Development of energy bars formulae for athletes, based on the essential nutrients balance

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Abstract. This work is devoted to creating formulae for energy bars for sports nutrition, based on the maximum balance in the ratio of proteins, fats and carbohydrates. To create the bars, only natural, nutritionally rich ingredients were used. Forecasting of the nutritional value of formulae various options for and their further evaluation by quality indicators, made it possible to obtain the optimal ratio of components corresponding to high nutritional and energy values and consumer activity.

1. Introduction
The market for sports products is developing rapidly in Russia. Such products include a special group of food products, which is produced mainly for people leading an active lifestyle and engaged in sports activities [1,5]. The use of such products is mainly aimed at improving athletic performance, as well as increasing stamina and improving health [1,2].

In products intended for sports nutrition, the composition should contain enough proteins and carbohydrates, with a small amount of fat. Today, a large number of products are being developed that are enriched with vitamins and other beneficial substances. When choosing such products, consumers should pay attention to the composition, quality and safety of products, as well as their shelf life [3,4,7,9].

In the modern rhythm, athletes need healthy foods for a snack between the main meals. Therefore, the creation of such products becomes an urgent task. These products include energy bars. Bars provide the necessary energy. They look like ordinary chocolate bars, and you can buy them not only in specialized stores, but also in ordinary supermarkets [5,8,9].

Depending on the composition and purpose of use, the bars are divided into the following types:

- cereals - recommended for those who want to lose weight, contain a large amount of fiber;
- high-protein - contain protein (over 50%). Recommended for gaining muscle mass;
- low-calorie - recommended in the fight against excess weight, the composition often contains carnitine;
- high-carbohydrate - bars with high energy value, are recommended for use when gaining muscle mass [3,5,8].

The value of basic nutrients for the body lies not only in their quantity, but also in the correct ratio among themselves. The optimal ratio of proteins, fats and carbohydrates on average is: Proteins 20-34%,...
Fats 19-34, Carbohydrates 45-65%, depending on the purpose, gender and age. A properly balanced composition of the bars ensures that the body receives the necessary nutrients. Taste is of great importance, as purchasing power, as well as digestibility by the body, will depend on it [3,5].

Purpose of work is to develop a formula composition of the energy bar for sports nutrition, based on maximum balance of proteins, fats and carbohydrates.

2. Materials and methods

Various types of raw materials rich in protein, minerals and energy were selected as objects of study.

The following ingredients were selected for the prescription composition of the energy bar [6]:

- **Powdered milk (whole) 25% fat.** Proteins of milk powder contain 18 amino acids, 10 of which are irreplaceable. It contains up to 1000 mg of calcium and 1200 mg of potassium, as well as a sufficient amount of polyunsaturated fatty acids, including omega-3. Potassium strengthens blood vessels, calcium is essential for bone strength. The content of protein in milk powder contributes to a set of muscle mass, which is important for athletes. Milk is easily digested, it should also be noted that with its sufficiently high fat content, it practically does not contain harmful cholesterol.

- **Oatmeal Extra No. 1** have a positive effect on the body. They contain a large amount of coarse dietary fiber, which when ingested, bind wastes and toxins and remove them. Fiber normalizes the digestive tract. Oatmeal is rich in iodine, which is especially important for residents of the Krasnoyarsk Territory, since there are a large number of patients with thyroid disease. Flakes contain a large amount of vitamins A and E, which are natural antioxidants.

- **Cedar cake.** Due to the fact that most of the fat is removed in the oilcake, it is therefore less caloric and stored longer. The use of cedar cake helps to restore during injuries, strengthen the cardiovascular system, improve liver function and restore the body under heavy loads. On average, oilcake contains about 20-30 g of protein (19 amino acids), a large amount of fat and carbohydrates, which gives energy and helps to increase muscle mass. The amount of phosphorus in the meal covers the daily requirement of the body by 160%, and magnesium by 140%. Also, a huge number of trace elements such as manganese and copper, a large amount of iron and zinc.

- **Dried apricot GOST (state standard) 32896-2014.** Dried apricots occupy a leading position among foods rich in potassium, that is, strengthens the heart muscle. Dried apricots contain vitamins A., B1, B2, C, PP, K. Vitamin K is involved in blood coagulation. Dried apricot helps cleanse your body of heavy metals.

- **Maple syrup** is a beneficial natural sweetener. There is a large amount of carbohydrates - 67 g per 100 g of product in the syrup. Syrup has a positive effect on the body, helps to prevent cancer. Due to the zinc content in the syrup, the inner layers of blood vessels in the body strengthen. A large number of vitamins and minerals contained in the syrup have a beneficial effect on the immune system.

- **Pumpkin seeds.** They contain pectins, amino acids, polyunsaturated fatty acids, minerals, especially a lot of manganese, phosphorus, magnesium, copper and silicon. Silicon in the body provides clarity and coordination of the work of all organs of the nervous system, prevents the development of atherosclerosis. Manganese regulates the metabolism of fat and carbohydrates in the body, improves the functioning of the reproductive system, strengthens the immune system, participates in the growth of cartilage and tissues. The main function of phosphorus is to ensure normal growth of bone and dental tissue, due to phosphorus compounds, muscle contraction occurs in the body, which leads to movement. The composition of the seeds includes vitamins A, group B, E, K, H and PP.

- **Flax seeds** envelop the mucous membranes of the gastrointestinal tract, protect the respiratory system, reduce blood cholesterol, and strengthen the immune system. The omega-3 content in flax seeds is higher than in fish. Omega-3 is necessary for the treatment and prevention of the cardiovascular system. Hormone-like substances - lignans present in the seeds have an antioxidant effect and reduce the risk of tumor formation. In the seeds there is a daily norm of vitamin B1, as well as manganese.

- **Peanut.** Its composition is rich in polyphenols, they help in the fight against premature aging. The use of peanuts can reduce the level of bad cholesterol and improve the functioning of the liver, nervous
and cardiovascular systems. Peanuts contain a large amount of vitamin PP, B9, and E. Their minerals have an advantage over silicon, copper, manganese, and cobalt.

_Lingonberry dried to a moisture content of 10%. _Lingonberry fruits in their composition have a unique vitamin-mineral complex and benzoic acid, which is a natural preservative. Lingonberry regulates the metabolism, remove salts of heavy metals and toxins from the body, improve digestion and the gastrointestinal tract. Lingonberry has a high content of vitamin A, E and C.

_Dried currants 10%. _Currant berries are a leader in the content of vitamin C. It is also a source of vitamins A, B, P, magnesium, potassium, iron, phosphorus and sodium, tannins and pectin, organic acids. The consumption of berries helps to eliminate fluid from the body, normalizes the work of the heart, gastrointestinal tract, and prevents the growth of cancer cells.

Organoleptic evaluation was carried out on a 5-point scale. Moisture determination was carried out according to GOST15113.4-77; determination of acidity - in accordance with GOST15113.5-77. Mathematical and statistical processing of the results was carried out using the computer program Statistica 6.0.

3. _Research results_

The composition of the bars was designed to ensure the highest possible balance of nutrients. For this, 10 formulae options were compiled (figure 1) in the following ratio of components:

![Figure 1. Options for the composition of bars.](image)

For all variants of the formulae, the nutritional value of the bars was calculated [6, 7]. As a result, 4 samples were selected closest to the balanced ratio of proteins, fats and carbohydrates: option 2,3, 7 10. Figure 2-3 presents the results of the study.
Figure 2. The content of basic nutrients in the studied samples of bars, g.

Figure 3. The ratio of PFC in the studied samples of bars, %.

According to these formulae, prototypes of bars were made. Finished products were investigated by the main indicators of quality. 6 people took part in the tasting evaluation of the products. The results are shown in figure 4.

Figure 4. Tasting evaluation of bars.

Physico-chemical indicators: the mass fraction of moisture in the bars varies between 6-8%, the mass fraction of fat is 26-32%, depending on the formulation. In addition to the content of basic substances, the mineral and vitamin composition of the bars is considered. The results are presented in figures 5-8.

Figure 5. The content of individual trace elements in bars.

Figure 6. The content of individual trace elements in bars.
4. Discussion of the results

The results of the study showed that the ratio of proteins: fats: carbohydrates (P: F: C) in option 2 is 24:28:48; in option 3 - 26:32:42; in option 7 - 25:29:46; in option 10 - 24:27:49 (figures 2, 3).

The organoleptic characteristics of these samples of bars had good results: the shape of the bars is correct, the taste is moderately sweet, with the prevalence of the main components according to the recipe composition, with the aroma of flavoring ingredients.

Tasting assessment showed that sample No. 7 and 10 had the best organoleptic characteristics, and sample No. 10 in terms of balanced PFC. The highest content of minerals and vitamins was observed in options 3, 7, and 10. Based on this, options No. 7 were selected as the best samples, and No. 10. The energy value of the bars is 392 and 398 kcal, which satisfies the average daily requirement of an adult by 15%. In confirmation of the positive results, the data are shown in table 1.

Table 1. Satisfaction of the daily needs of the body with the use of 100 g of Bars.

| Nutrients       | Average norms of daily requirement, g/day | Option 7 |          | Option 10 |          |
|-----------------|------------------------------------------|----------|----------|-----------|----------|
|                 | Content in the bar | Satisfaction degree, % | Content in the bar | Satisfaction degree, % |
| Proteins, g     | 80 (58-117) | 18.0695 | 22.58688 | 17.699 | 22.12375 |
| Fats, g         | 90 (60-154) | 21.342 | 23.71333 | 19.551 | 21.72333 |
| Carbohydrates   | 350 (257-586) | 33.2999 | 9.514257 | 36.1795 | 10.337 |
| EV, ccal/J      | 2500/10463 | 398/1666 | 15.9 | 392/1641 | 15.6 |

Based on the data of the table, the presented samples of bars satisfy the daily need for proteins, fats and carbohydrates by more than 20%, and energy by 15%, which allows them to be attributed to products of a functional orientation.

5. Conclusions

An ingredient selection and justification of the formula composition of bars for sports nutrition has been carried out. It was established that the developed formulae have the most balanced composition of proteins, fats, carbohydrates, high content of minerals and vitamins. According to the degree of provision of the body in proteins, fats and carbohydrates, they can be attributed to the products of the functional orientation. Bars have high eating experience, they can be recommended for a proper, nutritious, healthy snack, not only for athletes, but also for the general adult population.

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