеризації у зразках йогуртової основи, збагаченої подрібненим насінням чіа, приготованої із молока ґатунків екстра та вищого. Показано, що висока ефективність пастеризації (>99,98 %) досягається при пастеризації йогуртової основи, збагаченої подрібненим насінням чіа, за температури +90…95°С протягом 10…20 хв. Рекомендовано для приготування йогуртової основи з подрібненим насінням чіа для виробництва йогуртових десертів для спортсменів, призначених для підтримання поточної ваги, подрібнене насіння чіа (розмір частинок 0,5 мм) вносити до йогуртової основи у процесі нормалізації за масовою часткою СЗМЗ разом з КСБ-УФ-75. Наведено технологічні схеми приготування йогуртової основи з цілими та подрібненими зернами насіння чіа для виробництва йогуртових десертів для спортсменів, призначених для схуднення і для підтримання поточної ваги відповідно.

Ключові слова: насіння чіа; хімічний склад; йогуртова основа; йогуртовий десерт для спортсменів; настоювання; пастеризація; температура; тривалість; кількість мезофільних аеробних і факультативно анаеробних мікроорганізмів; ефективність пастеризації.

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