Innovative methods to increase the antioxidant properties of fat-containing foods

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Abstract. The article provides information about domestic innovative developments aimed at improving the antioxidant properties of food products through the use of plant raw materials rich in active substances. The results of a comparative analysis of the antioxidant activity of water and alcohol extracts of certain types of plant raw materials are presented to substantiate the possibility of using it as fortifiers in food technologies to improve quality and preservation. Black chokeberry and mountain ash have high antioxidant properties, while cumin seeds and ginseng root have lower antioxidant properties. However, it is noted that alcohol extraction generally reduces the extraction of biologically active substances with antioxidant properties.

Innovative food technologies are aimed at creating products with increased nutritional value, preservation and competitiveness. Content analysis of innovative technologies of some food products has shown that a huge number of developments have been patented where non-traditional food sources rich in biologically active substances are used as ingredients. So, for example, in cheese-making for the enrichment of processed cheese, processed products of grain, fruits and vegetables, wild plants, seafood, by-products of milk processing and others are used [1].

Domestic and foreign scientists are studying the antioxidant properties of plant materials in order to assess the possibility of using them in food technologies to slow down oxidative processes and increase the preservation of products.

Low molecular weight antioxidants of traditional plant species (dill, pepper, spices) [2-4], as well as medicinal plants, buds and leaves of some tree species and shrubs [5, 6] were studied using chromatographic methods.

Oxidative processes in fat-containing foods are especially significant. Unsaturated fatty acids, lipoproteins and vitamins form compounds of a peroxide nature in the product which, as a result of complex chemical reactions (intermediate and final products of fat oxidation), are subject to oxidation in products.
The increased formation of free radicals or a decrease in the activity of the antioxidant system in the human body causes antioxidant deficiency. This causes an increase in the level of lipid peroxidation, leading to various pathological conditions and diseases [7]. The mechanism that prevents the onset of deficiency is a substance that is part of food, which can increase a person’s lifespan. An increase in free radicals in the cells of the body reduces the antioxidant defense, while free radicals oxidize the walls of blood vessels, protein molecules, DNA and lipids.

Antioxidants prevent the initiation of oxidative chains. Plant materials may contain several antioxidants of various chemical natures. Some antioxidants of plant materials have a synergistic effect, that is, they increase the effect of their action. The mechanism of synergism lies in the fact that some substances are able to inhibit the formation of free hydrocarbon radicals, saturating them. Other substances are able to destroy hydroperoxides. The effectiveness of antioxidants is reduced by elevated temperature and sunlight. The effectiveness of antioxidants may depend on the pH of the environment and the concentration of antioxidants. In industry, food additives, queretecin or dihydroqueretecin, are most often used as the concentration of antioxidants.

Innovative developments that increase the antioxidant properties of food products were proposed by scientists of the Kuban State Technological University, who studied bark extract from the Birch tree and proved that the active ingredient of the extract is triterpene alcohol - betulin, which has high antioxidant activity, increasing the shelf life of processed cheese [8].

In fat-containing products (mayonnaise, cheeses), it is proposed to introduce up to 0.1% by weight of oleoresins obtained from spices. Their antioxidant properties have been proven. A composite mixture of vegetable raw materials for processed cheese has been developed. This mixture has high antioxidant properties, which includes pumpkin seeds, milk thistle meal, calamus root, spirulina [9].

The aim of the research is a comparative analysis of the antioxidant activity of aqueous and alcoholic extracts of plant raw materials to substantiate the possibility of using it as fortifiers in food technologies to improve quality and preservation. The research was carried out in the laboratory of biochemistry of the All-Russian Institute of Selection and Technology of Horticulture and Nursery in 2020.

The total antioxidant activity of aqueous and alcoholic extracts (carbinol) was determined on a Helios Y spectrophotometer by the DPPH method in accordance with the official method of analysis [11].

The method is based on the interaction of antioxidant substances with a stable chromogen radical 2,2 - diphenyl-1-picrylhydrazyl, which has a blue-violet colour on a Helios Y spectrophotometer in the visible region of the spectrum (λ = 517 nm). In the course of the reaction (interaction of DPPH with water and alcohol extracts of the fruit), the colour changes to a faint purple or yellow. This is due to the addition of a hydrogen proton to the DPPH molecule to form DPPH-H. A 0.0025% DPPH solution was used as a background solution. The experiments were repeated three times, the experimental data were processed using the methods of mathematical statistics.

Antioxidant activity is calculated as a relative value and is determined by the ratio of extinction at a certain reaction time (10 minutes). Calculating the % inhibition of DPPH– radical by carbinol and aqueous solutions according to the formula:

\[ A = \frac{A_0 - A_{10}}{A_0} \times 100, \]

where \( A_0 \) is the optical density of the radical solution;
\( A_{10} \) is the optical density of the solution of the radical with the sample after 10 minutes.

The objects of the study were: fruits of black chokeberry, mountain ash, cumin seeds, ginseng root, chia seeds.

The research results are shown in table 1.
The results of the research showed that after water extraction the fruits of black chokeberry have the highest antioxidant activity - up to 77.03% inhibition of DPPH. Mountain ash had antioxidant activity of 69.04%. More than twice the antioxidant activity was found in the chia seeds. Ginseng root and cumin seeds have antioxidant activity of over 40%. When substantiating the antioxidant properties of plant materials, special attention is paid to phenolic compounds. Cumin seeds are a rich source of polyphenols. Moreover, mountain ash is also a powerful antioxidant due to its carotenoid content. Similar results of antioxidant activity were obtained when objects were extracted with alcohol. At the same time, it was noted that alcohol extraction generally reduces the extraction of biologically active substances with antioxidant properties. So, in the black chokeberry, the antioxidant activity is 55.88% compared to water, in the fruits of mountain ash - 39.19%, etc.

The highest antioxidant activity was found in aqueous extracts of black chokeberry (77.03%) and mountain ash (69.04%). Water extraction increases the antioxidant activity in all types of raw materials and is the highest in cumin seeds (81.74%) and black chokeberry (72.54%), the minimum is ginseng root (50.27%). With alcoholic extraction, the antioxidant activity is lower than in water, from 8.4% in cumin seeds and 29.85% in mountain ash. The investigated samples of plant raw materials, due to their high antioxidant activity, can be used separately or in the form of a mixture of ingredients in fat-containing products to increase antioxidant properties and preservation.

### Table 1. Antioxidant activity, % DPPH inhibition.

| Sample            | \( A_0 \) | \( A_{\text{water}} \) | \( \text{AOA}_{\text{water}} \) | \( A_0 \) | \( A_{\text{alcoholic}} \) | \( \text{AOA}_{\text{alcoholic}} \) | \( \text{AOA from water} \) |
|-------------------|-----------|-------------------------|-------------------------------|-----------|---------------------------|-------------------------------|-------------------------------|
| black chokeberry  | 0.775     | 0.178                   | 77.03                         | 0.775     | 0.336                     | 55.88                         | 72.54                         |
| mountain ash      | 0.824     | 0.247                   | 69.04                         | 0.790     | 0.480                     | 39.19                         | 56.76                         |
| cumin seeds       | 0.764     | 0.413                   | 46.01                         | 0.773     | 0.479                     | 37.61                         | 81.74                         |
| ginseng root      | 0.760     | 0.591                   | 29.92                         | 0.773     | 0.656                     | 15.04                         | 50.27                         |

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