The study of the phenotype of Viburnum vulgaris growing in the Krasnoyarsk Territory

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Abstract. The article presents the results of studies of individual and ecological-geographical variability of morphological characters and nutrient composition of the Viburnum vulgaris fruits growing on the Krasnoyarsk Territory. As a result of the assessment of the individual variability of traits of Viburnum vulgaris fruits from different natural populations, it was revealed that in all populations the morphological traits are characterized by average individual variability (Cav = 13.9-18.35%); for the nutrient composition - high (Cav = 27.42-36.63%). Three main groups of traits are distinguished: with a low, medium and very high level of variability in each populations of the species, depending on the level of variability There is a decrease in the variability of morphological characters and an increase in nutrients from south to north. A direct relationship was revealed between the variability of morphological traits and the nutrient composition: an increase in the variability of the former is associated with a decrease in the variability of the latter.

1. Introduction

Currently, research aimed at a comprehensive study and subsequent use in economic activity of berry plants with high nutritional value is acquiring special relevance. The common viburnum (Viburnum opulus L.) is of particular practical interest, since this plant has an extensive growing area, covering the European part, Western and Central Siberia in Russia. However, the rational use of viburnum is impossible without a clear knowledge of its ecological and biological features, in particular, without a thorough study of intraspecific biodiversity, based, first of all, on the assessment of the ecological and geographical variability of the chemical composition of berries, which are of the greatest practical interest. To date, there are sporadic information about the nutritional value of viburnum, but there is no information on the content of nutrients in the viburnum, depending on the region of its growth, therefore, studies aimed at studying the phenotype of the viburnum growing in various regions of the Krasnoyarsk Territory are relevant [1, 2, 3, 4, 5, 6, 7, 8, 9].

The aim of this work is to study individual and ecological-geographical variability of morphological characters and nutrient composition of the fruits of the common viburnum growing on the Krasnoyarsk Territory.

To achieve this goal, the following task was solved:

- to assess individual and ecological-geographical variability of morphological traits and nutrient composition in four natural populations of Viburnum vulgaris located in different natural zones on the border of the range.
2. Objects and research methods

The common viburnum was chosen as the objects, growing in four populations (the village of Tanzybey (northern macroslope of the Sayan Mountains, black taiga) of the Ermakovsky district of the Krasnoyarsk Territory; the village of Pritubinskoe (southern forest steppe) of the Minusinsky district of the Krasnoyarsk Territory; the outskirts of Krasnoyarsk (northern forest steppe); in the vicinity of Lesosibirsk (northern border of distribution of the species in Central Siberia, southern taiga)).

The content of the main nutrients in the fruits of the Viburnum vulgaris was determined using generally accepted methods. Determination of dry matter was carried out by the refractometric method. The quantitative determination of the protein was carried out according to the Roberts-Stolnikov method. Lipids were evaluated by the method of extraction with diethyl ether in a Soxhlet apparatus. The carbohydrate content was determined by colorimetric, anthrone methods and the McRury and Slattery method. The determination of pectin substances is based on the reaction of galacturonic acid with carbazole. The volumetric method was used for organic acids. The ability to give a red coloration with a vanillin reagent was used to determine the catechins; the calculations were carried out, using a calibration graph drawn from pure tannin. The extraction of flavones from fruits was carried out according to the Valovaya method, by precipitation with potassium hydroxide, followed by colorimetry. Phosphorus was determined by the method of Lowry and Lopez modified by V.N. Skulachev. Calcium and magnesium were quantified by the volumetric method using Trilon B in the presence of an indicator. Iron was determined colorimetrically. The method for the determination of copper is based on the reaction of copper with dithizone with the formation of yellow-red dithizonates. Manganese - a method modified by Rinkis, based on the oxidation of bivalent manganese in solution with potassium persulfate in an acidic medium to heptavalent manganese, followed by colorimetry. Zinc - by the volumetric method, by titration with trilon B. The quantitative content of vitamin C was carried out according to the method of determination in colored extracts, which is based on the Tillmans reaction. Carotene was determined by the Murry method based on extraction with acetone followed by colorimetry, methinone - by extraction with alcohol followed by titration with sodium hyposulfite in the presence of potassium iodide and starch.

3. Research results

The variability of the morphological characters of the Viburnum vulgaris growing in the Krasnoyarsk Territory was studied (figure 1), as a result of the conducted studies, it was revealed that moving from south to north, a decrease in variability was established, while its maximum value was recorded in Tanzybeiskaya (Cav = 18.35%), and the minimum is in the Krasnoyarsk population (Cav = 13.9%).

![Figure 1](image_url)  
**Figure 1.** Variability of the morphological characters of the common viburnum growing on the Krasnoyarsk Territory.

The variability of the nutritive composition of the Viburnum vulgaris was investigated (figure 2). The variability of the nutrient composition, on the contrary, increases from south to north, and the
minimum average value of the coefficient of variation is observed in the Tanzybei population ($C_{av} = 27.42\%$), and the maximum - in the Lesosibirsk population ($C_{av} = 36.63\%$).

A direct relationship was revealed between the values of the variability of morphological traits and the nutrient composition; it was found that an increase in the variability of morphological traits leads to a decrease in the variability of the nutrient composition, and vice versa. Apparently, the noted feature is associated with the conditions of heat supply and humidification of the air at the points of collection of materials. This fact can be explained by the fact that an increase in the average annual air temperature, as well as its relative humidity, affects the increase in the variability of morphological characters. At the same time, during the transition to more severe (in terms of heat supply) conditions of growth and with a decrease in the relative humidity of the air, an increase in the variability of chemical signs occurs, which apparently determines the protective properties of the organism in those environmental conditions.

![Variability of the nutrient composition of the common guelder-rose growing in the Krasnoyarsk Territory.](image)

The most stable nutrients in all populations include the content of dry matter ($C = 3.9-6.2\%$), proteins ($C = 2.0-5.6\%$), fats ($C = 1.4-6.5\%$) and calcium ($C = 8.6-11.2\%$). The content of pectin substances in
fruits (C = 44.4-52.2%), incl. soluble pectin (C = 50.1-61.5%) and protopectin (C = 49.5-56.0%), carotenoids (C = 40.0-100.0%) and manganese (C = 46.5-153.0%). The trait with an average level of variability is the content of methinone in fruits (C = 15.8-18.0%).

The change in the quantitative characteristics of the studied traits made it possible to reveal that:

• with a decrease in air temperature from south to north, in all populations, there is an increase in the length of the fruits and the content of dry matter and ascorbic acid in them;
• with an improvement in heat supply, in the direction from north to south, in plants, there is an increase in the content of protein, fructose and carotenoids.
• an increase in the average annual precipitation and relative humidity (including the growing season) in all populations leads to an increase in the width and weight of the fruit, the mass of 1000 seeds, organic acids, lipids, methinone, minerals (zinc, copper, manganese, iron).
• a decrease in the average annual precipitation and relative humidity (including the growing season), leads to an increase in the content of sugars, pectin substances, catechins, flavones, phosphorus and calcium in fruits.

4. Conclusions
Assessment of individual variability of traits of Viburnum vulgaris fruits from different natural populations made it possible to conclude that, in all populations, morphological traits are characterized by average individual variability (C_{av} = 13.9-18.35%); for the nutrient composition - high (C_{av} = 27.42-36.63%). In each of the populations of the species, depending on the level of variability, three main groups of traits are distinguished: with a low, medium and very high level of variability. Moving from south to north, there is a decrease in the variability of morphological characters and an increase in nutrients. A direct relationship was revealed between the variability of morphological traits and the nutrient composition: an increase in the variability of the former is associated with a decrease in the variability of the latter. From south to north, from more warm and humid growths to cooler conditions with less moisture supply, there is an increase in the length of fruits and the content of dry matter and ascorbic acid in them, but a decrease in the amount of protein, fructose and carotenoids. An increase in the average annual precipitation and relative air humidity leads to an increase in the width and weight of the fruit, the mass of 1000 seeds, organic acids, vitamin minerals (zinc, copper, manganese, iron), and their decrease leads to an increase in the amount of sugars, pectin substances in fruits, catechins, flavones, phosphorus and calcium.

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