The antioxidant properties mineral processing for specialized food products

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Abstract. The article contains data on the antioxidant properties of fortifiers for the production of specialized food products. Developed and scientifically proven a polycomponent plant food preparation from sugar-reducing plant raw materials, as well as a food additive with high anti-radical activity in comparison with the known analog. The degree of increase in the anti-radical activity of the developed food additive in comparison with the known one is 50.24%. Giving the polycomponent plant food preparation antioxidant properties is achieved due to the presence of functional food ingredients in it, such as vitamins E and C, selenium, manganese, zinc, P-active substances and chromium. The highest content of phenolic substances and flavonoids has a polycomponent plant food preparation freshly processed and after 12 months of storage.

Nowadays, there is a significant increase in the incidence of diabetes. A polycomponent plant food preparation (PPFP) from sugar-reducing plant raw materials used for the enrichment of specialized products for patients with type 2 diabetes was developed and scientifically substantiated. Sugar-reducing medicinal and technical raw materials, as well as food and biologically active additives such as pectin - inulin complex, flavocene (dihydroquercetin), selexene and chromium picolinate were used as ingredients for the concentrator [1-4].

The addition of antioxidant properties to PPFP is achieved by the presence of functional food ingredients such as dietary fiber, vitamins E and C, selenium, manganese, zinc, flavocene, and chromium [2-4]. Due to a thorough analysis, a high content of isoprenoids (fat – soluble vitamins) - tocopherols (alpha, delta, gamma), in the amount of 14.5 mg/100 g of PPFP was found. A prerequisite for the absorption of polyunsaturated fatty acids are tocopherols as natural antioxidants. Excessive intake of polyunsaturated fatty acids without the presence of vitamin E can lead to activation of oxidative degradation of lipids, which occurs under the action of free radicals. PPFP contains three forms of tocopherols, and the daily requirement for vitamin E is met by using 100 g of the fortifier by almost 96.7% [5]. The modes of raw material preparation and the production technology of PPFP allow to preserve the functional ingredients that provide an antioxidant effect as much as possible [6].

The aim of this work is to study the antioxidant properties of freshly processed PPFP (pre-production model №1). As a control, we used a freshly processed collection-powder for concentrator (collection of herbs "Arfazetin-e", Echinacea purpurea (aboveground part), a mixture of six varieties of bean leaves and a mixture of two varieties of flax seeds – in a ratio of 1:1:1:3). Due to the fact that the concentrator is supposed to be introduced into the recipes of food concentrates and a mixture for baking bread, which
provide for heat treatment at a temperature above 100 °C, the freshly processed PPFP was subjected to heat treatment at a temperature of 100 °C for 15 minutes (pre-production model №2), and pre-production model №3 was stored for 12 months.

The following methods were used to analyze the antioxidant parameters of the PPFP: total content of phenolic substances, flavonoids, as well as anti-radical and antioxidant activity. Water-ethanol extracts were obtained from four samples of the collection-powder and PPFP mixture at different raw material ratios: 50% ethanol as 1: 10. The extract is mixed with Folin-Ciocalteu reagent saturated with a solution of sodium carbonate in a ratio of 1:1:2 and the absorption coefficient is measured in the resulting mixture at 725 nm on the KKK-03-01 device.

The study of susceptibility to capture free stable radicals by the DPPH method is used both for evaluating individual phenolic substances and for food systems in general. The experiments were repeated three times, and the data were prepared using mathematical statistics (table 1).

**Table 1.** Results of studies on the antioxidant activity of PPFP.

| Index                                    | Control | pre-production model | % content from the control |
|------------------------------------------|---------|----------------------|---------------------------|
|                                           | №1      | №2       | №3     | №1   | №2   | №3   |
| Total content of phenolic substances, mg of Gallic acid/100 g of feedstock | 320.5   | 1066.0   | 854.0  | 1040.3 | 332.6 | 266.5 | 324.6 |
| Total flavonoid content, mg of catechin/100 g of feedstock      | 122.7   | 373.0    | 368.0  | 370.9  | 303.9 | 299.9 | 302.3 |
| DPPH antiradical activity, E_{50}, mg/ml | 28.4    | 16.7     | 22.2   | 18.8   | -     | -     | -     |
| Antioxidant activity in the linoleic acid system, % inhibition of linoleic acid oxidation | 47.5    | 95.4     | 78.7   | 87.9   | 200.8 | 165.7 | 185.1 |

Based on data on the content of phenolic substances in four samples, in mg of Gallic acid/100g of feedstock—in control (collection-powder) (320.5 mg); in freshly processed PPFP (1066.0); heat-treated PPFP (854.0) and PPFP after 12 months of storage (1040.3).

Based on studies of phenolic substances in sample № 2, conclusions can be drawn about the significant effect of heat treatment on the preservation of the content of phenolic substances.

The literature contains information about the effect of heat treatment on the antioxidant properties of food products subjected to heat treatment. A significant decrease in antioxidant activity was found at a temperature of 120 °C, which the authors explain by the destruction of anthocyanins [2].

Table 1 shows data on changes in the total number of flavonoids, antioxidant activity in the linoleic acid system, and anti-radical activity of freshly processed PPFP subjected to heat treatment at a temperature of 100 °C for 15 minutes and after 12 months of storage. The highest content of phenolic substances and flavonoids has PPFP freshly processed and after storage. As a result of studies of antiradical activity, the highest value was found in pre-production model № 1-16.7 mg / ml and № 3-18.8 mg / ml.

The results of the study of the antioxidant activity in the linoleic acid system show that in the control sample and in connection with the heat treatment of PPFP at this temperature (pre-production model № 2), the activity decreases slightly – by 2 times and 1.5 times, respectively, compared with the freshly processed PPFP.

One of the main indicators that characterize anti-radical activity by the DPPH method is E_{50} - the concentration of the antioxidant extract, at which 50% inhibition of DPPH radicals is observed. The indicator of anti-radical activity is expressed as the concentration of the extract, at which 50% of the radicals in the solution bind, that is, the higher the E_{50} indicator, the lower the anti-radical activity and...
Vice versa. In this case, the antiradical activity in pre-production sample № 1 is $E_{50}$, in mg / ml higher (16.7) than in the control sample (28.4), pre-production sample № 2 (22.2), and pre-production sample № 3 (18.8), since the binding of 50% of free radicals requires a lower concentration of this pre-production sample.

Analyzing the results of research, it can be noted that the content of phenolic substances (1066.0 mg of gallic acid/100 g of feedstock) and flavonoids (373.0 mg of catechin/100 g of feedstock) directly affects the anti-radical and antioxidant activity of PPFP. Despite the increased content of phenolic substances, flavonoids, and vitamin C (40.3 mg/100 g) in the PPFP, the DPPH antiradical activity was lower in the control pre-production model, pre-production models 1 and 3. The antioxidant activity of the freshly processed control pre-production model and the concentrator of the heat-treated concentrator and after 12 months of storage in the linoleic acid system is 47.5%, 95.4%, 78.7% and 87.9%, respectively. It is also possible to note the relationship between the content of P-active substances of flavocene and the ability to prevent lipid oxidation in the plant cell of the main plant raw material PPFP - a mixture of flax seeds. Comparing the results for the determination of phenolic substances, flavonoids, anti-radical and antioxidant activity, the highest values were obtained for the first two indicators, which show the best ability to capture free radicals.

A functional food additive with anti-radical activity used for creating specialized food products has been developed and scientifically substantiated. A functional food additive is prepared as follows. Ground to a powder particle size of 0.2-0.3 mm, dried calamus rhizomes, the meal of milk thistle, dried nettle leaves, dry thyme and mix with selectabase food additive "Selexen" in the mixer in the following ratio of components, kg: powder of rhizomes of calamus – 10 – 25; the powder meal of milk thistle – 15 – 25; the powder of nettle leaves – 15 – 25; food additive "Selexen" – 0.14 – 0.16; powder of cumin seeds – 34.85 – 49.84.

The active substances contained in the rhizomes of calamus, mainly essential oil and bitter glycoside acorin, affect the endings of the taste nerves, increase appetite, improve digestion, reflexively increase the secretion of gastric juice.

Milk thistle meal is a by — product of the production of milk thistle seed oil by cold pressing, containing unique biologically active compounds: polyunsaturated fatty acids omega-6, omega-9; amino acids – isoleucine, tryptophan, lysine; enzymes, saccharides; alkaloids, saponins; chlorophyll, phenols; dihydroquercitin; flavolignan complex: silidiani, silicristin and silybin.

Nettle leaves are used as a hemostatic, blood-purifying, wound-healing, general tonic, multivitamin, antiseptic. The benefits of cumin seeds for the body are provided by the content of more than 100 active substances.

To impart the antioxidant properties of a functional additive, the food additive "Selexen" is introduced into the mass, which contains the vital trace element selenium. In the human body, selenium stimulates metabolic processes, participates in the construction and functioning of the main antioxidant compounds. Selenium is directly involved in the elimination of various toxic substances from the body. Selenium displaces cadmium, thallium, lead, and is an antagonist of mercury and arsenic. it is necessary for many physiological and biochemical functions in the human body. The synergy of selenium and another powerful antioxidant, vitamin E [7, 8, 9, 10, 11].

In the mixer, mix 10 kg of powder from calamus rhizomes, 20 kg of powder from milk Thistle meal, additionally add 20 kg of powder from nettle leaves, 0.16 kg of food additive "Selexen" and 49.84 kg of cumin seed powder. The resulting product is a functional food additive with high anti-radical activity. Antiradical activity was checked by spectrophotometric method with a wavelength of 515 nm.

Antiradical activity of the claimed functional food additive is 92.75 %, compared to the known food additive 42.51 % [12]. The degree of increase in anti-radical activity compared to the known food additive is 50.24 %. The antiradical activity of a functional food additive is 50.24% higher than this indicator for a known additive, which confirms the effective composition of the food additive [13].

Thus, the dietary supplement is functional, as compared to the known one, it has an anti-radical activity – a higher ability to bind free radicals, thereby reducing the risk of cell membrane disruption and aging of the body.
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