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Prospects of economical use of *Vaccinium vitis-idaea* leaves in Kirov region

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Abstract: *Prospects of economical use of Vaccinium vitis-idaea leaves in Kirov region*. Significant variability of spatial resource inner-habitat parameters defines the necessity of data collection and field research in various geographical conditions in different administrative districts. Such a holistic method applied to cowberry (*Vaccinium vitis-idaea*) allows to work out complex measures for stable use of resources in regional conditions. Considering significant population density of the studied region and accessibility of cowberry beds, high level of arbutin content which meets the requirements of the State Pharmacopeia, *V. vitis--idaea* leaves are a prospective medicinal raw material for collection.

Key words: Vaccinium vitis-idaea, medicinal raw material, economical use.

INTRODUCTION

Rational use of non-wood plant resources is based on a complex study of wild species ecology and biology, production and spatial population structures, after-collection restoration of beds. Significant variability of spatial resource inner-habitat parameters defines the necessity of data collection and field research in various geographical conditions in different administrative districts. Such a holistic method applied to cowberry (*Vaccinium vitis-idaea*) allows to work out complex measures for stable use of resources in conditions of significant growth of collection volumes and increase of raw material quality.

OBJECTS AND METHODS

V. vitis-idaea is a holarctic species of forest and arctic zones of Europe which frequently occurs in coniferous forest and light forest habitats. Maximum yield of *V. vitis-idaea* berries in these kinds of area reaches 1000–3754 kg/ha [Egoshina 2003]. But besides fruits leaves of the species are also a valuable rsource. Biological stock (BS) of *V. vitis-idaea* leaves in European part of Russia is about 300 thousand tons, exploitation stock – up to 30 thousand tons by average productivity of 250 kg/ha [Egoshina 2005].

V. vitis-idaea leaves are a recognized medicinal agent use for several diseases. Decoction is use for urolithiasis and gout treatment as they promote salts excretion from the body. An important role among biologically active substances in leaves is played by arbutin which defines their pharmacological value [State Pharmacopeia… 1990]. It is established that such ecological factors as light level, soil acidity, quantities of mobile forms of mineral elements can affect *V. vitis-idaea* leaves productivity in highly illuminated areas – forests and swamps edges [Krylova 2003; Egoshina et al. 2005; Chirkova et al. 2009]. Inspite of possibilities of *V. vitis-idaea* cultivation in taiga regions of Russia [Egoshina, Luginina 2008] collection of medicinal raw material is common in natural populations of the species.

Materials which the study is based on were collected in 1979–2007 all over Kirov region. Investigations of ecological-coenotic and productional characteristics were made with common methods [Shreter, Krylova 1977; 1986; Skryabina 1978; Maznaya 2002].

20–30 sample plots (0.25 m²) were organized in different *V. vitis-idaea* beds regularly (for uniform plant distribution areas) of within *V. vitis-idaea* spots. Average plant height (3 measurements) and projective cover were determined on sample plots.

Soil samples from root-inhabited layer were collected in each plant coenosis and tested for main agrochemical parameters: acidity (pH), humus content, P, K, Ca and Mg content [Arinushkina 1962]; this allows to reveal interactions between soil properties and plant productivity.

Quantitative investigations of arbutin were conducted with titration method according to the requirements of pharmaceutical article (FS – 26–90) from USSR State Pharmacopeia [1990].

Raw material samples for heavy metals analyses were collected during dry weather. Plants from different plots were in the same phenological stage. Phytomass was collected according to the rules of raw material collection [Rules of collection… 1985]. Mineral composition of plants depends on various factors and so the collection of average samples was conducted in comparable typical habitat conditions. Leaves from 30–50 partial shoots of *V. vitis-idaea* were collected evenly within plots. Phytomass was dried in well-aerated rooms or in special drying oven. Samples were then packed in clean thick paper or plastic bags. Prepared and grounded samples were incinerated in a muffler at 450–500ºC. Ash residues were dissolved in 1 h HCl. The content of studied elements (Cu, Ni, Cd, Pb, Zn, Fe, Cr, Mn) was investigated with atomic absorption spectrometry on a plasma photometer Spectr 5–3 in an absorption mode [Obukhov, Plekhanova 1991; Methodic guide for investigation… 1992] threefold. Results are given in mg/ /kg dry weight. Samples were collected in Kirov region in ecosystems with different levels of pollution. All samples were divided into 2 groups: from polluted areas (roads, dumps, enterprises, urban territories, etc.) and from comparatively clean areas.

Received data were processed statistically [Plokhinsky 1970; Terentiev, Rostova 1977] with Excel 6.0, Statgraphics for Windows 5.0, Statistica 6.0.

Plant nomenclature is given according to S.K. Czerepanov [1995].

RESULTS AND DISCUSSION

In Kirov region *V. vitis-idaea* is found in pine and spruce-pine cowberry forests which are characterized by 30–100 years old forest stand, 4–25 m height, and 0.4–0.7 crown density. Arboreal layer is usually presented by *Pinus sylvestris*, *Picea × fennica*, and less often by *Abies sibirica*, *B. pendula*. The same species dominate in undergrowth. Underwood is formed by *Juniperus communis*, *Sorbus aucuparia*, *Frangula alnus*, *Rosa acicularis*, *Lonicera xylosteum*. Projective cover of herbaceous-undershrub layer doesn't exceed 50%, *V. vitis-idaea* dominates. It is often that *V. Myrtillus* is a co-dominant. Herbaceous vegetation is presented by species with insignificant projective cover of solitary found individuals: *Melampyrum sylvaticum*, *Diphasiastrum complanatum*, *Lycopodium annotinum*, *Pyrola rotundifolia*, and *P. chlorantha*, *Orthilia secunda*, *Chimaphila umbellata*, *Antennaria dioica*, *Solidago virgaurea*, *Goodyera repens*, *Hieracium pilosella*, *Luzula pilosa*, *Melica nutans*, *Milium effusum*, *Calamagrostis epigeios*, and some other species.

Moss cover is almost solid (80%) and formed mostly by green mosses *Pleurozium schreberi*, *Hylocomium splendens*, *Polytrichum commune*, *Dicranum polysetum*. Projective cover varies from 3 to 50%. Lichens are presented by genus *Cladina: C. arbuscula*, *C. rangiferina*, *C. stellaris*.

V. vitis-idaea prefers sabulous and sandy high-acidity (average pH 3.8), poor humus (2.4%), P, K (4.4. and 4.7 mg/100 g of soil correspondingly), Ca and Mg (2.0 and 0.75 mg-equiv./100 g of soil correspondingly) content.

Arbutin content in cowberry leaves samples collected in August in the studied region varies from 5.2 to 10.0% (Tab. 1) which is slightly higher than Pharmacopeia article requirements [State Pharmacopeia… 1990].

Plant samples from coniferous-deciduous forest subzone contained higher

TABLE 1. Arbutin content in *V. vitis-idaea* leaves (% dry weight) collected in different areas of Kirov region (Russia)

Study area	Agrochemical parameters						Arbutin content
	P	K	Humus %	pH	Ca	Mg	
	mg/100 g of soil				mg-equiv/100 g of soil		
Average per study areas							
Urzhumsky	0.45	2.15	1.70	3.4	2.68	9.05	7.35
Verkhoshozhemsky	1.01	2.23	3.40	3.7	2.25	0.19	8.10
Khalturinsky	2.53	4.03	3.33	3.9	6.41	0.94	7.80
Darovskoy	1.82	5.23	2.23	3.5	1.75	0.26	8.40
Aphanasievsky	1.57	3.14	1.09	3.8	1.21	0.31	6.70
Nagorsky	2.68	5.12	1.12	3.9	2.00	0.60	8.60
Malmyzhsky	51.04	2.34	1.01	3.7	1.05	0.27	7.36
Belokholonitsky	0.72	1.53	1.08	3.6	1.00	0.22	9.90
Slobodskoy	3.08	8.02	3.33	3.7	3.34	0.31	7.03
Luzsky	8.35	2.18	0.94	4.1	1.42	0.30	8.62
For all collected samples in whole							
Minimum	0.10	0.50	0.28	3.0	0.37	0.13	5.20
Average	3.82	1.79	3.81	2.0	0.77	7.72	7.99
Maximum	51.04	16.50	5.20	5.7	12.13	9.80	10.00

volumes of arbutin than samples collected in middle taiga subzone. But this difference is insignificant and statistically unreliable.

Correlation analyses of received data showed that arbutin content in all tested samples reliably depended on the level of soil acidity (r = 0.489; P > 0.90) increasing directly proportional. Significant variations in content of some macroelements both for the whole Kirov region and within administrative regions do not allow reliable conclusions about co-dependence of arbutin accumulation by *V. vitis-idaea* leaves and edaphic factors of the habitat to be made.

Among all other studied elements only Mg content positively correlated with projective cover level (r = 0.48) and leaves productivity (r = 0.61).

Active anthropogenic development of natural habitats leads to the increased level of many pollutants in the environment that can also lead to the pollution of plant raw material. The possibility of use of *V. vitis-idaea* leaves and shoots as a medicinal raw material have to consider its “cleanliness”.

Heavy metals (HM) that environment receives from industries, transport, fuel burning can be dangerous pollutants which plants accumulate from the atmosphere with dust and aerosols, and soils. The effect of these sources depends on the situation. Most pollutants in taiga zone are spread by atmospheric transfer. Shoots and leaves of *V. vitis-idaea* are perennial formations and can accumulate significant quantities of HM during several years.

Samples of raw material from different areas of the region including industrially developed were collected during the study. It was defined that comparatively polluted areas showed wider specter of data on HM content than background areas (Tab. 2). Samples with high concentration of Pb and Cd occur even more often. *V. vitis-idaea* fruits accumulate comparatively less pollutants than vegetative mass.

The content of HM in plants depends on their concentration in soils. During collection of plant samples soil samples were also taken. And comparison of HM content in soils and plants at given levels of pollution haven’t shown reliable co-dependence of these parameters (Fig. 1).

V. vitis-idaea grows in forest ecosystems which do not occur on industrial

TABLE 2. HM content in *V. vitis-idaea* plants of background (B) and polluted (P) areas (mg/kg dry weight)

Sample	Area	Cu	Ni	Cd	Pb	Zn	Cr
Cowberry shoots	B	***3.60 ±0.13**	**1.30 ±0.07**	**0.48 ±0.12**	**1.29 ±0.07**	**18.24 ±0.49**	**1.79 ±0.08**
		**1.17–8.16	0.45–3.50	0.01–1.20	0.20–4.01	13.20–30.10	0.20–4.00
	P	**4.46 ±0.34**	**1.29 ±0.11**	**0.86 ±0.11**	**2.36 ±0.27**	**17.59 ±0.53**	**2.07 ±0.2**
		1.71–11.16	0.20–3.50	0.09–3.01	1.05–6.15	12.30–30.10	0.48–5.60
Cowberry fruits	B	**4.20 ±0.41**	**1.15 ±0.12**	**0.19 ±0.05**	**0.50 ±0.09**	**18.72 ±1.65**	**1.67 ±0.39**
		0.96–7.21	0.50–2.40	0.08–0.21	0.19–0.90	10.00–30.10	0.12–4.66
	P	**3.46 ±0.41**	**0.95 ±0.15**	**0.15 ±0.03**	**0.43 ±0.06**	**20.52 ±2.09**	**1.56 ±0.56**
		1.86–4.17	0.50–1.35	0.10–0.26	0.25–0.60	16.1–28.10	0.69–3.65

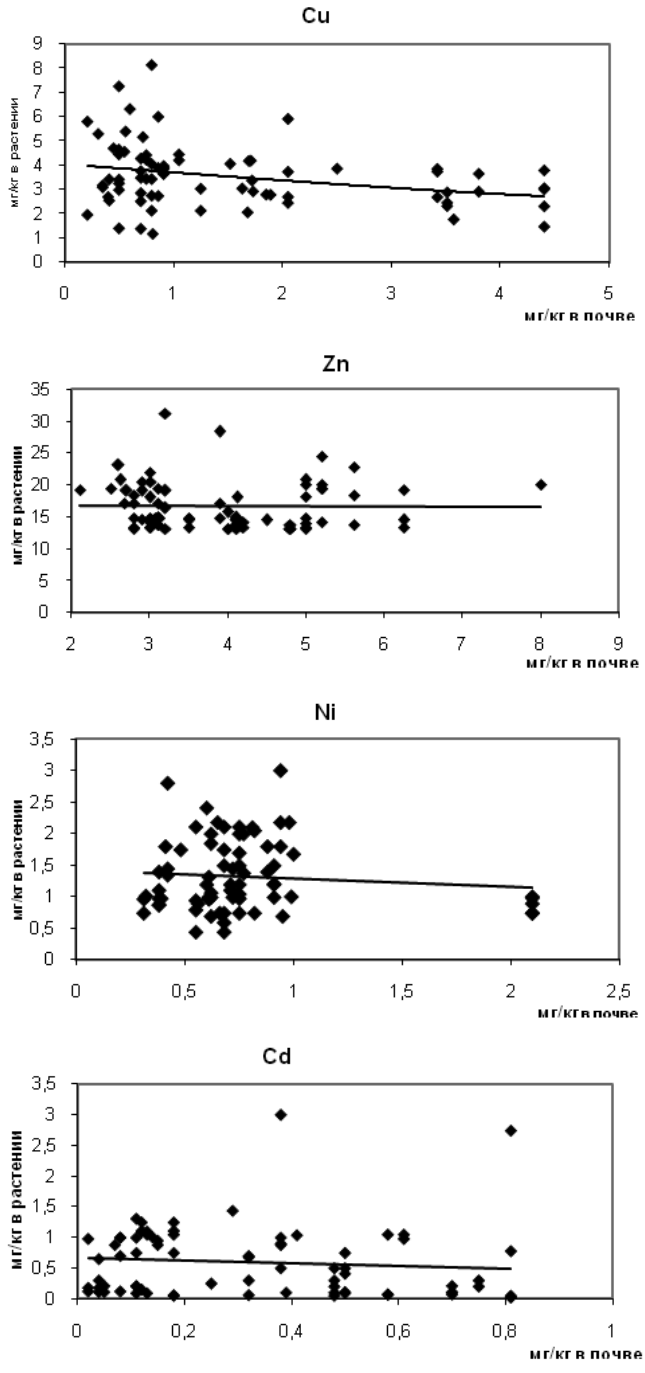

FIGURE 1. Co-dependence of HM content in soils and *V. vitis-idaea* plants (x-axis – content, mg/kg of soil; y-axis – content, mg/kg in plants)

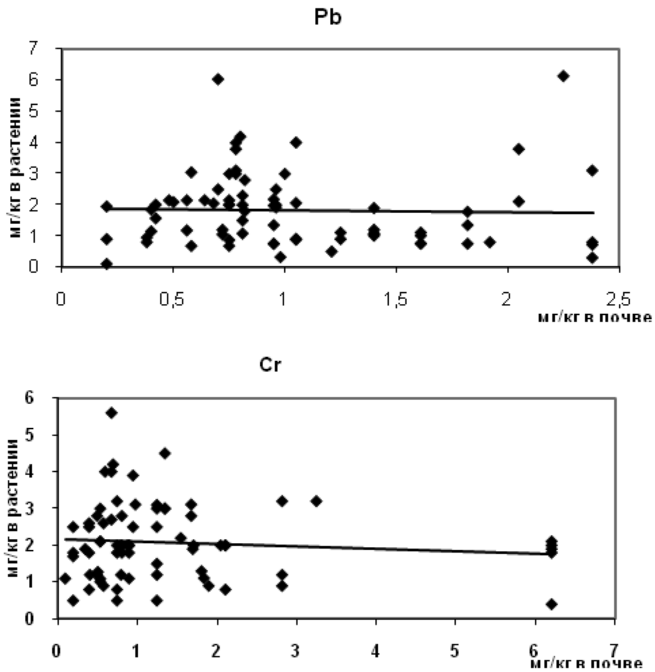

Figure 1. (continued)

lands. And raw material collected in the region is comparatively safe considering HM. But nevertheless strict regulation of pollutant concentration is necessary.

Projective cover of *V. vitis-idaea* plants in different vegetation subzones is almost equal and varies from 9.0 to 10.6%, plant height is also stable (12.8 to 14.1 cm). The highest average leaves productivity is marked for coniferous-deciduous forests (69.8 g/m²), the lowest – for southern taiga subzone (51.0 g/m²). The most productive forest types are lichen pine and cowberry pine forests (59.9 and 58.3 g/m² correspondingly). The lowest productivity is marked in bilberry spruce forest (38.4 g/m²). Lichen pine forest is also characterized by the highest average projective cover (12.5%).

Biological stock of *V. vitis-idaea* leaves in Kirov region is 9195.3 tons, possible annual collection volume is 184.5 t.

Correlation analyses allowed revealing high adaptive ability of *V. vitis-idaea* to agrochemical soil characteristics. It was defined that only Mg content correlates with leaves productivity insignificantly (r = 0.61). Correlations between leaves productivity and content of P, K and other elements in soils were not revealed (r = = –0.2 ±0.2). Projective cover and leaves productivity correlate (r = 0.9). It was found that with the increase of forest stand age and crown density both shoots height (r = 0.67 and 0.65 correspondingly) and leaves productivity (r = 0.51) increase; similar correlations were marked by R.V. Daubaras and D.K. Budrunene [1980].

CONCLUSIONS

The analyses of parameters of *V. vitis-idaea* participation in plant coenosis prove their high stability level. Low level of correlation between arbutin synthesis and accumulation, HM accumulation in leaves and fruits, environmental conditions, and high resistance to abiotic stresses that allows surviving in a wide range of factors, was defined.

Considering significant population density of the studied region and accessibility of cowberry beds, high level of arbutin content which meets the requirements of the State Pharmacopeia, *V. vitis-idaea* leaves are a prospective medicinal raw material for collection.

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Streszczenie: *Pespektywy ekonomicznego wykorzystania liści borówki brusznicy* (*Vaccinium vitis-idaea*) *w rejonie Kirov.* Przedstawiono analizę liści borówki pod kątem ich wykorzystania jako

surowca w medycynie. Stwierdzono potencjalną przydatność badanego materiału ze względu na jego dostępność w rozpatrywanym rejonie, wysoką zawartość arbutyny oraz odporność na abiotyczne stresy w szerokim zakresie czynników.

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