

Project name: IRN AP14871765 Development of BIO-AP biologically active additive with the production of micronutrients complex based on plant raw materials for food enrichment

Importance:

Lots of consumers are switching to a healthy lifestyle and begin to include functional foods in their diet. Many well-known companies route their work to the production of proper nutrition products by adding healthy ingredients to products, enriching food. Various dietary supplements also help to increase the awareness of customers about this type of products.

In this regard, food producers of our country and consumers have a need for domestic biologically active additives, the use of which in food products should have the following scientifically substantiated facts:

Their positive impact on human health;

Absence of negative effects on finished products;

Positive effect on the quality and consumer properties of the finished product.

The problem is that there is a low range of food products (meat and dairy products) enriched with biologically active additives (hereinafter dietary supplements) at present days in the Republic of Kazakhstan. There are a few studies on the use of dietary supplements in food production, their impact on finished products. That is why we see insufficient number of implemented into production studies on the development of food technology with useful ingredients, that positively affect human health.

The solution of the problem is the development of a biologically active additive with the production of micronutrient complexes based on plant raw materials for food enrichment.

Aim:

The aim of the project is to develop a biologically active additive BIH-AP with the production of micronutrient complexes made from natural plant raw materials (*Portulaca oleracea*), saskatoon berries (*Amelanchier*), to enrich and improve the effectiveness of healthy food products.

Expected results:

According to the expected results there will be:

- Monitoring and systematization of literary data and patent information on the research topic in the world practice will be carried out.
- The use of *Portulaca oleracea* and saskatoon berries (*Amelanchier*) as raw materials for the production of dietary supplements as a component of functional products will be justified.
- The technology of obtaining BIH-AP biologically active additive from *Portulaca oleracea* and saskatoon berries (*Amelanchier*) in the laboratory will be developed.

- Organoleptic, physico-chemical parameters, as well as safety indicators of dietary supplements from Portulaca (Portulaca oleracea) and saskatoon berries (Amelanchier) will be studied.
- The composition of functional ingredients of dietary supplements from Portulaca (Portulaca oleracea) and saskatoon berries (Amelanchier) will be studied.
- The formulation and technological modes of food production with the addition of biologically active additives will be developed (fermented milk products: yogurt, cottage cheese; meat products: boiled sausage, dietary sausages).
- An assessment of organoleptic and physico-chemical indicators, as well as safety indicators of the developed functional products will be given.
- The calculation of the economic efficiency of the developed biologically active additive (nutraceutical group), capable of competing in its quality indicators with various foreign types of dietary supplements, will be carried out.
- Regulatory and technical documentation of the developed dietary supplements (nutraceuticals group) will be developed and approved (organization standard, technological instructions).
- According to the results of the project implementation during the entire implementation period, at least 3 (three) for articles and (or) reviews in peer-reviewed scientific publications will be published in the Science Citation Index Expanded of the Web of Science database and (or) having a CiteScore percentile in the Scopus database of at least 35 (thirty-five); as well as at least 2 (two) articles or reviews in a peer-reviewed foreign or domestic publication recommended by COXON; 4 manuscript at an international conference.

The results obtained:

The results of the conducted studies have shown that dietary supplements based on purslane have high antioxidant properties that have a positive effect on finished meat products. The results showed that the methanol extract of the garden purslane variety exhibits a strong antioxidant restoring ability: FRAP from 43.5 ± 1.0 mg GAE/g of dry matter. Antioxidants are very important for human health because they reduce the risk of cell damage by free radicals. Studies of antioxidant activity (DPPH) have been conducted. The results were compared with ascorbic acid, there was a good correlation between the radical removal activity of DPPH and TPC ($R^2=0.782$), and, in addition, there was a reasonable correlation between DPPH and TFC ($R^2=0.996$). In addition, it has a balanced fatty acid composition, which has a beneficial effect on finished products. Dietary supplements based on irgi berries used for addition to fermented milk products have a good amino acid composition and flavonoid content. Experimental studies on the development of sausage technology have shown the positive effect of portulaca additives on the color stability of finished products confirming antioxidant activity.

Experimental studies have been conducted on the development of BIO-AP dietary supplement based on purslane. To do this, we used dry portulaca (Portulaca

oleracea), grown for 24 days. Pre-dried in a dehydrator at a temperature of 30C for 2 days. For the study, the stem and leaves were crushed at the same time. At the first stage, iron reduction abilities (FRAP) were studied to study the antioxidant potential of pre-dried *Portulaca oleracea* extracts. The results showed that the methanol extract of the garden purslane variety exhibits a strong antioxidant restoring ability: FRAP from 43.5 ± 1.0 mg GAE/g of dry matter. Antioxidants are very important for human health because they reduce the risk of cell damage by free radicals. Studies of antioxidant activity (DPPH) have been conducted. The results were compared with ascorbic acid, there was a good correlation between the radical removal activity of DPPH and TPC ($R^2=0.782$), and, in addition, there was a reasonable correlation between DPPH and TFC ($R^2=0.996$). Common phenolic compounds (TPC), which are important specialized metabolites, have been identified, so the total phenol content in extracts, expressed in gallic acid equivalents, ranged from 16.49 to 17.27 mg GAE/g. Experimental studies have been conducted on the development of BIO-AP dietary supplement using irgi berries (*Amelanchier*). Irgi berries were dried in a dehydrator, temperature 39C, for 2 days, after which grinding was carried out. The composition of organic acids was determined, as a result of research, citric 390 ± 78 mg /kg, tartaric 140 ± 28 mg / kg, lactic 240 ± 48 mg / kg acids were determined positively affecting both finished products where dietary supplements will be added and the human body. The content of polyphenols, the mass fraction of flavonoids, $0.413 \pm 0.005\%$, polyphenols $0.775 \pm 0.002\%$, tannins $2.63 \pm 0.02\%$, extractives 65.52% were determined, the results show high antioxidant activity. Thus, based on the conducted research on the development of BIO-AP dietary supplement, two formulations have been identified and proposed: 1. Formulation of a dietary supplement based on *Portulaca oleracea*, using portulaca powder; 2. Formulation of a dietary supplement based on irgi berry powder, which will consist of: whey protein concentrate -7%, dry powder of irgi berries -70%, citric acid -1.4%, sodium citrate – 0.5%, sodium bicarbonate -1.1%.

Thus, for addition to sausage products, it is proposed to use a biologically active additive based on purslane and for addition to fermented milk products, the use of a biologically active additive based on irgi berries is proposed. The use of these biologically active additives will positively affect both the nutritional and biological value, as well as the shelf life of finished products.

A study of the physico-chemical properties showed that the total content of flavonoids in a dietary supplement from purslane, expressed in mg of rutin equivalents per g of dry sample, which ranged from 25.36 to 27.3, confirms a good level of antioxidants. Carotenoids of 4.33 ± 0.57 mg/g of dry extract were determined. It is recommended that a healthy diet be enriched with foods with a higher omega-3/omega-6 ratio. In this regard, fatty acids were determined that showed optimal Omega-3 values: Linolenic C18:3 – $26.7 \pm 2.1\%$, Thymnodonic acid C20:5 - $1.2 \pm 0.4\%$, Omega-6 fatty acids: Linoleic C18:2 - $12.8 \pm 2.1\%$, Monounsaturated fatty acids: Erucic C22:1 - $10.6 \pm 2.1\%$, Nervonic C24:1 – $13.5 \pm 2.1\%$, Oleic C18:1 - $7.1 \pm 2.1\%$, Palmitoleic C16:1 - $1.9 \pm 0.4\%$, Saturated Fatty Acids: Palmitic C16:0 - $21.7 \pm 2.1\%$, Stearic C18:0 - $4.5 \pm 0.4\%$. Studies of the

vitamin composition showed good indicators of B1 (0.06 ± 0.01 mg/100g), B2 (0.13 ± 0.05 mg/100g), B3 (0.64 ± 0.13 mg/100g), B5 (0.05 ± 0.01 mg/100g), B6 (0.06 ± 0.02 mg/100g), C (20.06 ± 4.61 mg/100g), A (less than 10.0 mcg/100g), and E (less than 0.1 mg/100g). It is especially worth noting the high content of vitamin C, which also confirms the antioxidant properties of the product. The mineral composition showed significant amounts of trace elements such as potassium (46433.49 ± 7641.54 mg/kg), magnesium (15954.10 ± 3121.71 mg/kg), calcium (7656.16 ± 2663.69 mg/kg), iron (5309.65 ± 1056.76 mg/kg), and selenium (0.907 ± 0.280 mg/kg).

A study of a biologically active additive based on irgi berries with the addition of whey protein concentrate and mountain ash powder showed good amino acid content, in particular: arginine $2.355\pm 0.942\%$, lysine $2.355\pm 0.801\%$, tyrosine $1.009\pm 0.303\%$, phenylalanine $2.086\pm 0.626\%$, leucine+isoleucine $2.624\pm 0.682\%$, valine $2.288\pm 0.915\%$, alanine $1.750\pm 0.455\%$, glycine $1.615\pm 0.549\%$. The content of the above amino acids has a positive effect on the human body and promotes vasodilation, improves blood circulation and strengthens the immune system, which are necessary for energy metabolism, muscle growth and recovery. The analysis of the flavanoid content showed a high content of rutin 1.98 g/100 g, which can contribute to antioxidant protection, strengthen blood vessels and maintain the health of the cardiovascular system. Catechin 4.09 g/100 g is a powerful antioxidant that helps protect cells from oxidative stress, improve overall health and reduce the risk of various diseases. Tannins in terms of tannin 5.73 g/100 g have a beneficial effect on the digestive system, exhibit antibacterial properties and contribute to the overall strengthening of the body. Thus, the developed dietary supplements based on purslane and irgi berries represent a valuable product with a high content of vitamins, minerals and other useful substances that contribute to maintaining health and enriching nutrients in the diet.

To develop the technology of boiled sausages and sausages with the addition of a biologically active additive from purslane, it is proposed to add a dietary supplement in the amount of 1.2% of the total mass of raw materials. Beef and poultry meat serve as meat raw materials. The addition of a biologically active additive is suggested when cutting minced sausage for better distribution among finished products. The conducted organoleptic assessment shows that with an increase in the amount of the additive to 2% of the total mass of raw materials, a bitter taste is present in boiled sausage products, the appearance on the section becomes gray-brown. When adding dietary supplements to sausage products, the amount of vitamin E reaches 0.69 mg/100g. In order to determine the shelf life for 7 days, the dynamics of oxidative processes in finished products was determined. The results showed that the changes in the peroxide number were insignificant and varied within the normal range from 2.1 to 4.3 meq/kg. The indicators of light stability (l-lightness, a-redness and b-yellowness) of the finished sausage products were also determined. The results showed that, before exposure to color l-lightness 63.54 ± 0.4 , a-redness 14.47 ± 0.41 and b-yellowness 12.01 ± 0.37 , after exposure to color l-lightness 62.31 ± 0.4 , a-redness 13.04 ± 0.5 and b-yellowness 13.73 ± 0.4 .

Thus, color stability was 88.75%. The data obtained show that the color characteristics did not decrease significantly, this indicates that the dietary supplement based on purslane has antioxidant properties and prevents oxidative processes of meat products.

To develop the technology of fermented milk products, various dosages of dietary supplements were selected. Dietary supplements based on irgi powder were introduced before fermentation. Cow's milk was used to produce fermented milk products. MicroMilk starter culture was used as a starter. The starter culture was introduced in an amount of 5% of the volume of milk. The organoleptic evaluation showed that the developed products meet the requirements of fermented milk products. The fermentation process for yogurt and cottage cheese was carried out in the laboratory. The fermentation temperature for yogurt was 25-28 C. For cottage cheese 28-32 C .

The process of introducing dietary supplements was carried out in two ways: 1 - before fermentation; 2 - after fermentation. In the yogurt variant, the introduction of dietary supplements before fermentation showed better organoleptic characteristics than the introduction of dietary supplements after fermentation. Yogurt fermented with dietary supplements had a uniform color and a richer taste. Yogurt with the addition of dietary supplements after fermentation had a sour taste and a non-uniform consistency. In the case of cottage cheese, samples with dietary supplements after fermentation had the best organoleptic characteristics. When applying dietary supplements before fermentation in the technology of cottage cheese production, during pressing, a significant amount of dietary supplements passes into curd whey, which worsens the appearance and taste of the finished product.

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Information for potential users:

A technology for the production of biologically active additives with the production of micronutrient complexes based on plant raw materials for food enrichment will be developed. Based on the data obtained, a technology for the production of meat and dairy products with the use of biologically active additives from vegetable raw materials will be developed.