A comparative study of the chemical composition and antioxidant value of fruits and vegetables

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Abstract. Natural sources of antioxidants are plant materials, which include dietary fiber, oligosaccharides, vitamins, and minerals. Fruits and vegetables are the main natural sources of dietary fiber, vitamins, macro- and microelements and one of the popular ingredients for creating functional products that have a regulatory effect on many body systems and the body as a whole. The article examines the biochemical characteristics of fresh fruits and vegetables in order to highlight the most promising ones for bakeries. As a result of a comprehensive assessment of the biochemical characteristics of fresh fruits and vegetables, the most promising ones for baking were identified.

1. Introduction

The health of a modern person directly depends on his lifestyle and nutrition. Long studies at the Research Institute of Nutrition of the Russian Academy of Medical Sciences and other scientific institutions indicate a large deficiency of antioxidants, dietary fiber, vitamins, macro- and microelements, polyunsaturated fatty acids and other substances in the human diet that are necessary for our body, including due to insufficient consumption of fruits, vegetables and products of their processing [1, 2].

The most important way to create products that provide a healthy diet is to fortify basic foods with missing physiologically functional ingredients. The development of technologies for the production of new functional food products based on natural raw materials is currently one of the most important directions in the development of the food industry and public catering in the 21st century, which requires an immediate solution [3-5].

Fruit and vegetable raw materials are a plant basis of unique biological significance and usefulness for creating functional food products. The importance of plant products in nutrition is great, since they are a rich source of a number of nutrients necessary for the body, the intake of which cannot be provided only from animal products [4-7].

Antioxidants in fruits and vegetables are represented by biologically active substances (vitamins, macro- and microelements, phytoncides). Ingredients containing high values of ascorbic acid, carotenoids, and P-active substances are of the greatest interest for the enrichment of functional products with antioxidants. Local fruits and vegetables are promising natural sources of antioxidants: garden strawberries, sea buckthorn, currants, apples, raspberries, mountain ash, wild rose, hawthorn, sweet pepper, broccoli [5-8].

To highlight the most promising ingredients for enriching functional rye-wheat bread with antioxidants, we studied the biochemical characteristics of fresh fruits and vegetables.
The purpose of the work is to give a comparative assessment of the biological value of fruits and vegetables growing in the Tambov region.

The objects of research are the fruits of sweet peppers of the Kolobok variety, inflorescences of broccoli of the Vitaminnaya variety, the fruits of strawberries Zephyr, the fruits of the sea buckthorn of the Lyubimaya variety, Zelenaya Dymka currant, the Bogatyr apples, the Gusar raspberries, the Titan rowan fruits, rosehip fruits of Vitaminniy variety, hawthorn fruits of Michurinsky Dessertniy variety.

2. Materials and methods
The study of the biochemical characteristics of fruits and vegetables was carried out in 2016-2020 in the educational and research laboratory of functional food products.

Ascorbic acid was determined by the iodometric method according to GOST 24556, carotenoids were determined according to the method of I.K. Murri. P-active substances—flavonols and catechins—were determined by the colorimetric method modified by L.I. Vigorov using a KFK-2 photoelectric colorimeter, anthocyanins were determined according to the method of the Nikitsky Botanical Garden.

Antioxidant value was determined by quercetin (method of JSC “Khimavtomatika”, 2007) using a Tsvet Yauza-01-AA liquid chromatograph according to the calibration graph; quercetin was used as a standard. Sample preparation was carried out by grinding, obtaining an extract in water, and filtration. The study of the extract was carried out for each of three parallel samples in 3 consecutive measurements of the output signal [9-12].

3. Results of research on the chemical composition and antioxidant value of fruits and vegetables
Antioxidants in fruits and vegetables are represented by biologically active substances (vitamins, macro- and microelements, phytoncides). Of greatest interest for the enrichment of functional products are ingredients containing high values of ascorbic acid, carotenoids, P-active substances, dietary fiber, organic acids. Fresh samples of plant raw materials were evaluated according to the main indicators of nutritional value and the content of antioxidants (Table 1).

| Name of samples of fresh fruits and vegetables | Vitamin C [mg%] | Carotenoids [mg%] | P-active [mg%] | AOA [mg/100 g of quercetin] |
|---------------------------------------------|-----------------|------------------|--------------|-----------------------------|
| Garden strawberry, Zephyr                    | 22.8            | 1.6              | 167.0        | 184.5                       |
| Sea buckthorn, Lyubimaya                     | 78.8            | 4.9              | 211.0        | 259.0                       |
| Currant, Zelenaya Dymka                      | 33.8            | 0.8              | 118.0        | 233.0                       |
| Apples, Bogatyr                              | 31.5            | 2.0              | 186.0        | 196.0                       |
| Raspberry, Gusar                             | 21.8            | 1.7              | 188.0        | 292.5                       |
| Rowan ordinary, Titan                        | 33.0            | 1.6              | 612.0        | 588.0                       |
| Rosehip, Vitaminniy                          | 1250.0          | 44.0             | 445.0        | 1550.0                      |
| Hawthorn, Michurinsky Dessertniy             | 122.0           | 16.0             | 188.0        | 544.0                       |
| Sweet pepper, Kolobok                        | 112.0           | 10.0             | 105.0        | 273.0                       |
| Broccoli, Vitaminnaya                        | 78.0            | 12.0             | 118.0        | 255.0                       |

The most promising in terms of the content of antioxidants and biologically active substances are samples of vegetables: sweet peppers, broccoli, fruits: sea buckthorn, raspberries, mountain ash, wild rose, hawthorn.
Pectin is a non-digestible dietary fiber capable of forming a gel-forming mass that collects toxic substances from the intestinal walls and removes them from the body naturally. Pectin substances belong to the group of polysaccharides. They are found in large quantities in fruits and plant stems as insoluble protopectin.

When fruits ripen and are stored, protopectin transforms into soluble forms, thus improving the taste of the fruit. Soluble pectins are present in plant juices. The use of products containing pectin normalizes metabolism by normalizing intestinal motility. The uniqueness of pectin lies in its ability to maintain the bacteriological balance of the human body. Table 2 shows data on the content of pectin substances in the samples under study.

**Table 2. Mass fraction of PS (pectin substances and fiber) in the investigated fruits and vegetables**

| Name of samples of fresh fruits and vegetables | Total PS Mass fraction of PS [%] |  |
|-----------------------------------------------|---------------------------------|--|
|                                               | Total PS | fiber | soluble pectin | insoluble pectin | total pectin | starch |
| Garden strawberry, Zephyr                      | 2.3      | 0.9   | 0.7            | 0.6              | 1.3          | 0.1    |
| Sea buckthorn, Lyubimaya                       | 2.4      | 1.0   | 0.5            | 0.4              | 0.9          | 0.1    |
| Currant, Zelenaya Dymka                        | 1.8      | 0.9   | 0.4            | 0.4              | 0.8          | 0.1    |
| Apples, Bogaty                                 | 1.2      | 0.8   | 0.3            | 0.1              | 0.4          | -      |
| Raspberry, Gusar                               | 1.5      | 0.7   | 0.5            | 0.3              | 0.8          | 0.1    |
| Rowan ordinary, Titan                          | 2.3      | 1.1   | 0.5            | 0.5              | 1.0          | 0.2    |
| Rosehip, Vitaminniy                            | 1.9      | 0.6   | 0.8            | 0.4              | 1.2          | 0.1    |
| Hawthorn, Michurinsky Dessertniy               | 2.3      | 1.6   | 0.4            | 0.2              | 0.6          | 0.1    |
| Sweet pepper, Kolobok                          | 11.2     | 7.6   | 2.4            | 0.8              | 3.2          | 0.2    |
| Broccoli, Vitaminnay                           | 1.5      | 0.7   | 0.4            | 0.3              | 0.7          | 0.1    |

The study of the biochemical composition of the studied samples of plant raw materials testifies to the high nutritional properties of fruits and vegetables. Thus, they are a source of various biologically active substances, especially vitamins, due to which 10-30% of the daily requirement can be satisfied, which makes it possible to consider them functional and most suitable for bread enrichment.

**4. Conclusion**

Of greatest interest for the fortification of functional bread are ingredients containing high values of ascorbic acid, carotenoids and antioxidant value. Our studies have shown that the most promising in terms of a set of biochemical characteristics for use in baking are the following plant objects: fruits of Titan mountain ash, Vitaminniy rose hips, Kolobok sweet pepper, inflorescences of Vitaminnaya broccoli cabbage.
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