Substantiation of vitamin and mineral composition stability of
Rubus saxátilis L. berries

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Abstract. For the purpose of continuous research and development of technology for Siberian
plant raw material processing as well as obtaining finished products with increased nutritional
and biological value, both mineral and vitamin composition of stone brumble berries (Rúbus
saxátilis L.) growing in Krasnoyarsk Territory and harvested in various years, were studied.
The stone brumble berries were found to be rich in magnesium, calcium, potassium,
phosphorus and in vitamins P and C. The analysis of the mineral and vitamin composition of
stone brumble berries (Rúbus saxátilis L.) of various years of harvest proved the raw material
studied to be a promising stable source of vitamins, macro- and micronutrients. Thus stone
brumble berries (Rúbus saxátilis L.) can be recommended as a source of valuable biologically
active substances in food production.

1. Introduction
In recent years the world faces the challenge of preserving biodiversity, which depends on the state
of natural ecosystems that suffer from human economic activity, sometimes even until extinction.
A resource-conscious production technology leading to reducing amounts of the processed footstock
on one hand and obtaining finished products of increased nutritional and biological value on the other
is one of the possible solutions of this problem.

Wild growing berries represent an organic raw material possessing unique nutritional and
antioxidant qualities, they are considered as a valuable polyvitaminic and medicinal product; the
berries of Rubus genus possess these qualities to the full extent.

The plants of the genus Rubus (Rubus L., clan Rubeae Dumort. subclan Rubiinae Focke, subfam.
Rosoideae, fam. Rosaceae Adans.) are widely distributed around the globe, they are grown in almost
all latitudes except in desert areas and Antarctic. Most of the genus grows in tropical, subtropical and
temperate regions, mainly in forest phytocenoses, from the middle belt of mountains to plains.
Sufficiently large adaptive capabilities, a variety of life forms, participation in vegetation cover,
various forms of vegetative propagation, resistance to anthropogenic press, cultivation and
naturalization, common phenomena of hybridization and apomixis, medicinal and nutritional values
determine the great scientific and practical interests in this genus [1].

One of the representatives of Rubus genus – stone brumble (Rúbus saxátilis L.) is widespread in
Siberia. Rúbus saxátilis L. is a herbaceous perennial plant, a representative of the
family Rosaceae (Rosaceae). The stems and shoots of the plant are finely needle-shaped, quite thin and pubescent as well as leaf petioles, the plant height does not exceed 30 cm, the leaves are triple, on long petioles, the lateral leaflets are located on very short petioles, bilobate, leaves are hairy and green on both sides, all notched-toothed. The fruit is collected from bright red rather large size, juicy fruit with a wrinkled bone. The berries are quite juicy and sour to taste. It blooms mainly in May - July, bears fruit from July to August [2,3].

Stone brumble (Rúbus saxátilis L.) grows in coniferous, mixed forests, on old clearings, and prefers moist, mossy and fertile soils.

In Russian Federation stone brumble (Rúbus saxátilis L.) is widespread in most areas of the European part (except the extreme south), as well as in Siberia and the Russian Far East. In Central Russia it grows in all areas. The stocks of stone Rúbus saxátilis L. are poorly understood. However, it can be noted that, despite the variability of occurrence by land category, stone brumble exhibits stability in yield, which does not vary significantly and fits the range from 18.41 to 22.43 g / m² [4].

According to published data, the chemical composition of stone brumble berries is represented by a wide range of biologically active compounds. They contain components of vital importance for the human health, such as vitamins, organic acids, macro- and micronutrients, carotenoids, pectins and others, which allows them to be widely used in dietetics and traditional medicine; the berries are used to compensate for vitamin deficiency, to treat anemia, colds, inflammatory processes, as an antipyretic and general tonic.

The rationale for choosing wild-growing stone brumble (Rúbus saxátilis L.) the object of this study became its fairly wide distribution area in Siberia along with lack of sufficient data regarding its chemical composition.

The purpose of the study was to survey the dynamics of the vitamin and mineral composition of stone brumble berries (Rúbus saxátilis L.) growing in Krasnoyarsk Territory at various years of harvest in order to substantiate the stability of the raw material and to develop recommendations for it industrial processing.

2. Methods and results
The objects of the study were the stone brumble berries (Rúbus saxátilis L.), growing in Uyar district of Krasnoyarsk Territory, harvested during the period of technical maturity in 2014 - 2017.

The sampling included 2 - 5 % of each package of total batch of stone brumble berries collected and packed. Spot samples from each control package were taken from different layers (top, middle, bottom), then mixed properly, a pooled sample was formed, and an average sample of the required mass was taken for the study.

The mineral composition of Rúbus saxátilis L. berries of various harvest years was identified by means of spectral analysis.

The vitamins content was determined in accordance with State standard 14122-2013, State standard14663-2014, State standard 14152-2013 and State standard 34151-2017 using high-performance liquid chromatography, the quantitative content of vitamin P was determined by the titrimetric method, which is based on oxidative ability of potassium permanganate.

Statistical processing of the data obtained was carried out using Student's criterion, the boundary values of the confidence interval of the average result were calculated and mean deviation was determined. It is well known that mineral substances are vitally important to a wide range of biochemical and physiological processes in humans.

The 10 minerals that play the most significant biological role in human body are magnesium, copper, potassium, iron, zinc, sodium, calcium, manganese, cobalt and molybdenum. The method used for minerals identification allowed to determine the quantitative content of seven macroelements (K, Na, Ca, P, Mg, P and S) and ten trace elements (Fe, Cu, Mn, Mo, Co, Ag, B, In, Ti and Tl).

The summary data on mineral content of stone brumble berries in reference with the year of harvest is presented in table 1.
Table 1. Mineral content dynamics of *Rubus saxatilis* L. berries.

| Mineral content | Harvest year of *Rubus saxatilis* L. berries |
|-----------------|---------------------------------------------|
|                 | 2014 | 2015 | 2016 | 2017 |
| Ca, mg/100g     | 16,785 | 16,596 | 16,457 | 15,708 |
| Mg, mg/100g     | 15,638 | 15,498 | 14,511 | 14,562 |
| Fe, mg/100g     | 0,4045 | 0,5418 | 0,5852 | 0,5534 |
| Na, mg/100g     | 1,0206 | 0,4837 | 0,5978 | 0,5523 |
| Mn, μg/100g     | 0,5607 | 0,5929 | 0,6181 | 0,6036 |
| S, mg/100g      | 11,067 | 10,668 | 9,94 | 10,224 |
| K, mg/100g      | 121,59 | 126,49 | 116,90 | 121,12 |
| Mo, μg/100g     | 0,28 | 0,14 | 0,28 | 0,21 |
| P, mg/100g      | 23,646 | 23,219 | 22,638 | 22,892 |
| Co, μg/100g     | 0,14 | 0,14 | 0,14 | 0,15 |
| Ag, μg/100g     | 0,12 | 0,35 | 0,07 | 0,02 |
| B, μg/100g      | 0,903 | 0,819 | 0,77 | 0,83 |
| In, μg/100g     | 0,49 | 0,21 | 0,42 | 0,44 |
| Ti, μg/100g     | 0,7 | 1,05 | 0,9 | 0,6 |
| Tl, μg/100g     | 0,77 | 0,7 | 1,05 | 0,85 |

Mean average deviation of mineral content data is less than 10%.

The mineral content analysis indicates that stone brumble berries are rich in valuable macro- and trace elements such as potassium, sodium, calcium, magnesium, iron, manganese, cobalt and molybdenum. It was found that *Rubus saxatilis* L. berries are plentiful in potassium, the maximum of potassium content was found in 2015 harvest berries - 126.49 mg/100g, the smallest amount of this element contained the berries harvested in 2016 - 116.90 mg/100g.

The berry raw material analyzed contained significant amounts of phosphorus, *Rubus saxatilis* L. berries were found to accumulate a rather stable amount of phosphorus every harvest, its average content was 23.10 mg/100g.

The sulphur concentration in *Rubus saxatilis* L. berries was quite noticeable, the berries harvested in 2014 contained the greatest amount of sulfur - 11.07 mg/100g whereas in 2016 harvest sulfur was found in minor amount – not more than 9.94 mg/100g.

Both calcium and sodium were found in rather substantial concentrations. The highest level of calcium accumulated by the berries reached up to 16.79 mg/100g in 2014 harvest. The berries of 2014 harvest contained the largest quantity of sodium - 1.02 mg/100g.

The two vitally important elements – iron and magnesium – were found at balanced levels. The highest iron content in stone brumble berries reached up to 0.59 mg/100g in 2016 harvest whereas the lowest content of 0.40 mg/100g was found in 2014 harvest berries. The berries harvested in 2015 showed the smallest accumulation of magnesium - 0.56 mg/100g, the greatest amounts of this mineral contained the 2016 harvest berries - 0.62 mg/100g. The greatest amounts of manganese were found in 2016 harvest berries - 0.62 mg/100g and the smallest amount of 0.56 mg/100g was found in 2014 harvest. The level of molybdenum reached its maximum in berries harvested in both 2014 and 2016 - 0.28 μg/100g whereas the 2015 harvest showed the lowest level of this mineral - 0.14 μg/100g.

The content of cobalt remained quite stable as well with average level of 0.14 μg/100g. Thus analysis of mineral content of *Rubus saxatilis* L. berries showed insignificant annual fluctuations which proved its stability over period of study. Vitamins are known as substances playing an important role in human life support participating in metabolism, manifesting catalytic properties in cell functioning, increasing resistance to infectious diseases, repressing the course of many diseases, reducing the negative impact of various occupational hazards; they are proved to be vitally important food compounds.

It has been established that stone brumble berries contain a complex of valuable vitamins. The vitamin content over four-year’s harvest period is presented in table 2.
Table 2. Vitamin content dynamics of *Rúbus saxátilis* L. berries.

| Harvest year | Vitamin B<sub>1</sub> (thiamine) | Vitamin B<sub>2</sub> (riboflavin) | Vitamin B<sub>6</sub> (pyridoxine) | Vitamin C (ascorbic acid) | Vitamin P |
|--------------|-------------------------------|-----------------------------------|----------------------------------|----------------------------|-----------|
| 2014         | 0,021±0,003                   | 0,021±0,002                       | 0,053±0,002                     | 58,84±0,01                 | 25,98±0,01|
| 2015         | 0,030±0,002                   | 0,023±0,005                       | 0,062±0,003                     | 53,88±0,01                 | 26,78±0,01|
| 2016         | 0,026±0,001                   | 0,020±0,003                       | 0,046±0,006                     | 61,44±0,01                 | 25,55±0,01|
| 2017         | 0,028±0,003                   | 0,024±0,001                       | 0,051±0,002                     | 56,12±0,01                 | 27,23±0,01|

As a result of the study, it was found that the stone brumble berries contained modest amounts of vitamin B1, the smallest amount of 0.021 ± 0.003 mg% was found in the berries of 2014 harvest, the berries of 2015 harvest showed the largest amount of B1 vitamin accumulation - 0.030 ± 0.002 mg%.

The vitamin B2 content in *Rúbus saxátilis* L. berries was not high either, the largest amount was found in the berries of 2017 harvest - 0.024 ± 0.001 mg%, with the lowest content of 0.020 ± 0.003 mg% in the berries of 2016 harvest. The concentration of B6 vitamin in *Rúbus saxátilis* L. berries was slightly higher. In regard to vitamin B6 accumulation, the berries of 2015 harvest showed the best result - 0.062±0.003 mg%, the lowest B6 content was found in 2016 harvest berries - 0.046±0.006 mg%. According to the results of the research, the *Rúbus saxátilis* L. berries contained significant amounts of vitamin C, with the highest level found in 2016 harvest - 61.44 ± 0.01 mg% and the lowest in 2015 harvest of 53, 88 ± 0.01 mg%.

Vitamin P contained in the berries in a sufficiently large amount, the berries of 2017 harvest had the highest vitamin P accumulation of 27.23 ± 0.01 mg%, the minimum amount was found in 2016 harvest - 25.55 ± 0.01 mg%. During the time period of berries harvesting they showed stability of mineral and vitamin content.

An overall analysis of both mineral and vitamin content of stone brumble berries (*Rúbus saxátilis* L.) allowed for identification and quantification of seven macroelements, ten trace elements and vitamins B 1 B 2, B 6, C and P. It was shown that the fluctuations in the accumulation of minerals and vitamins in the stone brumble berries (*Rúbus saxátilis* L.) of different harvesting years were not significant, which indicated the stability and suitability of berry raw material for processing.

Thus our results proved *Rúbus saxátilis* L. berries to be a prominent source of both vitamins and vitally important minerals. The data obtained allowed *Rúbus saxátilis* L berries to be recommended for further in-depth study as valuable raw material rich in macro- and micro nutrients and vitamins.

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**References**

[1] Poddubnaya-Arnoldi V A 1982 *General embryology of angiosperms* (Moscow: Publishing house Science) p 353
[2] Koshcheev A K 1981 *Wild edible plants in our diet* (Moscow: Publishing house Food industry) p 256
[3] Koshcheev A K Smirnyakov Yu I 1995 *Forest berries* (Moscow: Publishing house Ecology) p 270
[4] Rybitsky N A, Gavrilov I S 1994 *Wild fruits and berries and their processing* (Perm: JSC “Triangle”) p 254