BIOLOGIJA. 2008. Vol. 54. No. 2. P. 93–96
DOI: 10.2478/v10054-008-0018-4

Evaluation of productivity and biochemical components in fruit of different *Viburnum* accessions

Laima Česonienė[1*], Remigijus Daubaras[1], Pranas Viškelis[2]

[1] *Kaunas Botanical Garden of Vytautas Magnus University, Ž. E. Žilibero 6, LT-46324 Kaunas, Lithuania*

[2] *Lithuanian Institute of Horticulture, Kauno 30, LT-54333 Babtai, Kaunas distr., Lithuania*

Accessions of the genus *Viburnum* with edible fruits were investigated in the field collection of the Kaunas Botanical Garden of VMU and those most valuable were selected. Three accessions of *V. opulus* and the species *V. trilobum* were distinguished for productivity and raceme size. Biochemical examination of fruit revealed a considerable variation among the accessions in regarding the content of ascorbic acid, anthocyanins, phenolic compounds and carotenoids. *V. trilobum* and *V. sargentii* fruits should be appreciated as a source of valuable biochemical components, phenolic in particular.

Key words: biochemical component, cultivar, fruit, productivity, variation

INTRODUCTION

Species of the genus *Viburnum* L. with edible fruits, such as *Viburnum opulus* L. (European cranberry bush), *V. trilobum* Marsh. (American cranberry bush) as well as *V. sargentii* Koehne are widely used in traditional and folk medicine. Preparations of its bark and fruits exhibit hypotensive, cardiotonic, calming, spasmolytic and anti-inflammatory properties [1, 2]. Flowers, bark and leaves are an important medicinal raw material because of a high content of tannins, carotenoids, isovalerianic acid, saponins, and glycosides [3, 4]. Moreover, fruit of these species could be a valuable dietary product as well as a source for the production of food supplements. The most comprehensive research work on *V. opulus* was accomplished hitherto in Russia and Ukraine. Different cultivars were included into the Russian official register and recommended for growing.

The species *V. opulus* is widely spread in Lithuania and well-known as a medicinal and horticultural plant. *V. trilobum* is a native plant in North America. The morphological peculiarities of the latter species are very similar to those of *V. opulus*, but it distinguishes for resistance to aphid attack and more intense fall colour. *V. sargentii* is a natural common species in the Far East, Korea, Altai and Sakhalin. This species is suitable for crossing with *V. opulus* [5, 6].

The aim of this study was to estimate the productivity, fruiting properties and assess the amounts of some biologically active substances of *Viburnum* accessions as well as to select the most prospective potential donors for breeding.

* Corresponding author. E-mail: l.cesoniene@bs.vdu.lt

MATERIALS AND METHODS

Eleven accessions of *V. opulus* as well as two introducted species, *V. trilobum* and *V. sargentii*, were selected for the evaluation at the Kaunas Botanical Garden of VMU in 2000–2007.

The productivity and fruiting properties (mean yield per bush, the number of fruit in a raceme and the mean weight of a fruit) were studied. The results were statistically analysed using the ANOVA technique with a comparison of means by Duncan's multiple range test. The standardized data matrix was used to generate similarity indices based on Euclidean distances. Clustering was carried out by the Unweighted Pair Group Method Arithmetic Average (UPGMA) technique.

Investigations of the biochemical composition of fruits were conducted at the technical maturity stage. The total content of phenolic compounds was determined with the Folin–Ciocalteu reagent according to the Slinkard and Singleton method [7]. The absorbance of all samples was measured at 765 nm using the Genesys10 UV/V spectrophotometer after incubating at 20 °C for 1.0 h. Results were expressed in mg of gallic acid equivalent (GAE) per 100 g of fresh weight.

The pigments were extracted with methanol acidified with 0.1 M HCl [8]. Anthocyanin content was estimated as cyanidin 3-glucoside at 530 nm using the molar absorptivity coefficient of 26900 and expressed in mg per 100 g of fresh weight [9].

The carotenoid levels expressed as β-carotene were estimated from the extinction value $E_{1\,cm}^{1\%} = 2592$ at 450 nm [10]. The ascorbic acid content was measured by titration with 2,6-dichlorphenolindophenolsodium salt solution, using chloroform for intensively coloured extracts [11].

RESULTS

Investigations of productivity revealed statistically reliable differences among the accessions (Table 1). A constant large yield was typical of the cultivars 'Leningradskaya Otbornaya' (8.5 ± 0.67 kg per bush) and 'Zarnitsa' (6.2 ± 1.99). The species *V. trilobum* was distinguished for a high productivity as well. The accessions of *V. opulus* showed significant differences in raceme size. The number of fruit in a raceme varied from 28.1 ± 5.83 ('Upninkai') to 51.0 ± 6.1 (cultivar 'Krasnaya Grozd'). *V. trilobum* racemes on average contained 47.8 fruits.

Statistically reliable differences were determined by comparing the mean weight of a fruit. The cultivars 'Zarnitsa' and 'Leningradskaya Otbornaya' produced the largest fruits (0.74 ± 0.09 g and 0.66 ± 0.05 g, respectively). The cultivar 'Shukshinskaya' and *V. trilobum* had the smallest fruit (0.45 ± 0.04 g and 0.43 ± 0.03 g, respectively). The length of a cluster stalk varied from 2.9 ± 0.10 ('Leningradskaya Otbornaya') to 5.2 ± 0.22 cm (*V. trilobum*) and on average was 3.9 cm. The length of stalk of a raceme as well as the mean weight of a fruit showed a medium variation, with the coefficients of variation 13.6% and 15.7%, respectively. Productivity variation of *Viburnum* accessions was high (C_v = 38.1%). Regression analysis revealed that the response of yield per bush to the number of fruits in a raceme could be best expressed by the exponential equation $y = 0.33685 \times e^{0.4969x}$ at the coefficient of determination $R^2 = 0.895$. The relationship between the yield and mean weight of a fruit was weak and not significant at the coefficient of regression $R^2 = 0.138$.

Different accessions were compared according to the content of ascorbic acid, carotenoids, anthocyanins and phenolic compounds. Statistically reliable differences were ascertained (Table 2). Fruits of different accessions accumulated 22.9 mg/100 g (P3) to 49.9 mg/100 g ('Leningradskaya Otbornaya') of anthocyanins and 732.5 mg/100 g ('Souzga') to 1504.3 mg/100 g (*V. sargentii*) of polyphenolic compounds. Ascorbic acid content ranged from 13.0 mg/100 g ('Souzga') to 44.7 mg/100 g (P3). Fruits of the cultivar 'Leningradskaya Otbornaya' accumulated the largest amounts of carotenoids. The statistical analysis of biochemical components of the fruits revealed high variability of ascorbic acid (C_v = 32.7) and carotenoids (C_v = 22.3), whereas medium variability was ascertained for anthocyanins (C_v = 17.1) and phenolic compounds (C_v = 17.8). Fruits of the accessions distinguished by a higher content of ascorbic acid accumulated larger amounts of phenolic compounds as well. A correlation between these biochemical components was established (r = 0.665, P = 0.01). A negative correlation between ascorbic acid and anthocyanin content was found (r = –0.662).

DISCUSSION

The number of fruits in a raceme is one of the most important indices for the selection of *Viburnum* accessions with a predictable high yield in natural habitats. Therefore, accessions selected in the *Viburnum* collection in respect to high productivity and fruit number per raceme should be used in the breeding of new cultivars. The results of investigations conducted on the yield, weight of a fruit and the number of fruits in a raceme reveal statistically reliable differences within *Viburnum* accessions. The dendrogram based on the data of yield per bush and an average number of fruit per raceme shows two main clusters (Figure). The first cluster recognizes four accessions ('Krasnaya Grozd', 'Leningradskaya Otbornaya', P3 and *V. trilobum*) which show a good productivity and have large racemes. The cultivar 'Leningradskaya Otbornaya' could be characterized as the

Table 1. **Comparison of significant economic properties of *Viburnum* accessions, 2000–2007**

Accession	Origin	[1]Mean fruit weight, g	[2]Fruit number per raceme	[3]Stalk length of a raceme, cm	[4]Yield, kg/bush
V. opulus					
'Krasnaya Grozd'	Latvia, National Botanical Garden	0.51 *abcd*	51.0 *e*	3.1 *ab*	5.8 *abc*
'Kiyevskaya Sadovaya'	–"–	0.64 *efgh*	34.4 *abc*	3.8 *bcde*	4.1 *abc*
'Leningradskaya Otbornaya'	–"–	0.66 *fgh*	43.1 *bcde*	2.9 *a*	8.5 *c*
'Zarnitsa'	–"–	0.56 *cdef*	35.1 *abcde*	3.6 *abcd*	6.2 *abc*
P1	Ukraine, Central Botanical Garden	0.58 *def*	37.8 *abcde*	4.2 *de*	3.2 *abc*
'Souzga'	Latvia, National Botanical Garden	0.54 *bcde*	32.3 *ab*	3.9 *cde*	2.7 *a*
P2	Lithuania, Kaunas distr.	0.56 *cdef*	35.0 *abcde*	3.2 *abc*	5.9 *abc*
'Shukshinskaya'	Latvia, National Botanical Garden	0.45 *ab*	33.8 *abc*	3.6 *bcd*	3.0 *a*
'Zarnitsa-2'	Lithuania, Ukmergės distr.	0.51 *abcd*	33.8 *abc*	4.2 *de*	2.6 *a*
P3	Lithuania, Kaunas distr.	0.47 *abc*	42.5 *bcde*	4.6 *efg*	6.3 *abc*
'Upninkai'	Lithuania, Ukmergės distr.	0.74 *h*	28.1 *a*	3.9 *cde*	4.3 *bc*
V. sargentii	Lithuania, Kaunas Botanical Garden	0.57 *cdef*	39.2 *abcde*	4.1 *de*	3.5 *abc*
V. trilobum	Lithuania, Kaunas Botanical Garden	0.43 *a*	47.8 *cde*	5.2 *g*	6.5 *abc*
Average of trial		0.55	37.98	3.86	4.81
Sx		0.028	3.797	0.188	1.146

[1] 100 fruits were collected and examined, [2, 3] 20 racemes were examined, [4] 10 bushes were examined.

Means followed by the same letter in columns are not significantly different at P = 0.05 (Duncan's multiple range test).

Table 2. **Content of some biochemical components in fruits of *Viburnum* accessions, 2007**

Accession	Biochemical component, mg/100g			
	Carotenoids	Phenolic compounds	Anthocyanins	Ascorbic acid
V. opulus				
'Krasnaya Grozd'	1.7 *ab*	1136.0 *bc*	36.8 *defg*	20.9 *b*
'Kiyevskaya Sadovaya'	1.6 *ab*	1103.1 *bc*	35.7 *def*	26.6 *c*
'Leningradskaya Otbornaya'	2.8 *f*	962.0 *ab*	49.9 *i*	13.8 *a*
'Zarnitsa'	2.2 *cd*	976.9 *ab*	39.0 *fg*	26.4 *c*
P1	2.3 *cd*	1157.9 *bcd*	40.4 *f*	32.2 *g*
'Souzga'	1.7 *b*	732.5 *a*	34.0 *cd*	13.0 *a*
P2	2.1 *c*	1220.5 *bcdef*	37.9 *cdef*	35.3 *de*
'Shukshinskaya'	2.2 *c*	1007.0 *bc*	31.0 *bc*	31.9 *d*
'Zarnitsa-2'	1.4 *a*	1002.5 *abc*	38.4 *def*	21.2 *b*
P3	1.4 *a*	1280.0 *cdef*	22.9 *a*	44.7 *f*
'Upninkai'	2.7 *f*	1065. 6 *bc*	35.2 *de*	33.3 *de*
V. sargentii	2.4 *d*	1504.3 *f*	37.1 *defg*	35.6 *e*
V. trilobum	2.3 *d*	1454.9 *efg*	28.0 *b*	32.5 *de*
Average of trial	2.04	1123.6	36.0	27.8
Sx	0.074	68.86	0.821	0.74

Means followed by the same letter in columns are not significantly different at P = 0.01 (Duncan's multiple range test).

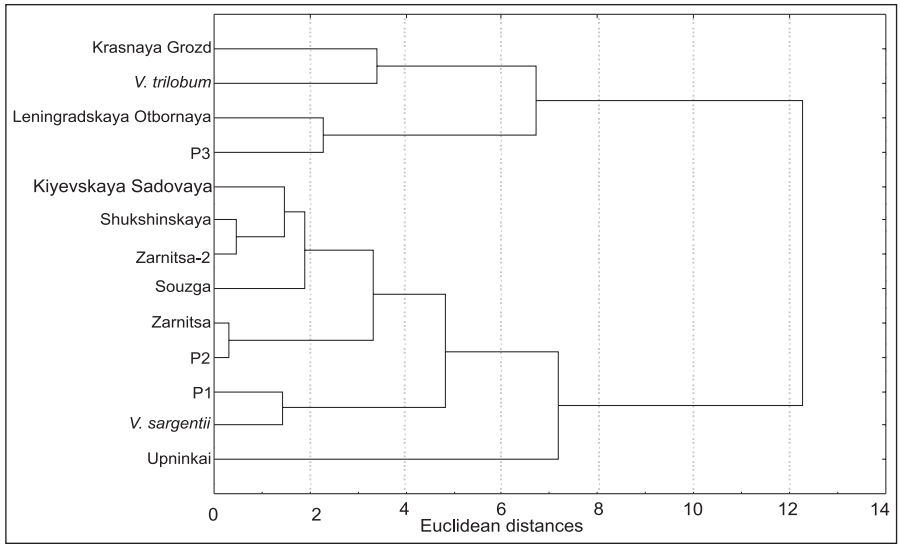

Figure. The UPGMA dendrogram of *Viburnum* accessions based on productivity and cluster size

most productive. The second cluster groups nine accessions ('Shukshinskaya', 'Zarnits'a, 'Souzga', P1, P2, 'Zarnitsa-2', 'Kiyevskaya Sadovaya', 'Upninkai' and *V. sargentii*) which are less valuable in respect of productivity.

The biochemical composition of fruits is one of the most important aspects of the conservation and preservation of *Viburnum* genetic resources. As several authors [12, 13] have described, *V. opulus* fruits are a source of valuable biochemical components such as ascorbic acid, flavonols, lipids, phenolic compounds, iridoids, etc. The above-mentioned substances are characteristic of antioxidant activity, antiviral and anticancer properties [14, 15]. This study has confirmed a considerable variation among the test accessions as regards the content of biochemical components. Fruits of *Viburnum* accessions accumulate exceptionally large amounts of phenolic compounds. The *V. sargentii* and *V. trilobum* species are valuable because of the largest content of phenolic compounds, however, they were regarded as worthless till now. Therefore, these introduced species as well as the most valuable *V. opulus* accessions 'Leningradskaya Otbornaya', P3, P2 and 'Zarnitsa' could be selected for breeding in respect of the highest content of biologically active substances.

ACKNOWLEDGEMENTS

This work was supported by the Lithuanian Ministry of Education and Science Programme "Scientific Researches of Plant Genetic Resources".

Received 3 February 2008
Accepted 24 April 2008

References

1. Jordheim M, Giske NH, Andersen M. Biochem Syst Ecol 2007; 35(3): 153–9.
2. Евтухова ОМ, Теплюк НЮ, Леонтьев ВМ, Иванова ГВ. Химия растительного сырья 2000; 1: 77–9.
3. Sagdic O, Aksoy A, Ozkan G. Acta Aliment 2006; 35(4): 487–92.
4. Kananykhina EN, Pilipenko IV. Chem Nat Compd 2000; 36(2): 148–51.
5. Panteev AV, Batchilo AI, Grakovich ZV. Acta Hort 1995; 390: 133–6.
6. Shröder E. Laubgehölze. Leipzig, Interdruck, 1977.
7. Slinkard K, Singleton VL. Am J Enol Vitic 1977; 28: 49–55.
8. Rubinskiene M, Viskelis P, Jasutiene I et al. Food Res Intern 2005; 38(8–9): 867–71.
9. Giusti MM, Wrolstad RE. In: Wrolstad RE, Acree TE, An H et al. (eds.): Current Protocols in Food Analytical Chemistry. New York, 2001.
10. Scott KJ. In: Wrolstad RE, Acree TE, An H, et al. (eds.): Current Protocols in Food analytical Chemistry. New York, 2001.
11. Helrich K (ed.). Official Methods of Analysis. Arlington, 1990.
12. Karimova AR, Ynusova SG, Galkin EG et al. Russ Chem Bull 2004; 53: 245–50.
13. Andreeva TI, Komarova EN, Yusubov et al. J Med Pharm Chem 2004; 38(100): 548–50.
14. Deineka VI, Sorokopudov VN, Deineka LA et al. Chem Nat Compd 2005; 41(2): 162–4.
15. Евтухова ОМ, Теплюк НЮ, Шемберг МА. Химия растительного сырья 2002; 2: 139–42.

Laima Česonienė, Remigijus Daubaras, Pranas Viškelis

VIBURNUM PAVYZDŽIŲ PRODUKTYVUMO IR VAISIŲ BIOCHEMINIŲ KOMPONENTŲ ĮVERTINIMAS

Santrauka

VDU Kauno botanikos sodo lauko kolekcijoje įvertinti *Viburnum* genties pavyzdžiai, kurių vaisiai naudojami maistui, ir išskirti vertingiausi. Didžiausiu derlingumu ir kekių dydžiu išsiskyrė *V. opulus* veislės 'Krasnaja Grozď ir 'Leningradskaja Otbornaja', P3 klonas ir *V. trilobum* rūšis. Biocheminiais vaisių tyrimais nustatytas didelis askorbo rūgšties, antocianinų, fenolinių junginių bei karotinoidų kiekių varijavimas. Didžiausiu bendru fenolinių junginių kiekiu pasižymėjo *V. trilobum* ir *V. sargentii* rūšys.