Lipid composition of viburnum and barberry fruits

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Abstract. The objects of the study were the fruits of viburnum vulgaris (Viburnum opulus L) and barberry (Berberis vulgaris). Powders were obtained from fresh viburnum and barberry fruits by convective drying. The lipid complex of powders from viburnum and barberry fruits was studied. The total content of lipids in barberry powder was determined to be 7.6%, and in viburnum powder – 7.1%. The group composition of lipids of powders, which is represented by neutral and polar lipids, was examined. The main part of lipids is triglycerides. Unsaturated fatty acids (LC) predominate in the composition of lipids of powders. Barberry powder contains essential fatty acids, such as linoleic – 35.54% and linolenic – 35.60%, which indicates a high biological efficiency of barberry lipids, viburnum powder has 46.56 % of oleic acid and 46.14 % of linoleic acid. The fractional composition of sterols of viburnum and barberry powders was studied. It was revealed that the fractional composition of viburnum powder sterols contains more fractions than the sterols of barberry powder.7 fractions were identified in the composition of viburnum powder sterols: campesterol, beta-sitosterol, beta-amyrin, stigmasta-5.24(25) - dien-3-ol, alpha-amyrin, cycloartenol, citrostadienol. The predominant fractions are alpha-amyrin, beta-amyrin, and beta-sitosterol. 3 fractions were identified in the composition of barberry powder sterols: campesterol, beta-sitosterol, delta-5-avenasterol, the main fraction is beta-sitosterol.

1. Introduction

The nutrition of the Russian population is mainly unbalanced due to the lack of certain nutrients and unstable trace element composition. There is a deficit of essential fatty acids, dietary fiber, minerals, including calcium, iron, selenium, etc., vitamins A, B1, B2, C, and flavonoids. One of the ways to solve this issue is to add environmentally safe non-traditional raw materials of plant origin in food production, the use of which will enrich trace element composition with vital nutrients. It is possible to expand the range of products with raw materials of plant origin in the recipes of traditional food products made from fruit and berry raw materials that contain a complex of valuable biologically active substances.

The flora of Russia is represented by a variety of wild fruit and berry plants that are environmentally friendly in comparison to cultivated crops that contain chemical elements or fertilizers. Considering this information, it might be stated that the creation of comprehensive technologies for processing wild fruit and berry raw materials in order to extract vital nutrients and add them to healthy food products is an important direction that can help to solve the problem of the unbalanced structure of nutrition [1, 2]. The study of wild plant elements is currently being conducted.
profoundly for researchers to develop scientifically based recommendations on their usage [3, 4]. The technology of processing fruits and berries should aim to maximize the preservation of biologically active substances. Since the harvest of wild fruits and berries is seasonal, the production of powdered products has been widely utilized to ensure the conditions for fruits’ storage and transportation are optimal. The use of powdered products in the manufacturing of various food products makes it possible to intensify technological processes and enrich products with macro- and micronutrients [5, 6, 7].

Among the non-traditional sources of raw materials for food production that grow in different regions, the fruits of viburnum and barberry are promising because the harvesting of these fruits is possible on a significant economy of scale.

Viburnum is a genus of wild and ornamental fruit shrubs and trees in the honeysuckle family (Caprifoliaceae) that has about 200 species. Viburnum opulus L. species is the most common type of viburnum in the central part of the Russian Federation.

Barberry is a genus of evergreen shrubs or trees in the barberry family (Berberidaceae), consisting of 580 species of plants. Barberry grows across Europe, North America, Persia, Central Asia, and Kazakhstan. In Russia, the most common barberry (Berberis vulgaris) mainly grows in the forest-steppe zone of the country and the North Caucasus.

Viburnum and barberry fruits are used both in a raw form and in the form of processed products (pastilles, marmalade, compotes, as seasonings for meat dishes, liqueurs, in culinary products). Their fruits are widely used in traditional and herbal medicine. Viburnum and barberry fruits have a significant content of micronutrients and functional food ingredients in their composition, such as dietary fibers, vitamins, flavonoids, organic acids, minerals, and others. Therefore, they gained such widespread usage options.

When evaluating the biological value of raw materials, researchers pay much attention to the study of sterols that are precursors of vitamin D and exhibit anticarcinogenic properties [8]. Plant lipids include phytosterols (plant sterols), derivatives of hydroxylated polycyclic isoprenoids that have the same cyclic structural basis as cholesterol and differ in the structure of ring chains, which significantly change phytosterols’ biological function. There are more than 40 types of sterols involved in the construction and stabilization of cell membranes in plants with a wide range of biological activity. The physiological role of phytosterols in the human body is to reduce blood cholesterol levels by inhibiting the absorption of exogenous and endogenous cholesterol in the intestines, thereby reducing the risk of cardiovascular diseases [9].

Phytosterols exhibit anticarcinogenic properties due to changes in the metabolism of acidic and neutral steroids. Due to the similarity of the chemical structure, phytosterols can replace cholesterol in the micelles formed during the absorption of fats in the intestines. The inclusion of phytosterols or phytostanols in food consumption in an amount of 1-3 grams per day helps to reduce the cholesterol level of low-density lipoprotein fractions by 10-20%.

Despite the fact that substantial attention is currently paid to the study of wild plant elements, their chemical composition and technological features remain insufficiently investigated in relation to barberry and viburnum. There is limited data on the content of lipids in the fruits of viburnum and barberry, as well as insufficient data on the structure of lipids and the composition of phytosterols [10, 11].

The purpose of this research was to determine the total lipid content of viburnum and barberry fruits powders and to examine the collective, fatty acid composition of lipids and the fractional composition of sterols.

2. Materials and methodology
Researchers used wild fruits of viburnum vulgaris, collected in the Moscow region in 2018 and the fruits of wild barberry, collected in Uzbekistan in 2018.

Freshly harvested viburnum and barberry fruits were dried convectively at a temperature of 50-60°C to an air-dry state, then crushed in a knife mill to a particle size of no more than 50 μm. From this
process, dark red powders (of viburnum) were obtained with a humidity level of 8.4% and brown powders (of barberry) with a humidity level of 7.6%. The persistence of vitamin C served as an indicator of the temperature effect on fruits because ascorbic acid is a light- and thermolabile substance.

The granulometric composition of viburnum and barberry powders was determined by the granulometry device GIU-1 to analyze the granulometric composition of powdered food particles.

The total amount of lipids in powders from viburnum and barberry fruits was determined by the gravimetric method of exhaustive hexane extraction in the FexIKA extractor/analyzer (Germany).

Group composition of lipids was examined by thin-layer chromatography on "Silufol" device plates with a fixed layer of silica gel followed by the densitometry on the "Chromoscan 200" device; solvent system proportions included: hexane: diethyl ester: acetic acid (80:30:1.5) by volume. Composition and content of fatty acids were studied by gas capillary chromatography using the Carlo Erba Strumentazione chromatograph, HRGC 5300 Mega Series (Italy) with a flame ionization detector, on a gas-liquid chromatograph "Chrom-5" (Czechoslovakia) and also using the C-R6A Chromatopac integrator of Shimadzu company. The calculation was performed using the internal normalization method.

The composition of individual sterols in the unsaponifiable lipid fraction was determined using gas-liquid chromatography and mass spectrometry (GC-MS) of trimethylsilyl esters with an internal standard of 5α-cholestane-3β-ol. [12].

3. Discussion of results

Studies have shown that powders contain a significant amount of lipids. Powder from fruits of viburnum contained 7.1% of lipids, the powder from barberry fruits had 7.59% of lipids.

The group composition of lipids in powders is shown in Table 1. The lipids from viburnum and barberry powders are represented by different groups with the main fraction of triacylglycerols. Polar lipids are mainly represented by phospholipids, while sterol esters are found only in the lipids of viburnum fruit powder.

| Groups of lipids                  | Barberry powder | Viburnum powder |
|----------------------------------|-----------------|-----------------|
| Polar lipids(phospholipids)       | 2               | 2               |
| Monoglycerides                   | 1               | -               |
| 1,2-diglycerides                 | 4               | 3               |
| 1,3-diglycerides                 | 3               | 3               |
| Sterols(Стерины)                 | 4               | 1               |
| Not identified                   | 5               | 3               |
| Not identified                   | -               | 3               |
| Free fatty acids                 | 9               | 9               |
| Waxes                            | -               | 2               |
| Triglycerols                     | 72              | 64              |
| Sterol esters                    | -               | 10              |

The composition of fatty acids of lipids in fruits powders is shown in Table 2.

The results of the study of the fatty acid composition of viburnum and barberry powders indicate high biological efficiency of lipids in powders obtained from wild-growing raw materials. Comparative evaluation of the ratio of fatty acids in the composition of lipids showed that the predominant acids are unsaturated fatty acids, namely oleic, linoleic, and linolenic. The lipids in viburnum powder are dominated by oleic and linoleic acids. In contrast, the lipids in barberry powder contain a significant amount of essential linoleic and linolenic acids.
Table 2. Fatty acid composition of lipids in powders, %

| Name of fatty acid | Fatty acid index | Barberry powder | Viburnum powder |
|--------------------|-----------------|-----------------|-----------------|
| lauric             | 12:0            | 0,04            | 0,15            |
| myristic           | 14:0            | 0,25            | 0,25            |
| pentadecanoic      | 15:0            | 0,03            | 0,00            |
| palmitic           | 16:0            | 7,21            | 3,10            |
| hexadecenoic       | 16:1            | 0,06            | 0,16            |
| palmitoleic        | 16:1 9-cis     | 0,11            | 0,18            |
| margaric           | 17:0            | 0,09            | 0,00            |
| heptadecenoic      | 17:1            | 0,07            | 0,00            |
| stearic            | 18:0            | 2,44            | 0,84            |
| elaaidic           | 18:1 9-trans    | 0,09            | 0,00            |
| oleic              | 18:1 9-cis     | 16,49           | 46,56           |
| vaccenic           | 18:1 11-trans   | 0,74            | 1,41            |
| cis, trans -linoleic | 18:2 9-cis, 12-trans | 0,00 | 0,07 |
| trans, cis -linoleic | 18:2 9-trans, 12-cis | 0,07 | 0,00 |
| linoleic           | 18:2ω-6        | 35,54           | 46,14           |
| γ-linolenic        | 18:3            | 0,21            | 0,05            |
| α-linolenic        | 18:3 ω-3       | 35,60           | 0,56            |
| arachidic          | 20:0            | 0,28            | 0,11            |
| gondoic            | 20:1            | 0,27            | 0,31            |
| behenic            | 22:0            | 0,21            | 0,10            |
| lignoceric         | 24:0            | 0,22            | 0,00            |

Data on the composition of sterols in viburnum and barberry powders are given in tables 3 and 4.

Table 3. Fractional composition of the sterols in viburnum fruit powder

| Sterol fractions            | mg/g |
|-----------------------------|------|
| Campesterol                 | 0,34 |
| Beta-sitosterol             | 6,42 |
| Beta-amyrin                 | 7,23 |
| Stigmasta-5,24 (25)-dien-3-ol | 1,17 |
| Alpha-amyrin                | 21,83|
| Cyeloartenol                | 1,92 |
| Citrostdienol               | 1,12 |

Table 4. Fractional composition of the sterols in barberry fruit powder

| Sterol fractions            | mg/g |
|-----------------------------|------|
| Campesterol                 | 0,47 |
| Beta-sitosterol             | 3,88 |
| Delta-5-avenasterol         | 0,78 |
It is shown that the composition of the sterols in viburnum fruit powder includes seven fractions, the dominant ones are alpha-amyrin, beta-amyrin, and beta-sitosterol. Only three sterol fractions were found in the barberry fruit powder; the dominant fraction is beta-sitosterol. Viburnum fruit powder contains more sterols, and their composition is more heterogeneous.

4. Conclusion
The authors of the article studied the lipid complex of powders obtained from viburnum and barberry fruits. The results obtained indicate high biological efficiency of powders from viburnum and barberry fruits since these products contain a significant amount of lipids, which are characterized by the predominance of unsaturated fatty acids, including essential ω-6 and ω-3, and the presence of a substantial amount of phytosterols. It can be stated that the introduction of such powders into the composition of food products, even in small quantities, will expand the range of healthy food products.

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