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INNOVATIVE TECHNOLOGY OF PLANT-BASED DRINK "CHOCOLATE" BASED ON AMARANTH FLOUR

Annotation

The paper presents the factors that contribute to the development of the plant-based milk production industry in Ukraine, shows the prospects for the development of this segment of the market during the next decade in the country, outlines the segment of Ukrainians who are potential consumers of the target product - "plant-based milk". Based on the analysis of literary data, the relevance and expediency of processing amaranth flour as a raw material with high nutritional and biological value, which is produced today in Ukraine by enterprises of the oil and fat industry, into plant-based beverages, is substantiated. The technology of processing amaranth flour into a plant-based drink "Chocolate" using natural raw ingredients based on amaranth flour, developed during research at LLC "Khmilnytskyi dry skimmed milk plant "Molochny Visit", is presented. The process of production of the target product is detailed in the form of a vector scheme; all are described stages of the technological process of the production of ultra-pasteurized herbal drink "Chocolate" with a detailed justification of technological parameters. The industrial approbation of the developed technology of the herbal drink "Chocolate" using natural raw ingredients based on amaranth flour was carried out at LLC "Khmilnytskyi dry skimmed milk plant "Molochny Visit". The indicators of the quality of the produced drink were determined - organoleptic, physicochemical and microbiological. The evaluation of the organoleptic indicators of the herbal drink "Chocolate" produced in production conditions according to the developed recipe and innovative technology proved that they correspond to those of the herbal drinks presented today on the consumer market of Ukraine: the taste of the drink is rich, sweet, with a taste of cocoa and a light nutty aftertaste; the consistency of the drink is homogeneous, with a slight sediment at the bottom of the container; the color is pronounced brown, uniform throughout the entire mass of the drink. The microbiological indicators of the herbal drink "Chocolate" meet the requirements of industrial sterility, which guarantees its safety for the consumer. It is recommended to take the physico-chemical indicators of the produced drink "Chocolate" as a basis when developing regulatory documentation for the product.

Key words: plant-based drink; technology; amaranth flour; reverse-osmosis treated water; ultrapasteurization; industrial approbation; quality benchmarks.

Introduction

Experts note that Ukraine has great potential, a favorable geographical location, certain climatic conditions and natural resources that contribute to the development of the livestock industry and the dairy industry in general. A serious challenge to the producers of the dairy industry is the spread of healthy eating trends in society, within which the consumption of "plant-based milk" as an alternative to animal milk is increasing. In Ukraine, the "plant-based milk" market exists and is developing on the wave of the spread of healthy food. And this serves as an incentive in the direction of improving the activity of the food industry and finding new methods and means of meeting the needs of consumers. An enterprise that successfully and regularly implements innovative activities necessarily gains competitive advantages on the market [1-2].

In the global trend of growing demand for products of plant origin, one of the factors that restrains the development of the "plant milk" industry in Ukraine is the cost, since the price of alternative products of plant origin is much higher than the price of the usual, traditional products of animal origin. Therefore, one of the directions of research is also the search for ways to create a product, competitive milk not only in terms of quality, but also in terms of price for the consumer [1].

Today, the demand for vegetarian food is increasing, more and more people are looking for alternative food products of animal origin, and especially in the field of dairy products, they are looking for alternatives to lactose-free products with full preservation of nutritional qualities in plant substitutes. The main consumers of "plant-based milk" in Ukraine are [1-2]: people suffering from lactose intolerance; vegans, vegetarians, raw foodists; those who strictly adhere to the restriction of religious fasting; people who are on a diet for medical reasons; people who want to use products without antibiotics and hormones used in animal husbandry; who follow fashionable trends in the field of nutrition, in particular, are concerned about the problem of losing weight. In addition, consumers of "plant-based milk" include people who want to diversify their diet. Therefore, scientific research aimed at finding new raw materials for the production of plant-based beverages, as well as substantiation of recipes and technologies for their production are currently relevant and timely.

Literary review

Today, there is no state standard for "plant-based milk" in Ukraine. That is, requirements for raw materials, conditions of transportation and storage. These drinks too suddenly broke into the everyday diet of Ukrainians. Manufacturers did not wait, and began to cook according to their own recipes. That is why all pro-

duction secrets are not revealed at both enterprises, and products are produced according to technical conditions. That is why it is impossible to find any similar drink in composition. And the prices are also very different - from UAH 40. up to UAH 300 per litre.

The assortment of "plant-based milk" on the market of Ukraine is constantly increasing. Today, the consumer is morally ready to buy new types of "plant milk", so the issue of finding new types of raw materials for its production is urgent. Consider amaranth flour as a raw material for herbal drinks.

Amaranth is often called a superfood or miracle grain, even though it is not technically a grain. Its seeds contain as much as 15-28% protein, but unlike real cereals, they are rich in the amino acids lysine and methionine [3].

Chemical composition of amaranth grains: vitamins of group B, A, C, RR, vitamin E of youth; iron, calcium, potassium, selenium, zinc, phosphorus; linoleic, stearic, oleic and palmitic acids; biologically active components: carotenoids, pectin, starch; fats, triglycerides, which are the main source of energy for humans [3].

Regular use of amaranth lowers cholesterol and blood sugar, strengthens blood vessel walls and normalizes the work of the genitourinary system, has a beneficial effect on the heart and blood pressure. Soothes arrhythmia and tachycardia.

The presence of a substance capable of saturating cells with oxygen (squalene) in the composition of amaranth allows you to significantly increase immunity and quickly heal from all types of inflammatory and cold diseases [3].

Protein of vegetable origin restores damaged muscle fibers and bones, participates in the formation of new, healthy cells and tissues. The complex of useful substances reduces the likelihood of developing bone and joint diseases, including arthritis and arthrosis, osteoporosis. The absence of gluten grains allows amaranth to be used as an alternative to other grains for people suffering from celiac disease [4].

Vitamin K participates in the process of blood clotting, preventing the development of internal bleeding. Potassium has a beneficial effect on the work of the heart muscle, lowers blood pressure, and prevents the development of varicose veins. Vitamin A in a complex with carotene improves visual acuity, slows down the development of cataracts [5–6].

Today, amaranth flour is produced from cereals grown in Africa, Asia, and America. For its preparation, seeds are crushed, and flour is ground from the resulting meal. The squeezes are pre-treated, removing the oil, for better product storage. The oil is removed either by the method of mechanical pressing under a press, or by extraction. The flour is yellow in color, with a slight nutty smell and taste [3–6].

The composition of amaranth flour is rich in vitamins and minerals [3–6]: vitamins: A, B_1, B_2, B_3, B_4, C, D, E; minerals: potassium, calcium, iron, phosphorus, copper, magnesium; fiber; oxalic acid; amino acids: lysine, tryptophan, methionine; phytosterols; squalene; fatty acids: omega-6, tocotrienol, linoleic acid.

The nutritional value of amaranth flour [3, 4, 6]: proteins - 8.9 g; fats – 1.7 g; carbohydrates – 61.7 g; caloric content (fat-free product) - 298 g/100 g; with normal fat content – 344 kcal.

Amaranth flour is of great benefit to people with celiac disease (gluten intolerance). Such people cannot consume cereals (wheat, rye) without harming their health, amaranth does not contain this substance, so baking from it is a godsend for gluten allergy [3-6].

Thanks to amino acids and polyunsaturated fatty acids, calcium and protein, the product certainly has a beneficial effect on the production of hormones and enzymes necessary for normal metabolism, has a positive effect on the musculoskeletal system, strengthens muscle tissue, bones, cartilage and ligaments, helps the production of collagen, which is necessary for the elasticity of tissues and skin, accelerates regeneration processes after injuries or surgical interventions [3–6].

The product is often recommended during rehabilitation in the postoperative period. Flour products prevent fatty deposits in the liver, help remove toxins and drug breakdown products.

Amaranth flour products normalize the activity of the digestive tract, restore damage to the gastrointestinal tract mucosa, regulate acidity, normalize the work of biliary organs, and help remove harmful cholesterol [3].

Flour products are also useful for the sexual sphere and the central nervous system [6]: active substances in amaranth flour stimulate the production of sex hormones and enzymes necessary for the nervous system, have an antibacterial effect, and normalize sleep. Regular use of amaranth flour products helps in the treatment of sexual impotence in men, prostate diseases, has a beneficial effect on the genitourinary system in women, regulating the hormonal balance.

The product is especially useful for expectant mothers, if you take into account the vitamin composition and the presence of minerals necessary to support the female body during this period. In children's nutrition, the product contributes to the normal development of the growing organism, increases its protective mechanisms [4, 6].

Potassium and magnesium, squalene and phytosterols participate in hematopoiesis, increase the elasticity of blood vessels, prevent an increase in blood pressure and strengthen the heart muscle. Brazilian scientists in the course of research noted the positive effect of amaranth on the body of patients who underwent chemotherapy. A positive effect on the health of diabetics has also been established: the product significantly lowers blood sugar levels.

From those listed in the table. 1 data shows that amaranth grains contain more protein, including essential amino acids - lysine, methionine, and tryptophan, and about 50% polyunsaturated fatty acids in the composition of fats [3–6].

A comparison of the nutritional value of amaranth seeds with priority food crops revealed a higher protein content in amaranth, while it is well balanced in terms of amino acid composition. It should be emphasized that the deficient amino acids of cereal plants are lysine and methionine, which are contained in amaranth seeds in twice the quantity. These properties give

amaranth a special value in the modern world, when the population of most countries constantly experiences an acute lack of protein food with a balanced amino acid composition (Table 2) [4].

As evidenced by the data in the table. 2, amaranth seeds contain a sufficient amount of all essential amino acids that play a very important role for the human body, namely, they take part in protein and lipid metabolism, hormone synthesis and hematopoiesis, and are also necessary for the full growth of the human body and harmonious work hearts [4–6].

In addition, amaranth flour is rich in such minerals as iron, calcium, potassium, contains extremely important polysaturated fatty acids, from which we would like to isolate linoleic, which is not synthesized in the human body and must come with food products. Among other compounds, we note the high content of vitamins B2, E, B, vitamins of group D, bile acids, steroids and phytosteroids.

Amaranth grain contains vitamin E in a rare, especially active form. Most plants contain vitamin E in a fairly passive tocopherol form. In amaranth grains, it is contained in the tocotrienol form, the antioxidant properties of which are 40-50 times higher than those of tocopherol forms (Table 3) [3, 5–6].

Amaranth seeds and flour are a valuable source of vitamin and mineral complex (Table 3). It is worth noting that in terms of iron, calcium and copper concentrations, amaranth flour is superior to wheat flour, namely: iron in wheat flour is 2.1 mg, in amaranth flour – 28.0 mg; calcium, respectively, 74.0 and 96.0 mg; copper – 0.18 and 2.4 mg [3–6]. In addition, amaranth flour is not only a valuable biologically active food product, but also has a general strengthening and health-improving effect on the human body due to a complex of various therapeutic and preventive properties (immunostimulating, antitumor, anti-inflammatory, bactericidal, wound-healing, antiviral, antifungal) [3, 4].

People with such health problems should use amaranth flour with caution [3–6]: pancreatitis; cholecystitis; liver, kidney and gall bladder diseases.

Excessive consumption of amaranth flour can cause heartburn, nausea or stool disorders. The product should not be used when using drugs aimed at regulating sugar levels and normalizing blood pressure, as it has the same effects [5].

Given the rich composition of amaranth flour, its use is useful for everyone, regardless of age, because it does not cause allergies, helps strengthen immunity and is an aid for people who struggle with excess weight. It is important to remember that abuse can reduce the beneficial properties and harm the body [3–6].

Taking into account all the listed positive properties of amaranth flour, it is advisable to use it as the main raw material for the production of herbal drinks.

Table 1 – The content of food, mineral substances and vitamins in different types of flour

Component names	Component content per 100 g		
	Wheat flour I grade	Amaranath flour	Oat flour
Protein, g	10.60	16.00	13.00
Carbs, g	67.10	54.50	59.20
Fats, g	1.30	6.50	6.20
Fiber, g	0.20	0.85	1.30
Minerals, g	0.72	3.60	1.24

Table 2 – Amino acid composition of proteins of some cereal crops

Amino acid	Content per 100 g		
	Amaranth	Wheat	Buckwheat
Lysine	0.73	0.35	0.61
Histidine	0.38	0.26	0.29
Arginine	1.03	0.54	0.93
Threonine	0.54	0.38	0.48
Valin	0.66	0.50	0.65
Methionine	0.22	0.18	0.16
Isoleucine	0.56	0.43	0.48
Phenylalanine	0.52	0.57	0.49
Leucine	0.85	0.81	0.79

Table 3 – The content of vitamins and minerals in amaranth seeds

Vitamin	Content, mg/100 g	Minerals	Content, mg/100 g
Vitamin C	3,0-7,1	Calcium	215-650
Vitamin E	1,5-1,8	Copper	1-4
Vitamin B_9	42,0-44,0	Iron	21-104
Vitamin PP	1,0-1,5	Magnesium	300-340
Vitamin B_2	0,19-0,22	Manganese	3-5
Vitamin B_r	0,10-0,14	Potassium	520-564
Vitamin A	0,02-0,14	Sodium	22-26

Formulation of the problem

The aim of the presented work was to develop the technology of the herbal drink "Chocolate" using natural raw ingredients based on amaranth flour.

Objectives of the study:

to develop a detailed technological scheme for the production of the herbal drink "Chocolate" based on

- amaranth flour;
- provide a description of the technological process of the production of the ultra-pasteurized "Chocolate" vegetable drink with a detailed justification of the technological parameters;
- carry out an industrial approbation of the developed technology at LLC "Khmilnytskyi dry skimmed milk plant "Molochny Visit" and provide recommendations on the introduction of the developed technology into production.

Materials and methods

To develop the technology of the vegetable drink "Chocolate" using natural raw ingredients based on ama-

ranth flour, standardized methods and methods that are used in the food industry in the development of innovative technologies of new food products were used.

Results of the study and their discussion

The technology of the plant-based drink "Chocolate" based on amaranth flour at LLC "Khmilnytskyi plant of dry skimmed milk "Molochniy Visit" includes the operations shown in fig. 1.

The main raw material for the production of a herbal drink is amaranth flour, which is produced by the Ukrainian oil and fat company LLC "Organic Oils" in accordance with TU U 10.4-39764614-003:2019 [99]. The quality assessment of amaranth flour is carried out in the laboratory of LLC "Khmilnytskyi Dry Skimmed Milk Plant "Molochniy Visit" in order to establish the compliance of the raw material with the current technical conditions. The laboratory also carefully assesses the quality of all other raw ingredients – gellan gum, sugar, alpha-amylase, glucoamylase, cocoa powder, acidity regulator.

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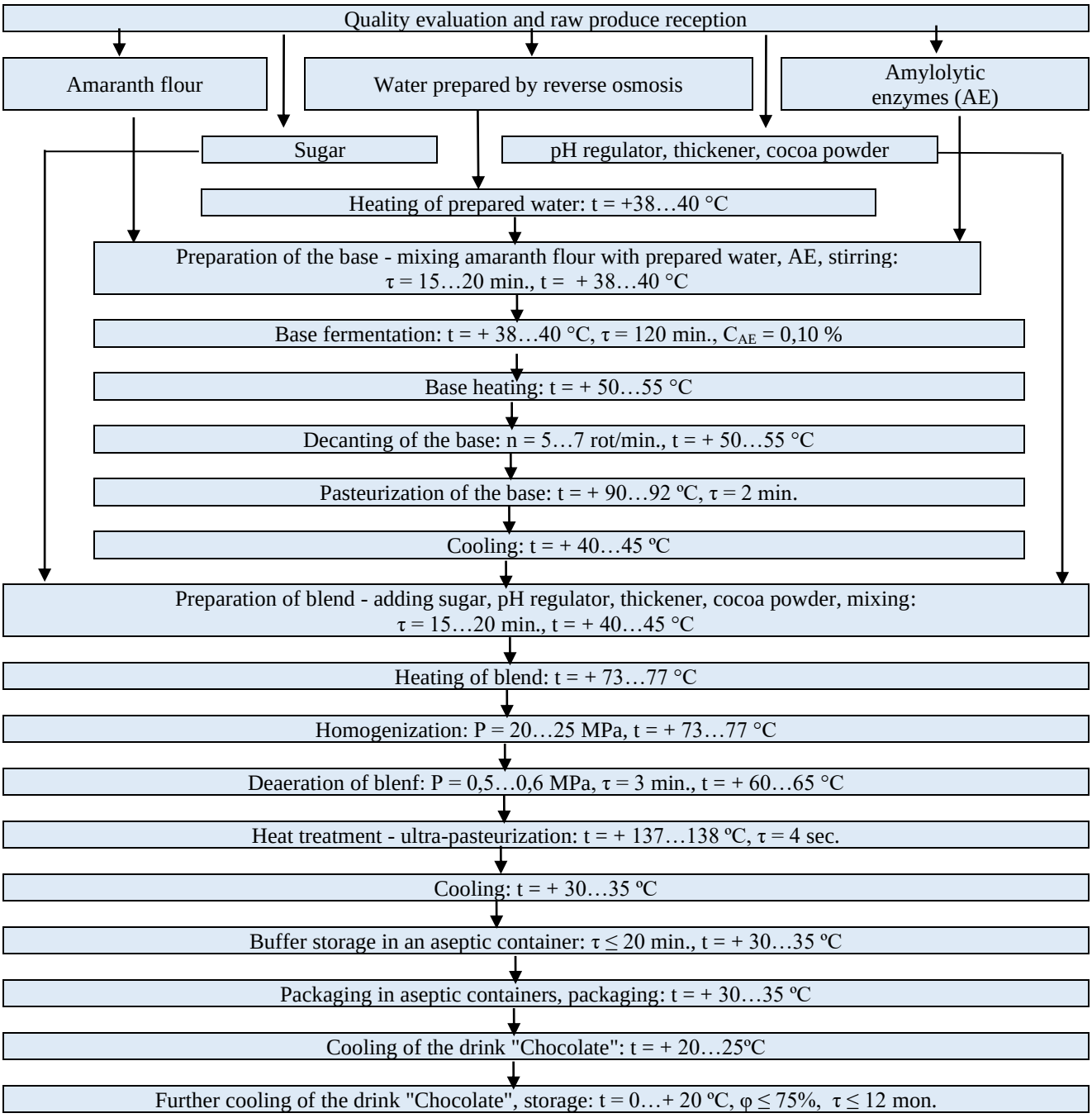

Fig. 1. Vector technological diagram of the production of the plant-based drink "Chocolate" based on amaranth flour at the LLC "Khmilnytskyi dry skimmed milk plant "Molochniy Visit"

conditions. The laboratory also carefully assesses the quality of all other raw ingredients – gellan gum, sugar, alpha-amylase, glucoamylase, cocoa powder, acidity regulator.

Prepared water is used to restore amaranth flour - water desalination is done with reverse osmosis.

At the first stage of production of the plant-based drink "Chocolate", amaranth flour is dissolved in prepared water and fermented with amylolytic enzymes. For this purpose, the prepared water from the tank is fed by a centrifugal pump to a plate heater, where it is heated to a temperature of +38...40 ºC. At this temperature, the water is fed into a tank for dietary products with a jacket and a stirrer, where the previously prepared amaranth flour is also introduced. Amaranth flour is stored in special warehouses at a temperature of 0...15 ºC and a relative humidity of no higher than 75% in kraft bags, in which the concentrate is supplied by the producing company – the Ukrainian oil and fat company "Organic Oils" LLC. Before use, the necessary amount of amaranth flour (according to the calculations according to the recipe) is sifted on a sieve for dry components and fed through a dispenser for dry components into a tank with heated water, where it is thoroughly mixed for 15-20 minutes. until the maximum complete dissolution of the dry substances of the concentrate in water. Amylolytic enzymes – alpha-amylase and glucoamylase are added to the concentrate solution according to the recipe and kept at a temperature of +38...40 ºC for 40 minutes. for fermentation. During the fermentation of the protein concentrate solution with amylolytic enzymes, starch is partially hydrolyzed to maltose and glucose, which increases the digestibility of the product and improves its organoleptic indicators (increases sweetness). Also, the alpha-amylase enzyme partially hydrolyzes the fiber to dextrins, which helps increase its digestibility and reduces amaranth flour waste during subsequent decanting of the base.

To decant the base, it is heated to a temperature of +50...55 ºC. For this purpose, the fermented base is supplied by a centrifugal pump to the leveling tank, and by the pump to the first section of the plate pasteurization and cooling unit, where it is heated by the hot base leaving the system to a temperature of +50...55 ºC. The heated base is fed to the decanter, where it is cleaned of undissolved particles: the decanter rotates at 5...7 rpm.

The purified base is fed to the second section of PPOU recovery, where it is heated to a temperature of +65...70 ºC, after which - to a pasteurization section, where it is heated with hot water supplied from the boiler by a hot water pump to a temperature of +90...92 ºC.

Pasteurasation is performed with the following goals: destruction of all pathogenic microflora; destruction of most of the vegetative saprophytic microflora; inactivation of enzymes, hormones, bacteriophages.

In addition, during pasteurization, one should try to preserve the useful (native) properties of raw materials as much as possible.

During pasteurization, all pathogenic bacteria die (they are asporogenic – they do not form spores; pasteurization regimes are based on the tubercle bacillus - the most heat-resistant pathogenic culture), vegetative forms of microorganisms, and spores and some types of vegetative heat-resistant bacteria remain, but their activity is significantly reduced. Pasteurization also inactivates lipolytic, proteolytic and other enzymes that cause changes in the components of milk during the production and storage of dairy products. The most heat-resistant enzyme is bacterial lipase (it is inactivated at a temperature of +85 ºC, while the native one is at +80 ºC), so pasteurization of the base at a temperature above +85 ºC causes the inactivation of all enzymes in the fermented base.

The efficiency of pasteurization depends not only on the temperature, but also on the duration of the process. The higher the pasteurization temperature used, the less time is needed to inactivate the microflora and ensure the proper pasteurization effect. Pasteurization efficiency (PE) is expressed as a percentage - it is the ratio of the number of inactivated (destroyed) bacteria to their initial number in raw milk:

$$PE = \frac{\text{AMAFAB}_1 - \text{AMAFAB}_2}{\text{AMAFAB}_1} \times 100, \ \% \qquad (1)$$

where PE is pasteurization efficiency, %;

AMAFAB – the amount of mesophilic aerobic and facultatively anaerobic bacteria (CFU/cm3) in the raw material before pasteurization;

RAMAFAB. – residual amount of mesophilic aerobic and facultatively anaerobic bacteria (CFU/cm^3) – their amount after pasteurization.

The efficiency of pasteurization is affected by the degree of mechanical contamination of the base and the content of dry substances in it due to the creation of a protective barrier for bacteria from thermal effects (a high content of dry substances reduces the efficiency of pasteurization). The efficiency of pasteurization is considered high if its value is ≥99.98%; satisfactory if it is 99.90%, low if 98.0...98.5%.

The effectiveness of pasteurization of the base is controlled using a thermometric method, microbiological analysis, and a phosphatase test.

Pasteurization of the fermented base on PPOU occurs as follows. In the PPOU pasteurization section, it is heated with hot water to a temperature of +90...92 ºC, and with this temperature, under the pressure of the following portions of the base, it is pushed into the pipeline, in which the temperature sensor is mounted. The temperature sensor records the temperature of the base: if it is lower than the specified one (+90 ºC), the base is sent to the leveling tank with the help of a three-way valve and it goes through the whole process again; if the temperature of the base has reached the specified value, it is fed into a tubular holder (type "pipe in a pipe"), which it passes in 2 minutes. The pasteurized basis is submitted to PPOU: first to the second recovery section, passing through which it gives off heat to the incoming fermented base, cooling down to +67...72 °C, after that the partially cooled base enters the first recovery section, where it heats the base supplied to the system, cooling down to the temperature +52...57 °C, after which it undergoes a section of cooling with tap water. The temperature of the base at the exit from the tap water cooling section is +40...45 ºC.

The pasteurized cooled base is served in an intermediate container /pos. 10/, where other recipe ingre-

dients are added (according to the recipe) – sugar mixture with cocoa powder, pH regulator and thickener.

All raw ingredients are stored in the warehouse for dry components at a temperature of 0...+15 ºC and relative humidity not higher than 75%. The necessary amount of raw ingredients is weighed on scales (according to calculations according to a certain recipe), the sugar is sifted on a special sieve for dry components, the sifted sugar is mixed with cocoa powder for better dissolution and served in a tank with a pasteurized fermented base, where it is thoroughly mixed for 15... 20 min. until the maximum complete dissolution of the introduced dry raw ingredients in the base.

After mixing, the finished mixture is submitted to thermo-mechanical treatment – homogenization, ultrapasteurization and cooling.

The purpose of homogenization in the production of plant-based beverages is to ensure the necessary stable consistency of the finished beverage, which does not become stratified during long-term storage. Homogenization allows you to prevent significant losses of raw materials, improves the digestibility and consistency of plant-based drinks, the taste of plant-based drinks with fillers due to their uniform distribution in the volume of the product, increases the stability of drinks during storage.

For homogenization, a valve-type homogenizer based on a high-pressure multi-plunger pump is used. According to the type of homogenizing head, one-, two-, and multi-stage homogenizers are distinguished. Two-stage homogenization is used for products with an increased content of dry substances, for products that require low viscosity and to achieve the maximum effect of homogenization. Single-stage homogenization is used for products with low fat and for products with a low dry matter content and low viscosity (in particular, for plant-based drinks). In practice, the use of a multi-stage homogenizer is not economically justified, therefore, the use of a single-stage homogenizer is provided.

Determining factors affecting the efficiency of homogenization are temperature, pressure, mass fraction of fat and solids in the mixture for the production of plant-based beverages. Homogenization can be effective when the entire fat phase is in a liquid state (although the fat content in the vegetable mixture is negligible), so usually the optimal temperature is +60...65 °C. The homogenization pressure depends on the type of product and the composition of the drink. For plant-based drinks with a long shelf life, homogenization under a pressure of 20...25 MPa at a temperature of +73...77 ºC is used to ensure high stability throughout the entire storage process. The indicated mode of homogenization ensures the efficiency of the process at the level of 95...96%, which prevents stratification of plant-based drinks in the finished product.

The prepared mixture from the tank is fed by a centrifugal pump to the plate heater-recuperator, where it is heated to a temperature of +73...77°C, after which the mixture enters the homogenizing head of the homogenizer /pos. 13/, where it is homogenized under a pressure of 20...25 MPa. The homogenized mixture is fed to the heat treatment line - HTL.

In the technology of plant-based drink, the use of ultrapasteurization is provided as a method of heat treatment to obtain a product with a long shelf life.

Ultrapasteurization is carried out with the aim of destroying all microorganisms in the vegetative form in the vegetable mixture, as well as their spores, inactivating enzymes, hormones, bacteriophages, provided that the properties of the raw materials are minimally changed. Ultrapasteurization is carried out at a temperature higher than the boiling temperature, namely at a temperature of +137...138 ºC with a holding time of 3...4 seconds. and aseptic bottling in bags made of multi-layer combined material.

Ultra-pasteurization processing at high temperatures and bottling of plant-based drink in aseptic conditions make it possible to produce high-quality products with a long shelf life. The disadvantage of the ultra-pasteurized vegetable drink is that its nutritional and biological value is lower than that of the pasteurized one, due to the negative effect of high temperature on the thermolabile components of the protein concentrate, in particular, albumins and vitamins. But, at the same time, it is precisely this method of heat treatment that allows you to preserve the native properties of raw materials better than sterilization in a container (one- or two-stage), because during ultra-pasteurization heat-labile components are destroyed to a lesser extent: whey proteins and heat-labile vitamins (vitamin C), than during sterilization. This method of heat treatment of plant mixtures allows you to save time, labor costs, energy, production space, has less effect on the organoleptic indicators of raw ingredients compared to sterilization in a container.

During ultra-pasteurization of the herbal mixture in the stream, aseptic filling of the processed herbal mixture into bags made of sterile materials is mandatory. Cooling and storage of ultra-pasteurized plant-based drink before bottling should also be carried out in aseptic conditions.

So, when using the HTL line for ultra-pasteurization, the vegetable mixture after the homogenizer is sent to the deaerator, where air is removed from it. When air is removed, the vegetable mixture is cooled to +67...70 ºC, and at this temperature it is fed to the HTL line. In the HTL line, the vegetable mixture is ultra-pasteurized when it is mixed in an injector with hot steam (the temperature of hot steam is +160...170 ºC). Water to obtain hot steam is purified on several filters, and then using electrodialysis (up to 90% of minerals are removed). When mixed with hot steam, the herbal mixture is instantly heated to a temperature of +137...138 ºC and at this temperature it is fed into a tube holder, which passes in 3...4 seconds. After the holder, the temperature of ultra-pasteurization is controlled (with the use of a temperature sensor). The vegetable mixture, heated to the specified temperature, is sent to the right vacuum chamber using a three-way valve, in which, due to the vacuum, the vegetable mixture instantly boils, as much steam evaporates from it as was introduced into the injector, while the vegetable mixture cools to a temperature of +76... 78 ºC. The cooled plant mixture from the vacuum chamber is fed for aseptic cooling in a plate cooler, where it is cooled in aseptic conditions to a temperature not higher than +20 ºC. At this temperature, the processed herbal mixture is fed to an aseptic (sterile) tank,

where it can be stored for no more than 1 hour. Before packaging in a hermetic container, the ultra-pasteurized vegetable drink "Sunnyashnikovy" is stirred for at least 15 minutes, filtered on a tube filter /pos. 19/, fed into the second aseptic tank, and after that - for packaging in Tetra-Pak bags of combined materials.

If the prepared vegetable mixture, after mixing with hot steam and waiting, has a temperature below +137 ºC, it is fed to the left vacuum chamber, where it also boils under vacuum, as a result of which all the injected steam evaporates from it and the vegetable mixture cools to a temperature of +76...78 ºC. From the vacuum chamber, the partially cooled vegetable mixture is fed to the recuperator plate heater, where it is cooled by the incoming cold mixture to +2...6 ºC and returned to the tank, after which the process repeats.

The ready-made plant-based drink "Chocolate" based on amaranth flour is filled on a packaging machine into Tetra-Pak bags in the form of a parallelepiped with a capacity of 1.0 dm3 in aseptic conditions. The 4-layer packing material for Tetra-Pak bags consists of laminated paper, polyethylene and foil. The material in direct contact with the product is food-grade polyethylene. The strength of the package is given by paper, polyethylene makes the package impermeable to liquids, and foil prevents oxidation of the product, as it does not allow light to pass through. Tetra-Pak bags for packing an ultra-pasteurized plant-based drink are formed from a roll directly in the machine for packing and packing the product. The inner surface of the roll is immersed in a bath with a 15% hydrogen peroxide solution, after which it passes over an ultraviolet lamp, the temperature of which is + 70...80 ºC. Hydrogen peroxide decomposes into water and atomic oxygen; the latter disinfects the inner surface of the roll. After the ultraviolet lamp, the inner surface of the roll intended for packaging ultra-pasteurized vegetable drink is dried with hot air (+75...85 ºC), after which the rolls are quickly formed into bags: first the sleeve is formed, then the vertical seam is sealed, the bottom of the bag is formed, the blank is filled with the product , after which the upper part of the package is formed and melted. Before capping, air is pumped out of the bag and inert gas - nitrogen is pumped inside.

Tetra-Pak packages are made with a slope, taking into account the fact that a screw cap will then be built into the package. The machine installed for packaging is equipped with an aseptic chamber and a device for pumping out air from the bag, so the developed plant-based drink "Chocolate" based on amaranth flour, packaged in this machine, can be stored for 12 months (taking into account that the SIR station is used for washing the equipment).

Plant-based drink "Chocolate" based on amaranth flour, packaged on automatic machines in Tetra-Pak bags, is fed by a chain conveyor to a machine for forming a lid, and then by a chain conveyor to a machine for packing Tetra-Pak bags into transport containers. Cardboard trays with subsequent wrapping in shrink film serve as transport containers for plant-based drinks in Tetra-Pak bags. The packaged cardboard trays with the product are fed by a belt conveyor to the storage room, where they are placed on flat pallets, in which the drinks are stored.

The developed plant-based drink "Chocolate" based on amaranth flour in Tetra-Pak bags is stored at a temperature of 0...+20 ºC with a relative humidity of no more than 80% for 12 months, incl. at the manufacturing enterprise - no more than 2 months.

In order to introduce the developed and described technology of plant-based drink "Chocolate" based on amaranth flour into the production of LLC "Khmilnytskyi dry skimmed milk plant "Molochny Visit" it is necessary to install additional equipment for reverse osmosis of drinking water, since the company does not currently produce "plant milk".

The developed technology of the drink "Chocolate" based on amaranth flour was tested in the laboratory of the enterprise, the tasting of drinks was carried out with the involvement of the head of the laboratory, the chief technologist, the master of the production department of the LLC "Khmilnytskyi plant of dry skimmed milk "Molochniy Visit" and specialists of the department of TMOZHPtaIK ONTU. The evaluation of the organoleptic parameters of the herbal drink "Chocolate" produced in production conditions according to the developed recipe and innovative technology proved that they correspond to those of the herbal drinks presented today on the consumer market of Ukraine. The microbiological indicators of the herbal drink "Chocolate" meet the requirements of industrial sterility. It is recommended to take the physico-chemical indicators of the produced drink "Chocolate" as a basis when developing regulatory documentation for the product.

Conclusions

1. The technology of the vegetable drink "Chocolate" was developed using natural raw ingredients based on amaranth flour.
2. A detailed technological scheme for the production of the herbal drink "Chocolate" based on amaranth flour is provided.
3. The technological process of the production of ultra-pasteurized "Chocolate" vegetable drink is described with a detailed justification of the technological parameters.
4. The industrial approbation of the developed technology was carried out at LLC "Khmilnytskyi dry skimmed milk plant "Molochny Visit", based on which the technology and formulation of recommendations for the introduction of the developed technology into production were developed.

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ІННОВАЦІЙНА ТЕХНОЛОГІЯ НАПОЮ РОСЛИННОГО «ШОКОЛАДНИЙ» НА ОСНОВІ АМАРАНТОВОГО БОРОШНА

Анотація

В роботі наведено фактори, які сприяють розвитку галузі виробництва «рослинного молока» в Україні, показано перспективи розвитку даного сегменту ринку протягом найближчого десятиліття у країні, окреслено сегмент українців, які є потенційними споживачами цільового продукту – «рослинного молока». На основі аналізу літературних даних обґрунтовано актуальність та доцільність перероблення амарантового борошна як сировини з високою харчовою та біологічною цінністю, яке сьогодні в Україні виробляють підприємства олійно-жирової галузі, у напої рослинні. Наведено розроблену у ході проведення досліджень на LLC "Khmilnytskyi dry skimmed milk plant "Molochny Visit" технологію перероблення амарантового борошна у напій рослинний «Шоколадний» із використанням натуральних сировинних інгредієнтів на основі амарантового борошна. Деталізовано процес виробництва цільового продукту у вигляді векторної схеми; описано усі етапи технологічного процесу виробництва напою рослинного «Шоколадний» ультрапастеризованого із детальним обґрунтування технологічних параметрів. Проведено промислову апробацію розробленої технології напою рослинного «Шоколадний» із використанням натуральних сировинних інгредієнтів на основі амарантового борошна на ТОВ «Хмільницький завод сухого молока «Молочний візит». Визначено показники якості виробленого напою – органолептичні, фізико-хімічні та мікробіологічні. Оцінка органолептичних показників виробленого у виробничих умовах за розробленою рецептурою та інноваційною технологією напою рослинного «Шоколадний» засвідчила, що вони відповідають таким у напоях рослинних, представлених сьогодні на споживчому ринку України: смак напою насичений, солодкий, з присмаком какао та легким горіховим після смаком; консистенція напою однорідна, з незначним осадом на дні тари; колір – виражений коричневий, однорідний по усій масі напою. Мікробіологічні показники напою рослинного «Шоколадний» відповідають вимогам промислової стерильності, що гарантує його безпечність для споживача. Фізико-хімічні показники виробленого напою «Шоколадний» рекомендовано взяти за основу при розробленні нормативної документації на продукт.

Ключові слова: напій рослинний; технологія; амарантове борошно; вода, оброблена зворотним осомосом; ультрапастеризація; промислова апробація; показники якості.

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