Modern Technologies for Obtaining Innovative Therapeutic and Prophylactic Products from Plant Materials

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Abstract. The economic recession amid the COVID-19 pandemic, the difficult socio-economic conditions of the Russian Federation associated with the introduction and distribution of functional food products are not only a factor in the formation of state policy in the field of healthy lifestyles, but are a necessary condition for the preservation of the health of the nation. The article discusses the problematic issues associated with the need to create sports nutrition products based on lentil, as plant materials rich in protein compounds. Sports nutrition (SP) is a specialized food product that compensates for the deficiency of missing protein substances, contributing to the rapid recovery of the body's adaptive systems during periods of stress, both physical and immune. The analysis of the development of the sports nutrition market in the Russian Federation on the basis of marketing research of the agency “BusinessStat” is presented. Allows one to predict the prospects for the development of this direction. In order to obtain a high-quality target product, the possibility of using an electric-discharge effect on raw materials with a certain number of pulses to inactivate anti-nutritional compounds is presented, which prevents the assimilation of vegetable protein in the human body.

1. Introduction
Changes in the ecological and economic situation in various countries of the world against the background of the developing economic crisis associated with the COVID-19 pandemic, the difficult socio-economic conditions of the Russian Federation, issues related to the implementation, expansion of functional capabilities. food is not only a factor in the formation of state policy in the field of a healthy lifestyle, but also a vital task based on a balanced combination of all biologically active compounds necessary for the functioning of the body, which have certain functional (selective) properties and contribute to the formation of a stable immune system against various damaging internal and external factors.

The main nutritional disorders are:
- high consumption of animal fats containing high density lipoproteins (HDL);
- insufficient intake of dietary fiber;
- hypo- and hyper-, avitaminosis associated with a lack and lack of synergistic interaction;
- lack of macro- and micro-mineral substances.
Based on the foregoing, the development of new types of food products using non-traditional plant raw materials, rich in nutrients necessary for the human body, is a topical direction of the National Technological Initiative of Russian Federation “FoodNet”. Confectionery is a popular product on the Russian market, formulation modeling and the development of new innovative technologies to obtain functional products enriched with physiologically functional ingredients that are necessary for the development of individual nutrition.

2. Materials and methods
We have chosen sports nutrition as a scientific direction: “Sports nutrition (SP)”.

Sports nutrition (SP) is a specialized food product that replenishes the deficiency of missing protein substances, especially in the nutrition of athletes, “... taking into account sports specialization, the phase of the sports cycle, physical condition, adaptive potential state, age-sex characteristics, health status, individual food preferences and individual health characteristics and climatic and geographic conditions...” [2].

According to a study by BusinesStat in the report “Analysis of the sports nutrition market in Russia in 2015–2019, forecast for 2020–2024. “The average selling price of sports nutrition in Russia in 2015-2019 in 2019 amounted to 2040.8 rubles per kg. The economic crisis has led to a weakening of the ruble and an increase in the cost of imported products, a rise in the cost of sports nutrition. are produced by Russian enterprises due to the high dependence of the production process on imported raw materials ...” [3].

“... In 2015-2019, export prices for sports nutrition from Russia increased by 24.0%: from 7.5 to 9.3 dollars per kg. (table 1). According to forecasts, in 2020-2024, the average annual growth rate of prices for the export of sports nutrition from Russia will be 2.0%. ...” [3].

| Parameter                  | 2015 | 2016 | 2017 | 2018 | 2019 |
|----------------------------|------|------|------|------|------|
| Export (USD per kg)        | 7.5  | 7.4  | 8.7  | 8.9  | 9.3  |
| Dynamics (% to the previous year) |  | -1.8 | 17.9 | 2.5  | 4.5  |

Source: Federal Customs Service of the Russian Federation, EurAsEC Customs Union, BusinesStat.

There will be an increase in the export price of sports nutrition products (table 2).

| Parameter                  | 2020 | 2021 | 2022 | 2023 | 2024 |
|----------------------------|------|------|------|------|------|
| Export (USD per kg)        | 9.2  | 9.5  | 9.8  | 10.0 | 10.3 |
| Dynamics (% to the previous year) | -1.1 | 3.2  | 2.9  | 2.6  | 2.4  |

Source: BusinesStat.

The development of the sports nutrition market is based on the main trends in figure 1.
The share of Russian products in the domestic market increased to 60% of the total. Currently, the Russian market for sports nutrition products is promising and continues to grow (according to the World Federation of the Sporting Goods Industry – WFSGI). By 2024, according to the forecast, the supply of sports nutrition in the Russian market will continue to grow by 3.7–5.1% annually and in 2024 will amount to 14.44 thousand tons.

The direction of development of targeted sports products in the world is due to the development of physical culture and sports, as well as the promotion of a healthy lifestyle (HLS). Sports nutrition, originally intended for athletes, in the future will find "...therapeutic and prophylactic use to improve health and improve the quality of life of the population as a whole..." [2].

The increase in the number of diseases associated with unfavorable environmental influences dictates the need for widespread use of biologically active compounds of hepatoprotective, hypoglycemic action, ensuring the protection of organs and systems from damage by various types of external factors.

The sports nutrition market segmentation is divided into several components:

- The main types of joint ventures (table 3);
- Distribution channels;
- Consumers of the joint venture.
- The objects of our research are the development of sports nutrition products based on non-traditional plant raw materials. The use of raw materials grown in the Stavropol and Krasnodar regions will reduce the cost of production.
- From the point of view of a deficiency of contact with proteins, selected from the position of complete essential amino acids of plant origin and other food compounds, the processed product of legumes – lentil powder Lens culinaris, containing complete vegetable protein, with a high absorption capacity (up to 86%), dietary fiber, group B group vitamins, lecithin, minerals.
- As noted by domestic and foreign scientists: L.V. Antipova, A. Grebenshehikov, A.A. Mishchenko, N.A. Osipova “... against the background of the emergence of new artificially

**Figure 1.** Key trends in the joint venture market.
synthesized molecules of biologically active substances, lentil seeds are an actual raw material for obtaining sports nutrition products ...” [4].

**Table 3.** Segmentation of the sports nutrition market by main types of joint venture.

| Protein Powders Containing Protein | Creatine | Powder additives | RTD based proteins | Isotonic dry mixes | Carbohydrate drinks | Protein bars | Energy Bars | Protein-rich cookies |
|-----------------------------------|----------|------------------|--------------------|-------------------|--------------------|--------------|-------------|---------------------|
| The main types of joint venture   |          |                  |                    |                   |                    |              |             |                     |

The purpose of our work was:
- to delve into the depths of scientifically based recipes and technologies for sports nutrition based on lentil powder.
- to acquire lentil protein powder (protein content of 27–36%)
- to obtain on its basis a series of products: cookie-based protein lentil (“L–POWER”)  

The objects of the study were the beans of brown lentil (Lens culinaris), GOST 7066-77 “Food plate lentil” and red lentil, distinguished by their rich chemical composition (table 4) [5].

![Lentils](image)

**Figure 2.** Lentil appearance.

**Table 4.** Nutritional value and chemical composition of lentil.

| Indicators                     | Lentil brown or green, dried | Lentil red |
|-------------------------------|------------------------------|------------|
| Calorie content, kcal         | 297                          | 318        |
| Free moisture content,%       | 10.8                         | 11.1       |
| Proteins, g                   | 24.3                         | 23.8       |
| Lipids, g                     | 1.9                          | 1.3        |
| Carbohydrates, g              | 48.8                         | 56.3       |
| Insoluble dietary fiber, g    | 8.9                          | 4.9        |
| Aminoacid, Tryptophan, mg     | 198                          | 192        |
| K, mg                         | 940                          | 710        |
Lensculinaris is a valuable edible leguminous plant with a monocular, bivalve, flattened or slightly convex, close to rhombic shape, 1–3 seeds, with a beak. Seeds are flat or convex (almost spherical), large or small (diameter 2–9 mm) [3].

The value of the protein is determined by the amino acid composition and the degree of assimilation of the protein, based on the action of the enzyme preparation of the gastrointestinal tract of the human body, table 5.

Table 5. Comparative characteristics of the biological value of proteins.

| Food protein    | Biological value | Digestibility,% |
|-----------------|------------------|-----------------|
| Whey milk protein | 104              | 98              |
| Egg white (whole) | 100              | 100             |
| Egg albumin     | 88               | 95              |
| Casein          | 77               | 87              |
| Lentil protein  | 63               | 8.6             |
| Soy protein     | 74               | 61              |

The advantage of lentils over soybeans is a higher absorption rate. The low digestibility of soy proteins is associated with the presence of a greater number of types of trypsin inhibitors, accounting for 90% of the total amount by weight, which prevents the absorption of vegetable soy protein, the activity of which ranges from 6.67 to 37.68 mg / g.

Figure 3. Inhibitors - compounds that interfere with absorption of soy protein and amino acids [6,7, 8, 9, 10].

- Anti-nutritional soy bean compounds
  - Digestive enzyme inhibitors: soy, lectins, antitrypsin,
  - Steroid glycosides: ginestein, isoflavones, phytates
  - Anti-nutritional carbohydrates: raffinose, stachyose, verbaxose
Studies by foreign and domestic scientists have shown that more than 20% of inhibitors of the nature of soy protein, in particular antitrypsin or (SIT) (Pamirsky, Shtarberg, 2007, Kennedy, 1998), of the thermostable gastrointestinal tract interact with a dissolved enzyme to break down proteins (proteases and etc.), they form stable complexes that impede absorption.

“… The trypsin inhibitor is not digested by gastric pepsin and enters the duodenum in an active form, enters into active interaction with the pancreas trypsin, paralyzing its work by 90-95%. As a result, the digestion of soy proteins stops at the stage of polypeptides, which are not further absorbed ...”.

3. Results and discussion
Considering that lentils also contain inhibitors, we used the technology of exposure to electric discharge, which led to 96% inhibition of anti-nutritional factors in lentils [11].

A special feature is the process of short-term processing in order to inactivate the trypsin inhibitor using an electric discharge [12] of a certain shape and grinding to a powdery state of the composite with a particle size of 400 μm. The results of the experimental decrease in the activity of antitrypsin, determined by the standard method, depending on the number of pulses, are shown in figure 4.

![Graph showing decrease in activity of trypsin inhibitors depending on the number of pulses.](image)

**Figure 4.** Decrease in the activity of trypsin inhibitors depending on the number of pulses.

In the pulse range of about 300 imp/l, the antitrypsin content in the liquid phase of the suspension reached 1.65 mg/ml. And when more than 300 imp/l were injected, antitrypsin was cleaved. Lentil-based cookies were obtained from powder, the seeds of which were pre-treated with electric discharges according to the following scheme, figure 5.
The results experimentally determined by standard methods of changing the physicochemical parameters of the lentil powder before and after processing are presented in Table 6.

| Indicators                                      | Lentil before processing | Lentil after processing |
|------------------------------------------------|--------------------------|-------------------------|
| Moisture,%                                      | 13.9 ± 1.17              | 12.1 ± 0.98             |
| Proteins,%                                      | 25.4 ± 0.16              | 35.6 ± 0.18             |
| Lipids,%                                        | 1.86 ± 1.21              | 1.48 ± 0.8              |
| Polyunsaturated fatty acids, g / 100g           | 0.41 ± 0.19              | 0.71 ± 0.15             |
| Linoleic C<sub>18:2</sub>                       | 0.14 ± 0.12              | 0.07 ± 0.17             |
| Linolenic C<sub>18:3</sub>                      | 0.07 ± 1.13              | 0.056 ± 1.12            |
| Carbohydrates,%                                 | 56.2 ± 2.0               | 46.1 ± 1.02             |
| including starch                                | 38.3 ± 0.81              | 31.5 ± 0.97             |
| reducing sugars                                 | 1.19 ± 1.14              | 5.2 ± 1.13              |
| Odds:                                          |                          |                         |
| Protein digestibility                           | 0.87 ± 1.45              | 0.94 ± 1.12             |
| Protein efficiency                              | 1.22 ± 0.19              | 2.85 ± 1.16             |
| Biological value of protein,%                   | 62.8 ± 1.78              | 71.0 ± 1.17             |
| Energy value, kcal / kJ                         | 329/1362                 | 327/1368                |

The results of the experiment showed that after processing the digestibility (assimilability) and biological value of the protein increase.
4. Conclusion
We analyzed the need to expand the range of sports nutrition products in terms of replacement imports and showed the benefits of developing functional products in this area. The advantage of using non-traditional plant raw materials Lens culinaris in a comparative analysis with Glycine max, widely used in the production of sports nutrition, has been proven. A technology for reducing the content of anti-nutritional compounds in raw materials has been developed, technological parameters for the processing of inactivating anti-nutritional compounds have been determined.

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