Vegetation changes in the chemical composition of Rosa acicularis

E V Shanina
FSBEI of HE Krasnoyarsk State Agrarian University, 90, Mir Ave., Krasnoyarsk, 660049, Russia

E-mail: kras.olimp@mail.ru

Abstract. In the modern world consumers’ attention is attracted by wholesome, safe and ecologically-friendly food products that can be qualified as "natural." In this regard, wild plants growing in the region seem worth to be involved in processing. Rosa acicularis Lindl is of particular interest as a promising non-traditional medicinal and technical raw material. To assess its quality and use in products recovery, comprehensive information on both the chemical composition of fruits and plant biomass is required. This paper studies the dynamics of biologically active substances transformations in the Rosa acicularis biomass during the growing season. The change in the mechanical composition of the vegetative part of Rosa acicularis in the spring-autumn period is presented. The change in the content of vitamins, organic acids, pectin and tannins, pigments in shoots, leaves, roots and fruits of a plant during the growing season is considered. From May to June - July most biologically active substances are accumulated in the vegetative parts of Rosa acicularis. In fruits the maximum content of biologically active substances falls on August - September. This fact allows recommending not only fruits, but also the vegetative part of the plant for industrial processing.

1. Introduction

Every year the Krasnoyarsk Territory enterprises belonging to the Community of Consumer Cooperatives stock up to 500 tons of wild-growing raw materials (berries, mushrooms, ferns, nuts, medicinal herbs). In order to preserve their useful qualities, wild plants are subjected to drying, freezing, pickling, or salting [1]. Unfortunately, currently technologies for local raw materials deep processing are not fully applied. This is due to insufficient knowledge of the wild plants chemical biomass composition. Given the consumers’ interest and focus on healthy and safe food products, it becomes necessary to develop an integrated technology to process plant resources for the production of "natural" products.

Among the wide range of wild plants, the needle rose (Rosa acicularis Lindl) was chosen as a promising non-traditional medicinal and technical raw material. This shrub is characterized by a fairly high resource potential in the Krasnoyarsk Territory and contains a wide range of biologically active substances: vitamins, essential oils, pectin and tannins, pigments.

The argument for using the term “non-traditional raw materials” in the work is explained by the use of the vegetative part of the rosehip fruits for its deep processing. Non-traditional sources of biologically active substances include raw materials permitted for food use, not related to traditional types of resources, obtained as a result of chemical synthesis, biotechnological methods, wild and cultivated...
plants, new species, etc. In our case, this is a local wild plant, namely a plant of the Krasnoyarsk Territory [2].

Rosa acicularis occupies a special place among medicinal plants due to its valuable medicinal properties. Rosehip has long been used in traditional medicine in different countries. In scientific medicine, Rosa acicularis Lindl is used in the form of infusion, extract, fortified syrup and multivitamin preparations as a means of affecting metabolism. ‘Holosas’ preparation is obtained from it for the treatment of cholecystitis and hepatitis, and ‘carotolin’ for trophic ulcers and eczema. [3] Rosehips fruits are widely used in the food and confectionery industry. Fruits extracts are added in the production of marshmallows, caramel, and flour confectionery. At home, rosehip fruits are added to tea, fruit drinks, and jam [4].

To assess the quality of medicinal raw materials and obtain products for various purposes, comprehensive information is required on the chemical composition of both fruits and the entire plant biomass. In the literature, the chemical composition of rosehip fruits is covered in sufficient detail [5-7]; information regarding the vegetative part is limited. However, these data can provide a scientific basis for the integrated use of Rosa acicularis Lindl and the improvement of its processing methods.

The purpose of the work is to study the dynamics of biologically active substances accumulation in different parts of Rosa acicularis during the growing season.

2. Objects and methods of the study
The object of the research is Rosa acicularis Lindl biomass. The subject of research is the dynamics of changes in the biologically active substances content during the growing season.

Samples of vegetative parts of Rosa acicularis were collected along the floodplain of the Abakan River in the south of the Krasnoyarsk Territory. The selection of model plants was carried out in natural conditions by the methods used in botanical research [8]. This method allowed to provide the necessary samples representativeness of plant raw materials. Samples were collected in the third decade of each month from May to September. Leaves, shoots, roots and fruits were harvested separately. The sampling of the studied material was carried out from several shrubs: their upper, lower and middle parts. Incremental sample samples were pooled and mixed. The average sample was isolated from the combined mixture by the quartering method [9].

The raw material was crushed to particles size between 2 - 5 mm. The samples were stored at a temperature of + 10 °C.

The chemical composition of the vegetative and generative parts of Rosa acicularis Lindl was analyzed using methods generally accepted in plant biochemistry. The dynamics of ascorbic acid (vitamin C), rutin (vitamin P), thiamine (vitamin B1), and phylloquinone (vitamin K) accumulation was determined by titrimetric methods [10].

The content of pectin substances, free organic acids, tannins was determined according to the methods described in [11]. The quantitative determination of the sum of chlorophylls and carotenoids in the raw material was carried out by the spectrophotometric method according to [12].

3. Results and discussion
The study of mechanical and chemical composition of Rosa acicularis L biomass was carried out during three seasons. The ratio of plant parts is shown in Figure 1.
Figure 1. Mechanical composition of Rosa acicularis L biomass.

As you can see from the diagram the percentage of plant parts varies during the growing season. In May, most of the shrub is represented by shoots (more than 50%), fruits are not available. In the summer months, the proportion of leaves and fruits increases compared to May. In August - September, an intensive growth of the root system was noted, leading to a decrease in the percentage of the remaining parts of the shrub.

Rosa acicularis is most important as a source of vitamins. The work studied the dynamics of ascorbic acid, rutin, thiamine, and phylloquinone.

Among the vitamins in all parts of the rosehip fruits vitamin C predominates quantitatively. The highest content of ascorbic acid was detected in immature fruits in July (1923.52 mg %). While maturing it decreases by 15 - 20%. In shoots, the maximum of ascorbic acid also occurs in July (35.6 mg %). Rosa acicularis leaves are capable of accumulating a significant amount of vitamin C (35.80 mg%). During the growing season accumulation of vitamin C peaks in the middle of the summer season (33.96 mg %), followed by a decrease by September (23.55 mg %).

Similarly to other parts of the plant, the minimum content of vitamin C in the roots is shown in May (6.13 mg %) with further accumulation to 41.14 mg% by September.

The dynamics of rutin synthesis in the vegetative part and the generative part of Rosa acicularis is different. In shoots (2.46 mg %) and leaves (1.3 mg %), the maximum content of vitamin P was noted in May. By August it decreases by 20-25%. In September there is again a slight amount of rutin in the vegetative part of the plant. In fruits, the content of vitamin P during the growing season does not change significantly 0.75 - 0.90 mg % with a maximum in July.

The formation of thiamine in the vegetative part of Rosa acicularis occurs until July. The greatest fluctuation in the content of vitamin B1 was noted in leaves. Its peak was recorded in July (1.67 mg %); by August there is a decrease to 0.20 mg%. At the beginning of the growing season from May to July, the content of thiamine in the shoots remains practically unchanged and amounts to 0.90 mg%; followed by a decrease in vitamin B1 by almost 15 - 20%. In fruits, the maximum content of thiamine is observed in July (1.97 mg %), while in May (1.70 mg %) and September (1.40 mg%) it is slightly lower.

The study of the dynamics of phylloquinone accumulation showed that in the vegetative part of Rosa acicularis its content reaches its maximum in June (0.65 mg %), and a decrease is observed by September. In leaves, the maximum content of vitamin K (1.40 mg %) falls on June, with a subsequent decrease to 0.15 mg% by September. From May to June the content of phylloquinone in shoots varies insignificantly, 0.45 ± 0.05 mg%; by September, there is a 4 times decrease. The greatest fluctuations
in vitamin K during the growing season were found in the roots of the plant. Since May, phylloquinone begins to accumulate, reaching its maximum value in June - 1.10 mg%. By September, the content of vitamin K decreases to 0.10 mg%.

The content of vitamin K in flowers is 14 times higher than in fruits of technical maturity.

The results of changes in the dynamics of biologically active substances of the vegetative and generative parts of Rosa acicularis are shown in Table 1.

| Table 1. Chemical composition of Rosa acicularis. |
|-----------------------------------------------|
| Component                                    | Shoots | Leaves | Roots | Fruits |
|                                               | July    | September | July    | September | July    | September |
| Pectine substances, % from absolutely dry matter. |    |          |        |          |        |          |
| Including:                                    |    |          |        |          |        |          |
| Soluble pectin                               | 6.17  | 0.17      | 0.20   | 0.37      | 1.60   | 0.28      |
| Propectin                                    | 1.62  | 0.73      | 1.06   | 1.24      | 1.83   | 0.63      |
| Organic acids (in terms of apple), % of absolutely dry matter |    |          |        |          |        |          |
|                                               | 0.83  | 1.30      | 2.64   | 2.65      | 1.03   | 1.98      |
| Tannins, % of absolutely dry matter.          |        |          |        |          |        |          |
| Including:                                    |        |          |        |          |        |          |
| Tannids                                      | 0.52  | 0.52      | 2.34   | 2.59      | 1.04   | 2.08      |
| Solubles                                     | 12.00 | 14.00     | 32.00  | 34.50     | 13.50  | 20.50     |
| Not tannids                                  | 11.48 | 13.48     | 29.66  | 31.90     | 12.46  | 18.42     |
| Chlorophyll A, mg%                           | 14.80 | 10.40     | 108.10 | 118.60    | 4.30   | 8.80      |
| Chlorophyll B, mg%                           | 21.20 | 22.00     | 66.60  | 67.00     | 10.70  | 17.80     |
| Carotene, mg %                              |        |          |        |          |        |          |
|                                               |        | trace quantity | 15.10 | trace quantity | 0.30 | 185.30 |

Thus, it was found that during the growing season there is an accumulation of almost all the studied components in all anatomical parts of Rosa acicularis.

The largest amount of pectin substances was observed in shoots in July and amounted to 7.79% of the absolutely dry matter. During the growing season there is a decrease in the amount of pectin substances in all plant organs; propectin predominates, the amount of which significantly exceeds soluble pectin; the content of organic acids is not high, with the greatest amount found in leaves and fruits; the content of tannins also increased in all parts of the plant, with netannides and soluble substances predominating. Photocolometric method for pigments detection showed the highest content of chlorophyll A and B, carotene in leaves. The lowest pigment content was found in the roots. Only traces of carotene were found in shoots; chlorophyll A and B were present in small amounts.

4. Conclusion

The research has shown that all parts of Rosa acicularis contain valuable biologically active substances. This fact allows recommending both fruits and vegetative part of the plant for industrial processing. From May to September changes in the content of vitamins, pigments, tannins and pectin substances are...
noted. Based on the results of the work done, it was found that in order to maximize the extraction of biological substances from the vegetative part of the plant leafy shoots should be harvested in June - July. Harvesting of Ros aacicularis fruits should be done in August-September, when they have reached the stage of industrial ripeness.

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