Leaves of non-traditional crops in the production of food for a healthy diet

E I Popova¹, K V Bryksina¹, N V Khromov², A Yu Medelyaeva¹, Yu V Trunov¹

¹Michurinsk State Agrarian University, Internationalnaya str., 101, Michurinsk, 393760, Russia
²I.V. Michurin Federal Research Centre, Michurina str., 30, Michurinsk, 393774, Russia

E-mail: nitl@mgau.ru

Abstract. In the course of the study, it was determined that the chemical composition and nutritional value of the Viburnum vulgaris is explained by a group of substances of different nature. Their qualitative and quantitative component depends, first of all, on the growing region. The national economic value of viburnum is great—from culinary delights to medicines. The article presents the biochemical composition of the leaves of the viburnum of various varieties, which indicates the possibility of using viburnum leaves in the production of food, including a functional orientation.

1. Introduction

The production of healthy food is aimed at maintaining the natural physiological protective processes in the human body and is characterized by significant economic efficiency of production with the correct organization of marketing and advertising research [1].

Studies [2-5] have shown that the effectiveness of the use of functional food products largely depends on the feedstock and production technology.

Fruit raw materials are a source of easily digestible sugars, organic acids, mineral salts, vitamins and other biologically active substances necessary for normal human life.

Fruits are characterized not only by high nutritional qualities, but also by therapeutic and prophylactic properties, which allows them to be used in the production of functional products. It is impossible not to mention the value of the leaves of these crops, which, in terms of biochemical composition, not only are not inferior to fruits, but even surpass them in some indicators, which also indicates the need for their use in obtaining products for healthy nutrition [5].

Viburnum opulus L. is a powerful shrub or small tree, 4-5 meters high with a wide crown. The culture is undemanding to growing conditions, resistant to diseases and pests, frost-resistant.

The fruits of Viburnum vulgaris are well known to contain a number of biologically active substances, thanks to which they are a highly valuable raw material for food production, for obtaining healthy and functional food, as well as for therapeutic and prophylactic purposes.

In addition to fruits, the viburnum bark has also found application, especially in medicine and pharmaceuticals. It should be noted that viburnum leaves, in terms of biochemical composition, can be no less valuable raw material, due to the content of such organic substances as sugars, ascorbic acid, pectin substances, alkaloids, tannins, phenol carboxylic acids, higher fatty acids, etc.
So, in the leaves of Viburnum vulgaris contains up to 75 mg% of ascorbic acid, up to 5.5% of sugars, up to 1.2% of acids. The quantitative content of biologically active substances can change during the period of plant growth and development [3-6].

The most popular and widespread varieties of Viburnum vulgaris in the Central Black Earth Region include: Krasnaya Grozd, Eliksir, Krasny Korall, Michurinskaya Rannaya, Granatovy Braslet, Zarnitsa, Vigorovskaya, Zholobovskaya, Souzga, Taoyzhnye Rubiny, Ulgen, Shukshinskaya. All of them differ from each other in botanical characteristics, in the content of biologically active substances, as well as in purpose [7-9].

The aim of the work is to give a comparative assessment of the nutritional and biochemical value of the leaves of six varieties of Viburnum vulgaris grown in the conditions of the Tambov region, with the aim of using them in the production of food products of a functional orientation.

2. Materials and methods
The cultivar study of the common viburnum was carried out from 2011 to 2018 in the department of berry crops at the Federal Research Center named after I.V. Michurin in the city of Michurinsk, Tambov region and on the basis of the complex scientific testing laboratory of agricultural and food products of the Center for Collective Use of Michurinsky State Agrarian University “Selection of agricultural crops and technologies for the production, storage and processing of food for functional and therapeutic purposes.”

The objects of research were the leaves of 6 varieties of Viburnum vulgaris: Kievskaya Sadovaya, Zarnitsa, Granatovy Braslet, Taoyzhnye Rubiny, Ulgen, Krasny Korall. The variety Krasny Korall acted as the control option.

The content of ascorbic acid, P-active substances, and the total amount of antioxidants were determined in the leaves according to generally accepted methods. The content of ascorbic acid was determined according to GOST 7047-66 by iodometric titration, the content of P-active compounds was determined by the spectrophotometric method of Vigorov and Tribunskaya, the content of antioxidants was determined by the amperometric method using the TsvetYauza-01 detector.

3. Results and discussions
Table 1 shows the data on the content of ascorbic acid in the leaves of the guelder-rose of the studied varieties.

Leaves, like fruit and berry products, are the main source of various biologically active substances, especially vitamins, which are not synthesized by the human body, but come only with food.

A special role belongs to vitamin C, which is required for the passage of a number of redox processes in all living cells.

| Table 1. Mass fraction of soluble solids in the leaves of Viburnum vulgaris |
|---------------------------------------------------------------|
| Investigated varieties | Mass fraction of soluble solids [mg%] | X, mg% |
|------------------------|-------------------------------------|--------|
| Granatovy Braslet      | 2016 29.5 2017 28.2 2018 24.3       |        |
| Taoyzhnye Rubiny       | 16.4 24.6 18.7 19.9                 |        |
| Kievskaya Sadovaya     | 19.3 26.0 20.9 22.1                 |        |
| Ulgen                  | 16.6 27.2 25.7 23.2                 |        |
| Zarnitsa               | 15.6 26.7 27.4 23.2                 |        |
| Krasny Korall          | 16.4 26.8 24.8 22.7                 |        |

In terms of the content of soluble solids during the study period, the leaves of the varieties Granatovy Braslet, Ulgen, Zarnitsa are distinguished with an average value of 23.2%. In the control variant, the average content of soluble dry substances was 24.3%.

According to the data obtained, the content of ascorbic acid in the leaves of Viburnum vulgaris varied from 349.4 to 398.0 mg%. The leader in the content of vitamin C in viburnum leaves is the
Granatovy Braslet (control) variety, followed by the leaves of the Kievskaya Sadovaya variety. These are quite high rates in comparison with the daily requirement for this vitamin.

Leaves are also a source of phenolic compounds, which are represented by anthocyanins, flavonols, catechins. As you know, P-active compounds strengthen the walls of blood vessels, prevent capillary fragility, normalize lymph flow, increase the number of leukocytes in the blood, enhance the effect of treating malignant tumors, etc.

### Table 2. Content of ascorbic acid in the leaves of Viburnum vulgaris

| Investigated varieties       | Mass fraction of vitamin C, mg% | X, mg% |
|-----------------------------|---------------------------------|--------|
|                             | 2016                            | 2017   | 2018   |
| Granatovy Braslet           | 523.9                           | 332.6  | 337.5  |
| Taoyzhnye Rubiny            | 480.1                           | 343.1  | 320.2  |
| Kievskaya Sadovaya          | 451.2                           | 366.4  | 343.5  |
| Ulgen                       | 379.7                           | 370.8  | 341.3  |
| Zarnitsa                    | 362.6                           | 378.4  | 341.1  |
| Krasy Korall                | 446.8                           | 312.2  | 289.2  |
| LSD05                       | 0.4                             | 3.5    | 0.2    |

Table 3 presents data on the content of P-active compounds in the leaves of Viburnum vulgaris.

### Table 3. Content of p-active compounds in the leaves of viburnum

| Investigated varieties       | Content of p-active compounds, mg% | X, mg% |
|-----------------------------|-----------------------------------|--------|
|                             | 2016                              | 2017   | 2018   |
| Granatovy Braslet           | 199.3                             | 939.0  | 833.5  | 657.3  |
| Taoyzhnye Rubiny            | 276.4                             | 1084.0 | 984.0  | 781.5  |
| Kievskaya Sadovaya          | 289.5                             | 1152.6 | 865.8  | 769.3  |
| Ulgen                       | 294.8                             | 1143.4 | 812.5  | 750.2  |
| Zarnitsa                    | 174.0                             | 635.2  | 804.7  | 538.0  |
| Krasy Korall                | 269.3                             | 1190.0 | 860.5  | 773.3  |
| LSD05                       | 0.7                               | 0.8    | 0.6    | -      |

The data obtained showed that their amount varies from 528.0 mg% (Zarnitsa) to 781.5 mg% (Krasny Korall). A change in the content of P-active substances was also noted within the variety by years, which is associated with the weather conditions of the year. The content of P-active compounds in viburnum leaves indicates a high biological and antioxidant value.

### Table 4. Content of antioxidants in the leaves of Viburnum vulgaris

| Investigated varieties       | Content of antioxidants, mg% | X, mg% |
|-----------------------------|-----------------------------|--------|
|                             | 2016                        | 2017   | 2018   |
| Granatovy Braslet           | 865.6                       | 962.3  | 863.5  | 897.1  |
| Taoyzhnye Rubiny            | 837.7                       | 983.0  | 890.4  | 903.7  |
| Kievskaya Sadovaya          | 781.8                       | 828.6  | 793.6  | 801.3  |
| Ulgen                       | 904.2                       | 1001.5 | 893.8  | 933.2  |
| Zarnitsa                    | 812.8                       | 1105.3 | 912.0  | 943.4  |
| Krasy Korall                | 740.5                       | 934.8  | 738.0  | 804.4  |
| LSD05                       | 0.2                         | 0.2    | 0.8    | -      |

The antioxidant value of Viburnum vulgaris leaves is at the levels from 801.3 mg% (Kievskaya Sadovaya) to 943.4 mg% (Zarnitsa).
The high content of ascorbic acid, P-active compounds and antioxidants providing the daily requirement for them by 50 percent or more confirm the functional properties of the leaves of *Viburnum vulgaris*.

The study of the dynamics of the accumulation of biologically active substances in the leaves of *Viburnum vulgaris* by months during the growing season showed that the ability to accumulate ascorbic acid in the leaves showed a stable tendency to increase from May to August of each studied year. Weather conditions are the determining factor in the accumulation of ascorbic acid in the leaves. In 2016, the highest amount of ascorbic acid was noted in the leaves of viburnum, which is explained by the cold summer, high rainfall and cloudy days.

The dynamics of the accumulation of P-active compounds in the leaves of *Viburnum vulgaris* from May to September (the growing season of the plant) revealed a tendency for a quantitative increase in anthocyanins by the time of picking viburnum berries and an increase in flavonols followed by their decrease and a decrease in catechins by the end of the growing season of the viburnum.

4. Conclusion
The results of studies of the biochemical composition of leaves of *Viburnum vulgaris* of various varieties showed:
- the leader in the content of vitamin C are the leaves of the varieties Granatovy Braslet, Kievskaya Sadovaya, Taoyzhnye Rubiny;
- the leader in the content of P-active compounds are leaves of varieties Taoyzhnye Rubiny, Krasny Korall, Kievskaya Sadovaya;
- the varieties Zarnitsa, Ulgen, Taoyzhnye Rubiny were distinguished by their antioxidant value.

These data confirm that not only fruits, berries and products of their processing are a source of valuable biologically active substances.

Due to the contained nutrients and biologically active substances, the leaves of all studied varieties of *Viburnum vulgaris* represent no less valuable raw material for the production of functional food products and ingredients for enrichment (powder, extract, fruit tea).

Acknowledgments
The work was carried out using the scientific equipment of the Center for Collective Use “Selection of agricultural crops and technologies for the production, storage and processing of functional and therapeutic-prophylactic products.”

References
[1] Blinnikova O M, Babushkin V A, Akindinov V V,Perfilova O V, Novikova I M 2020 Production technology and mathematical method for modeling the formulation of fruit and jelly candies enriched with collagen *IOP Conference Series: Materials Science and Engineering* **919**(5) 052036
[2] Vinnitskaya V F, Popova E I 2012 Nutritional value of viburnum fruits and leaves and prospects for their use in the production of functional products *Bulletin of the State Agrarian University* **1** 223-225
[3] Popova E I, Khromov N V, Vinnitskaya V F 2012 Biochemical evaluation of guelder-rose varieties and prospects of its use in the production of functional food products *Scientific Bulletin of the Belgorod State Agrarian University* **21-1** 127-131
[4] Popova E I 2013 New types of viburnum products for functional nutrition *Bulletin of Michurinsk State Agrarian University* **1-1** 66-71
[5] Khromov N V 2015 Kalina is a beauty *Science and Life* **2** 129-133
[6] Vinnitskaya V F, Akishin D V, Perfilova O V, Danilin S I 2017 Assessment of the functional properties of little-used local plant materials and products of its processing *Bulletin of Michurinsk State Agrarian University* **3** 112-118
[7] Zhidekhina T V, Koveshnikova E Yu, Bryksin D M, Khromov N V 2016 Major achievements in breeding and variety study of berry and non-traditional crops at VNIIS n.a. I.V. Michurin Gardening and viticulture 12-19 (Moscow)

[8] Vetrov M Yu, Akishin D V, Akimov M Yu, Vinnitskaya V F 2016 Expansion of the range of anthocyanin food colorants from unconventional vegetal primary products Nutrition Issues 85(5) 108-113

[9] Babushkin V A, Perfilova O V, Vinnitskaya V F, Danilin S I 2015 Expansion of food products range for functional and prophylactic nutrition with usage of fruits and vegetables of Tambov region Ecology, Environment and Conservation 21 AS29-AS36