Justification of the quality of dry concentrates of functional protein-carbohydrate drinks for special nutrition of athletes

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Abstract. The purpose is justification of the quality of dry concentrates of functional protein-carbohydrate drinks based on plant raw materials for specialized nutrition of athletes. The material for the study was cedar meal from Scots pine fruits (Latin Pinus sylvestris), cedar meal flour, dried fruits of Siberian mountain ash (Latin Sorbus sibirica) and rose hips (Latin Rosa acicularis), powders from the specified fruit and berry raw materials, skimmed milk powder, stevioside, corn starch, experimental samples of dry concentrates of functional protein-carbohydrate drinks from plant raw materials and samples of ready-made drinks based on them with a 1:10 hydromodule for special nutrition for athletes. Organoleptic, physicochemical, microbiological studies were carried out using standard and original methods, methods of mathematical modeling and statistical processing of experimental data were used. The combination of new compositions of dry concentrates of protein-carbohydrate drinks from vegetable raw materials for sports nutrition was formed; the quality of compositions of dry concentrates of new types of protein-carbohydrate drinks of functional purpose based on vegetable raw materials - flour from cedar meal, powders from dried fruits of mountain ash and rose hips with the addition of dry skim milk, stevioside, corn starch was justified. The research is promising in the creation of a range of dry concentrates of protein-carbohydrate drinks for sports nutrition using new types of raw materials, the advantage of which is naturalness and a significant content of functional ingredients. This makes it possible to contribute to the development of technologies for products for sports nutrition.

1. Introduction
Sports activities are associated with serious stress on the body, especially among high-class athletes, whose professional vector is focused on achieving maximum leading results. Among the measures for the hygiene of sports activity, rational nutrition is of great importance, aimed at increasing sports
performance, endurance, adaptive capabilities to physical and neuro-emotional stress, and body recovery after stress [2].

The body of people during physical activity experiences an increased need for energy spent on muscle work. The diets of people involved in sports, first of all, should contain a sufficient amount of protein necessary for the development of muscles, increasing muscle mass during training [1].

In addition to protein, the diet of athletes should include ingredients containing a significant amount of various microelements and vitamins to increase the body’s resistance to physical and nervous stress [5].

The studies have shown that low-carb, moderate-protein drinks at a certain exercise intensity can improve aerobic endurance, even when they contain only half the carbohydrates and are 30% lower in calories than standard sports drinks. Likewise, compared to drinks containing standard amounts of carbohydrate sweeteners, drinking drinks that are low in digestible carbohydrates and supplemented with protein leads to increased endurance in cyclists. Low-carbohydrate drinks that contain protein in addition to sugars provide additional performance benefits — they increase the performance of endurance exercise compared to water and beverages without added protein components [8].

For sweetening, it is advisable to introduce into sports drinks, a calorie-free sugar substitute of natural origin - stevioside, the beneficial properties of which have been scientifically proven. In the literature, there are no reports of contraindications to the use of stevioside. A wide range of various useful properties makes it possible to widely promote stevioside as a substitute for sucrose in dietary and therapeutic-and-prophylactic nutrition, to recommend it as a non-calorie sweetener for functional and specialized beverages.

The purpose of the research stage presented in the article is to substantiate the quality of dry concentrates of functional protein-carbohydrate drinks based on plant raw materials for specialized nutrition of athletes.

2. Materials and research methods

The research material was non-traditional plant raw materials in a dried form and products of its processing (powders from berries and flour from cedar meal), structure-forming agents (dried skim milk - DSM, corn starch), and a sweetener - stevioside. All plant materials were used at the stage of consumer maturity, harvest 2017 (information is on the package).

Dried fruits of Siberian mountain ash (Latin Sorbus sibirica) and rose hips (Latin Rósa aciculáris) were used as an element of sports nutrition to maintain the required composition of electrolytes in the body, enrichment with vitamins and dietary fiber, produced by the processing company AFA (Biysk, Russia). Powders were obtained from dried rowan and rosehip berries. For this, the dried fruits of mountain ash and rose hips were preliminarily crushed to a particle size of less than 0.02 mm.

Dried skim milk powder used in the research, according to the main indicators, met the requirements of GOST 52791-2007, corn starch - GOST 32159-2013.

Stevioside (C38H60O18) produced by Royal Sweet International Technologies Ltd. (USA) was used in the work. The technology of stevioside production by the Royal Suite International Technologies group allows obtaining this glycoside in a powdery state, with a sweetness intensity 300 times sweeter than sugar, white, odorless.

Experimental samples of compositions of dry concentrates of new functional protein-carbohydrate drinks based on vegetable raw materials for special nutrition of athletes and samples of finished drinks based on them (hydromodule 1:10) served as the material for research.

In the samples of compositions of dry concentrates of new protein-carbohydrate drinks of functional purpose for sports nutrition, the content of vitamin C was determined by the method of potentiometric titration with a solution of 2,6-dichlorophenolindophenol (2,6-DCPIP), based on the redox reaction between ascorbic acid and indicator 2,6 - DCPIP (we took into account the intensity and nature of the color of the solution, - the intense blue color of this indicator in an alkaline medium turns into pink in an acidic medium [3].
The determination of carotenoids in the developed compositions of dry concentrates of new sports drinks was carried out by a physicochemical method based on photometry of the carotenoid solution obtained after its extraction from the analyzed products with an organic solvent (acetone).

Determination of macro- and microelement composition, vitamins E, PP, carotenoids in the studied objects was carried out in the testing laboratory of the State Center of Agrochemical Service "Krasnoyarsk", microbiological testing - in the Krasnoyarsk regional center of the State Sanitary and Epidemiological Supervision. Other studies were carried out at the Siberian Federal University.

The names for the developed products were compiled on the basis of the requirements for the name of the food product (group of similar products) in accordance with GOST R 51074-2003 [4].

The energy value of the developed all groups of dry beverage concentrates was calculated using the corresponding tables of the chemical composition of food products [7].

3. Research results and the discussion

Based on the average daily physiological need for the basic nutrients of people involved in sports, compositions of dry concentrates of protein-carbohydrate drinks based on non-traditional plant raw materials were compiled, taking into account their organoleptic properties and the potential ability of each multivitamin plant to have a general strengthening effect on the human body. Also, when choosing ingredients from vegetable raw materials as the basis of protein-carbohydrate drinks intended for special nutrition for athletes, the prevalence and availability of vegetable raw materials, its chemical composition, and the possibility of year-round processing were taken into account.

When composing the compositions of beverage concentrates, the following principles of rational nutrition and the theory of obtaining functional products were taken into account:

- drinks must contain at least 15% of functional nutrients from the daily requirement;
- by organoleptic indicators - have a harmonious taste and aroma, delicate homogeneous texture;
- drinks must be safe.

Dried skim milk (DSM) and corn starch were used as structure formers, stevioside was used as a source of sweetness. The composition of the compositions of dry concentrates of protein-carbohydrate drinks based on plant raw materials for the nutrition of athletes is presented in table 1.

| Table 1. Composition of new compositions of dry concentrates of protein-carbohydrate drinks from vegetable raw materials for sports nutrition, %
|---------------------------------|------------------|-----------------|------------------|-----------------|-----------------|
| Flour from meal of seeds of pine | Powder from berries (lat. Sorbus sibirica) | Powders from berries (lat. Rósa aciculáris) | DSM/Dry skim milk | Stevioside       | Corn starch     |
| nuts                            |                                |                 |                  |                 |                 |
| Composition 1 «Cedar-berry drink» | 50                             | 15              | 20              | 10              | 0.24            | 5               |
| Composition 2 «Cedar-Rowan drink» | 50                             | 35              | -               | 10              | 0.24            | 5               |
| Composition 3 «Cedar-dogrose drink» | 50                             | -               | 35              | 10              | 0.24            | 5               |

Technological losses during dosing (portioning) of dry mix of drinks – 0.24%.

a in each composition of a ready-to-drink drink for swelling flour from cedar meal, COM and corn starch, normalizing the system, water is introduced, treated with zeolites - hydromodule 1:10 in all versions.

b dried skim milk.

The obtained compositions were evaluated by the tasting committee on a 5-point scale for organoleptic indicators - "appearance", "taste and aroma (smell)", "color", "texture". The results of the
commission assessment confirmed the high organoleptic characteristics of the developed products (figure 1).

![Figure 1. Organoleptic characteristics of drinks based on plant raw materials.](image)

The content of the main nutrients in the developed compositions, as well as the calorie content of them and ready-made drinks (hydromodule 1:10) was determined:

- composition 1 "Cedar berry drink" (100 g of dry mixture) contains protein 27.9%, vitamin E 7.8 mg%, dietary fiber 15%, Mg 9.4 mg%, Ca 11.4 mg%, K 53 mg%, vitamin C 297 mg%, carotenoids 8.1 mg%, calorie content - 293.1 kcal (ready-to-drink drink (mixture consumption 10 g) - 29.31 kcal);
- composition 2 "Cedar-mountain ash drink" (100 g of dry mixture) contains protein 27.7%, vitamin E 7.7 mg%, dietary fiber 13.75%, Mg 10.5 mg%, Ca 13.6 mg%, K 54 mg%, vitamin C 133 mg%, carotenoids 11.7 mg%, calorie content - 270.1 kcal (respectively - 27.01 kcal);
- composition 3 "Cedar-rosehip drink" (100 g of dry mixture) contains protein 28.1%, vitamin E 7.9 mg%, dietary fiber 13.75%, Mg 6.0 mg%, Ca 5.9 mg%, K 17.5 mg%, vitamin C 420 mg%, carotenoids 5.8 mg%, calorie content - 310.4 kcal (respectively - 31.04 kcal).

Microbiological studies have found that in all types of compositions of dry concentrates of functional drinks, both freshly produced and at the end of the shelf life, pathogenic microorganisms were not detected, including salmonella, yeast, mold, E. coli bacteria. The growth of these microorganisms was not observed during the entire storage period. This testifies to the medical and biological safety, reliability and compliance with the requirements of the Technical Regulations of the Customs Union 021/2011 "On food safety" and 027/2012 "On the safety of certain types of specialized food products, including dietary therapeutic and preventive dietary nutrition" [6].

In order to create conditions for subsequent complete confidence in the safety of the products obtained, an action plan for the HACCP system was developed for the production of dry concentrates of functional protein-carbohydrate drinks using plant materials for sports nutrition. The HACCP plan aims to ensure the quality and safety of said products by systematically examining each stage of the production process - from raw materials to the final consumer of food products. To identify critical control points in the analysis of raw materials and production processes, a "decision tree" diagram was used. The significance of the potential hazard was identified using the structuring and the method of risk analysis according to the qualitative diagram depending on the probability of the hazardous factor being realized and the severity of the consequences from its manifestation. Based on the data obtained, hazardous factors were identified (for each factor, the degree of danger was determined to identify
critical control points), taken into account and controlled in the production of dry concentrates of functional protein-carbohydrate drinks based on plant raw materials, namely:

- microbiological factors - the amount of MAFanM, CFU / g, BGKP (coli-form) in 1 g of the product, Staphylococcus aureus in 1 g of the product, mold, CFU / g, yeast, CFU / g;
- chemical factors - toxic elements (heavy metals), radionuclides (cesium-137, strontium-90 and others);
- physical factors - mineral inclusions (stones, sand);
- environmental pollutants - dust, pollen and plant seeds;
- biological factors - insects and the products of their life activity.

4. Conclusions

As a result of the research, a fundamental image was formed and the quality of compositions of dry concentrates of new types of protein-carbohydrate drinks of functional purpose based on plant raw materials was justified, which gives every reason to recommend them for inclusion in the diets of people involved in sports, since the enrichment of these products is obvious biologically active substances - protein, dietary fiber, vitamins C, E, β-carotene, minerals. The results of the research proved that ready-to-drink drinks based on the developed dry protein-carbohydrate concentrates from plant raw materials (hydromodule 1:10) belong to the group of enriched low-calorie products, both functional and specialized, intended for sports nutrition. The calorie content of 100 g of the finished weighted average drink from the dry concentrate is 29.12 kcal.

To ensure stable quality and safety in the production of functional drinks based on dry protein-carbohydrate concentrates from plant raw materials for sports nutrition, the activities of the HACCP plan have been developed, according to which product control is supplemented by process control, and the Technological Regulations for obtaining these products in production conditions.

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