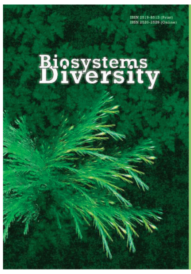

Biosystems Diversity

ISSN 2519-8513 (Print)
ISSN 2520-2529 (Online)
Biosyst. Divers.,
2019, 27(1), 56–61
doi: 10.15421/011909

Comparison of selected characteristics of cultivars and wild-growing genotypes of *Sambucus nigra* in Slovakia

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Article info

Received 29.01.2019
Received in revised form 07.03.2019
Accepted 10.03.2019

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Horčinová Sedláčková, V., Grygorieva, O., Vergun, O., Vinogradova, Y., & Brindza, J. (2019). Comparison of selected characteristics of cultivars and wild-growing genotypes of Sambucus nigra in Slovakia. Biosystems Diversity, 27(1), 56–61. doi:10.15421/011909

In view of global changes, it is necessary to consider plant breeding as a process of developing new varieties and cultivars for present and future needs, with an emphasis on improving their quantitative and qualitative characteristics. The aim of this study was to compare wild-growing genotypes of elderberry (*Sambucus nigra* L.) with three registered cultivars Haschberg, Sambo and Bohatka in selected economic traits in Slovakia. Characters of selected genotypes and cultivars were tested in dynamics of inflorescences and fruit clusters, the morphological parameters such as the weight of fruit clusters, weight and number of drupes and weight of cluster without drupes. On the cv. Haschberg we evaluated the number of inflorescences for each individual plant for a period of three years. A high number of inflorescences was established in the first 3 years of plant growth. This is evidenced by the measurements from the 2-, 3-, 4- and 5-year old plants with the number of inflorescences on average 21.3–25.7, 42.2–51.0, 65.1–73.7 and 99.0, respectively. The cultivars matured about two to three weeks later compared with wild-growing genotypes. The weight of the fruit clusters and the weight of drupes is an important trait in terms of plant production and efficiency of cultivation. For wild-growing genotypes, we also identified genotypes with a high weight of fruit clusters (111.1 g – SN-48) and weight of drupes (105.5 g – SN-48), which are determinant properties for selection of new genotypes for plant breeding and cultivation. The yield of juice is an important indicator for technological processing of elderberry fruit. For the cultivars the juice yield was found to range from 78.7% (cv. Sambo) to 82.9% (cv. Haschberg). We determined that the yield of juices of wild-growing genotypes ranged from 77.9–86.0%. The cultivar Haschberg had a better set of morphological traits compared to wild-growing genotypes, even though it was possible to find comparative genotypes in some characteristics. The results and knowledge obtained are useful for future breeders, cultivators, and processors of elderberries.

Keywords: elderberry; morphometric analyses; economic traits; inflorescences; drupes.

Introduction

The agriculture of the Slovak Republic needs to be prepared and adapted to the present or future situation in order to limit any adverse effects of climatic and environmental changes. Due to these global changes, it is necessary to consider plant breeding as a process of development of new varieties and cultivars for present and future needs with an emphasis on improving their quantitative and qualitative characteristics (Križanová et al., 2015). Plant genetic resources for food and agriculture is an essential element not only for growth but also for plant breeding. Slovakia is a country where one can still find old fruit plantations preserving the old varieties and landraces of fruit species (Benediková et al., 2015; Križanová et al., 2015).

The search for new and lesser-known plant species, the introduction and selection of these plants with higher production and content of biologically active substances, resistance and adaptability to biotic and abiotic factors significantly affects the stability and viability of crop production (Brindza et al., 2007, 2019; Grygorieva et al., 2014; Horčinová Sedláčková et al., 2018a). The plant breeding and reproduction of lesser-known and less-used species is important for various practical uses – bio-food, bio-dyes, biopesticides, bioremediation, bioenergy and others (Vinogradova et al., 2017; Klymenko et al., 2017; Rakhmetov, 2018). In this regard, the priority task is to assess the degree of variation of the genotype of cultivated plants, as well as search for new forms in the natural populations of their wild ancestors (Bolvanský et al., 2009; Monka et al., 2014; Ivanišová et al., 2017). In addition to the utilitarian value, such work is a necessary step in studying the rate of genome transformation and microevolution of species.

Genus *Sambucus* L. (Adoxaceae E. Mey.) contains a large number of ornamental cultivars, varieties, and forms. It is located on many continents, mostly in the mild and subtropical zone, very rarely located in the mountain areas of the tropics. According to Akerret et al. (2007), elderberry is one of the most frequently mentioned species of the genus *Sambucus* and it is one of the few species all of whose parts can be used (Bonet et al., 1999; Agelet & Vallès, 2003; Vallès et al., 2004). It had not been grown in the past, but wild-growing genotypes have appeared in all parts of our territory. With its soil-climatic conditions, great variation of terrain and excellent domestic and foreign cultivars, Slovakia offers rich opportunities for growing less widespread fruit species, such as the elderberry, which can be cultivated in climatically less favourable locations such as Malé Zálužie, Jahodná, Moťovská dolina.

The therapeutic effects of plant parts are used not only in folk medicine but also in the pharmaceutical and food industries. Due to the increasing interest in this species, breeding of this plant for acquiring new cultivars has been initiated. The advantage of cultural cultivars as compared with wild-growing genotypes is increased content of substances, greater inflorescences, higher production and resistance to biotic and abiotic environmental factors of the growing environment. The Research Institute of Fruit and Decorative Trees in Bojnice published and registered in the list of registered cultivars three cultivars; Sambo

(1983), Dana (1999) and Bohatka (1999), obtained by selection of natural material and subsequent evaluation in experiments (Machovec, 2013). Cultivar Haschberg was cultivated by cross-breeding in Klosterneuburg – Höhere Bundeslehr – und Versuchsanstalt für Wein und Obstbau in Austria (Hričovský, 2001). In the Slovak Republic, it has been cultivated since 1970 and registered in the list of registered cultivars since 1992 (List of registered varieties, 2018).

Since we have directed our attention to detection and selection of wild-growing genotypes in our previous experiments (Horčinová Sedláčková et al., 2018a, 2018b), the aim of the current study is to compare wild-growing genotypes and *Sambucus nigra* L. cultivars in selected characters, which are economically significant from the production and technological point of view. We suppose that in a natural wild-growing population we can detect such genotypes, which are comparable with cultivars in some evaluated characters. Thus, the knowledge acquired can be used in the selection of biological material for the breeding of new cultivars.

Materials and methods

Biological material. In the experiment, we evaluated 122 wild-growing genotypes of the elderberry population and 3 registered and cultivars in practical use; Haschberg, Sambo and Bohatka numbering 90 individuals in conditions of Slovakia. The plants were botanically identified in the Institute of Biodiversity Conservation and Biosafety of the Slovak University of Agriculture in Nitra. Photo-documentation was made at a plantation in Malé Zálužie. Samples were marked as SN (*Sambucus nigra*) and appropriate number, marks for cultivars Haschberg (SN-HA), Bohatka (SN-BA) and Sambo (SN-SA).

Morphometric and production analyses. Characters of selected genotypes and cultivars were tested for the following: dynamics of formation of inflorescences – 90 individuals (cv. Haschberg) of 2, 3, 4 and 5 annual plants at different planting ages; dynamics of formation of fruit's clusters (Haschberg, Sambo, Bohatka and wild-growing genotypes): weight of fruit clusters (g), n = 5 (SN-1 – SN-122) n = 10 (SN-HA, SN-BA, SN-SA) of the mature fruit; weight of drupes (g), n = 5 (SN-1 – SN-122) n = 10 (SN-HA, SN-BA, SN-SA) of the mature drupes; weight of cluster without drupes n = 5 (SN-1-122) n = 10 (SN-HA, SN-BA, SN-SA); number of drupes n = 5 (SN-1-122) n = 10 (SN-HA, SN-BA, SN-SA); yield of juices and dry matter content (%) – cv. Haschberg, cv. Sambo and cv. Bohatka. The yield is derived from the edible factor (0.7 for elderberry) by pressing the mashed fruit separated from the clusters. The fresh fruit samples were cleaned of stems and used in the experiments in quantities of 1 kg drupes from each sample measured by analytical balance (KERN DS – type D-72336, Kern and Sohn GmbH, Germany) accurate to 0.01 g. Fruit juice was obtained by pressing through the gauze; the flowers' dry matter content (%) of wild-growing genotypes and cv. Haschberg was assessed after using drying equipment (dryer Eta type 0301, Czech Republic) at 35 °C. The weights were evaluated by analytical balance (Kern ADB-A01S05, Germany), accurate to 0.01 g.

Statistical analysis. The variability of the test files was evaluated for each character using descriptive statistics. For the characteristics of the files, we used the basic descriptors of variability: average, minimum measured value, maximum measured value, the coefficient of variation (%). Data were analysed with the ANOVA test and differences between means compared through the Tukey-Kramer test. The degree of variability was determined by the coefficient of variation values. The given parameter is independent of the unit of the evaluated character. Theoretically, they can acquire different values (Stehlíková, 1998). We used the Dixon's Q test (DQn) at the significance level of $P < 0.05$ and 0.01 to find differences in yield of juices. To determine the differences in the set of genotypes, we used hierarchical cluster analysis, which can be represented using a dendrogram. The cluster dendrogram was performed in the free software for scientific data analysis PAST 2.10.

Results

For a more comprehensive evaluation of the economic value of elderberry and comparison of wild-growing genotypes and cultivars, we carried out morphometric analyses of inflorescences and fruit clusters, the technological analysis for the yield of juices and determination of dry matter content of flowers and fruits. These results can be used for the detection and selection of new potential genotypes for plant breeding purposes.

Dynamic of inflorescences formation. The dynamic of formation of inflorescences is an important economic trait. The development of the fruit also relates to the quantity of inflorescences. There is always a smaller number of fruit clusters than inflorescences on the plant. In the case of cv. Haschberg we evaluated the number of inflorescences for each individual plant for a period of three years.

Table 1
Dynamics of inflorescences formation
of cv. Haschberg (*S. nigra*) evaluated at different planting ages

Cultivar/Genotype	n	min	max	$\bar{x}$	V, %
	2008				
SN-HA 1-years plant	30	without inflorescences			
SN-HA 2-years plant	30	2	42	25.7	35.2
SN-HA 3-years plant	30	37	68	51.0	18.4
	2009				
SN-HA 2-years plant	30	10	32	21.3	27.2
SN-HA 3-years plant	30	14	67	44.3	33.7
SN-HA 4-years plant	30	53	91	73.7	14.1
	2010				
SN-HA 3-years plants	30	28	53	42.2	16.0
SN-HA 4-years plants	30	36	89	65.1	20.3
SN-HA 5-years plants	30	75	120	99.0	11.7

Note: n – the number of measurements; min, max – minimal and maximal measured values; $\bar{x}$ – arithmetic mean; V – coefficient of variation (%).

For 2-year old plants, an average of 21.3–25.7 inflorescences were formed for each individual, for 3-year plants 42.2–51.0 inflorescences, the 4-year plants had an average number of inflorescences in the range of 65.1–73.7, and 5-year plants 99.0 inflorescences per individual of cv. Haschberg. The coefficient of variation ranged from 11.7–35.2%, which shows a low to medium degree of variability (Table 1).

The dynamic of formation of fruit clusters. Weight of fruit clusters (g). In the evaluated cv. Haschberg, in 2008 we determined that the average weight of ripened fresh fruit clusters was in the range of 195.9–200.5 g (Table 2). In 2009 and 2010, we determined almost equal values, which ranged between 117.4–126.9 g. These differences may be due to different climatic conditions in individual years (e.g. dry, high rainfall). For cv. Sambo the average weight was 105.8 g and for cv. Bohatka 128.2 g. These measurements are compared to wild-growing genotypes (Table 3) with high values 97.9 g (SN-12) and 111.1 (SN-48). We can confirm that in natural populations genotypes with high production capacity were also found. For the Austrian Haschberg cultivar, we confirmed a high production potential.

Weight of drupes (g). The weight of drupes is proportional to the total weight of inflorescences. In the evaluations of cv. Haschberg for a period of three years we determined that this ranged from 171.3 g (3-year plants) to 205.9 g (2-year plants) in 2008. In 2009 and 2010, we recorded significantly lower values ranging from 112.0–120.4 g. There were no confirmed differences between the years 2008, 2009 and 2010 in the weight of inflorescences with regard to a relatively small collection of evaluated genotypes. Differences in measurements may be due to different climatic conditions in individual experimental years. The values of coefficients of variation varied between 22.6 (2009) and 55.8% (2008) and we documented a medium to high degree of variability among individuals, even within an individual (Table 2). Weights of cultivars showed higher values of the analysed parameter compared to the wild-growing genotypes. The results did not show a direct dependence between the age of the plants and the increase of drupes' weight on clusters. We selected 4 genotypes from the natural population with the highest values in the weight of fruit clusters and weight of drupes SN-03 (90.2 g), SN-12 (97.9 and 85.9 g), SN-48 (111.1 and 105.4 g), SN-54 (81.4 g), which could be a potential biological material for plant breeding new cultivars (Table 3). The cluster analysis was performed according to the hierarchical cluster analysis method using the mean value to distinguish similar groups among the various weights of fruit clusters of *S. nigra* genotypes.

Table 2
The variability of fruit clusters' weight and drupes' weight (g) of cultivars Haschberg,
Bohatka and Sambo evaluated at different planting ages and selected wild-growing genotypes of elderberry (*S. nigra*) in Slovakia

Weight of fruit clusters, g						Weight of drupes, g				
Cultivar/Genotype	n	min	max	x̄	V%	Cultivar/Genotype	min	max	x̄	V%
2008										
SN-HA 1-year plant	10					Without fruit clusters				
SN-HA 2-year plant	10	90.0	417.8	200.5	57.5	SN-HA 2-year plant	86.1	402.2	205.9	55.8
SN-HA 3-year plant	10	119.5	244.9	195.9	18.3	SN-HA 3-year plant	105.9	257.4	171.3	31.1
2009										
SN-HA 2-year plant	10	75.7	159.8	125.4	22.1	SN-HA 2-year plant	72.3	153.6	120.0	22.6
SN-HA 3-year plant	10	77.3	209.6	126.0	33.0	SN-HA 3-year plant	63.6	204.6	120.4	35.3
SN-HA 4-year plant	10	57.9	192.9	117.4	38.6	SN-HA 4-year plant	55.4	182.8	112.0	38.4
2010										
SN-HA 3-year plant	10	44.4	168.9	119.0	29.9	SN-HA 3-year plant	42.2	163.1	113.2	30.1
SN-HA 4-year plant	10	46.3	253.1	126.9	50.8	SN-HA 4-year plant	42.6	239.7	120.0	51.4
SN-HA 5-year plant	10	47.0	164.8	121.1	30.2	SN-HA 5-year plant	45.3	158.8	114.3	30.5
SN-BA	10	42.2	288.1	128.2	52.3	SN-BA	40.3	269.6	121.4	51.3
SN-SA	10	35.9	218.2	105.8	56.1	SN-SA	33.3	207.5	100.0	56.3
Genotypes with low character values										
SN-41	5	4.6	8.8	7.5	22.3	SN-62	2.1	11.5	6.5	54.2
SN-105	5	3.3	6.8	5.3	25.6	SN-105	3.0	5.8	4.7	23.9
SN-110	5	2.2	8.8	4.5	59.1	SN-110	1.3	4.5	2.6	49.8
Genotypes with high character values										
SN-48	5	59.9	155.4	111.1	33.6	SN-48	58.3	146.8	105.5	33.2
SN-12	5	82.5	137.5	97.9	23.1	SN-12	63.1	127.7	85.9	28.4
SN-03	5	65.3	152.3	90.2	39.7	SN-54	58.2	105.4	81.4	26.5

Note: n – the number of measurements; min, max – minimal and maximal measured values; x̄ – arithmetic mean; V – coefficient of variation (%).

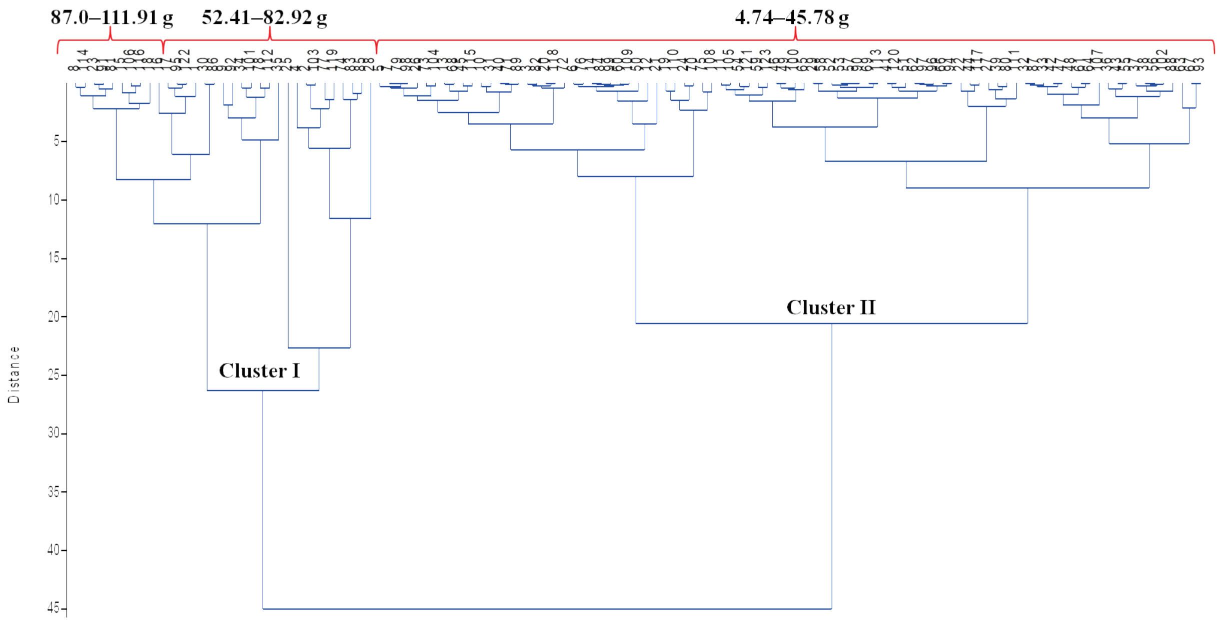

Fig. 3. Cluster analysis based on the weight of fruit clusters of wild-growing genotypes of *S. nigra*

Figure 3 clearly identifies significant differences between the tested genotypes of *S. nigra*. In this study, 122 genotypes were grouped into two main clusters based on the highest similarities. Cluster I is divided into two subclusters. Ist subcluster included only 9 genotypes ranging in weight from 87.0 to 111.9 g. Subcluster II contains genotypes ranging from 52.4 to 82.9 g. Cluster II comprises the majority of genotypes ranging from 4.7 to 45.7 g.

Weight of cluster without drupes (g). In the evaluation of weights of the cluster without drupes, we recorded following values 5.1–7.5 g (SN-H), 5.8 g (SN-BA), 6.7 g (SN-SA) and 0.6–9.9 g (SN-105 – SN-85). A low to high degree of variability was found for 3 cultivars (Table 3) and wild-growing genotypes (Table 5). Proportionality of weight of cluster without drupes depends on the fruit clusters' weight. If we compared a group of wild-growing genotypes and cultivars, we did not notice significant differences in this character.

Number of drupes. In Table 3 are shown the number of drupes per cluster for cv. Haschberg of different planting years. This trait shows average values in the range of 543.3–715.4 drupes per one cluster with a coefficient of variation 23.1–63.1%, which represents a medium to high degree of variability. In 2008, we detected on a 2-year plant up to 1806 drupes per cluster. Therefore, the results did not confirm the correlation between the age of plants and the number of drupes. These values in relation to the wild-growing genotypes range from 37.0 berries (SN-110) to 928.0 (SN-54) with low to high variability. We can conclude that it is possible to find genotypes which have a high production potential.

Flowers dry matter content. The values of dry matter content indicate a large variability in the water/dry matter ratio of elderberry flowers (Table 5). The coefficient of variation values for wild-growing genotypes are in the range of 0.6% (SN-08) to 37.5% (SN-20) and show a low to moderate degree of variability. These variations could be a result of the time series of individual measurements. When we evaluated dry matter content of cv. Haschberg, we measured 14.8–16.3% of dry matter content with a coefficient of variation in the range of 3.9–10.6%, which proved a low degree of variability of the trait.

Table 3
The variability in weight of clusters without drupes
and number of drupes of cultivars Haschberg, Bohatka and Sambo (*S. nigra*) evaluated at different planting ages

Cultivar / Genotype	Weight of cluster without drupes, g					Number of drupes				
	n	min	max	$\bar{x}$	V, %	cultivar/genotype	min	max	$\bar{x}$	V, %
2008										
SN-HA 1-year plant	10					Without fruit clusters				
SN-HA 2-year plant	10	4.0	16.2	7.5	52.9	SN-HA 2-year plant	401	1806	672.0	63.1
SN-HA 3-year plant	10	4.4	8.4	6.5	19.6	SN-HA 3-year plant	512	1049	715.4	25.4
2009										
SN-HA 2-year plant	10	3.4	6.6	5.1	3.4	SN-HA 2-year plant	398	839	543.3	23.1
SN-HA 3-year plant	10	2.9	13.7	5.7	2.9	SN-HA 3-year plant	363	1159	666.9	31.0
SN-HA 4-year plant	10	2.5	10.9	5.3	2.5	SN-HA 4-year plant	422	1178	701.2	37.1
2010										
SN-HA 3-year plant	10	2.5	8.3	5.9	31.4	SN-HA 3-year plant	154	948	660.0	36.6
SN-HA 4-year plant	10	3.7	13.2	6.7	43.8	SN-HA 4-year plant	252	1220	676.3	50.4
SN-HA 5-year plant	10	1.8	11.0	6.8	34.5	SN-HA 5-year plant	277	860	646.7	27.8
SN-BA	10	1.7	11.5	5.8	58.0	SN-BA	262	1170	655.8	52.9
SN-SA	10	1.7	18.4	6.7	70.5	SN-SA	240	1372	714.6	43.1
Genotypes with low character values										
SN-34	5	0.9	1.4	1.1	17.1	SN-31	18	60	37.2	46.1
SN-70	5	0.4	1.1	0.8	32.9	SN-63	27	98	65.2	47.7
SN-105	5	0.3	0.9	0.6	38.8	SN-110	20	62	37.0	53.6
Genotypes with high character values										
SN-10	5	5	3.8	13.5	6.8	SN-5	455	1199	839.4	39.4
SN-51	5	5	5.0	13.4	8.7	SN-25	627	1025	781.4	19.3
SN-85	5	5	5.7	12.4	9.9	SN-54	520	1208	928.0	28.0

Note: n – the number of measurements; min, max – minimal and maximal measured values; $\bar{x}$ – arithmetic mean; V – coefficient of variation (%).

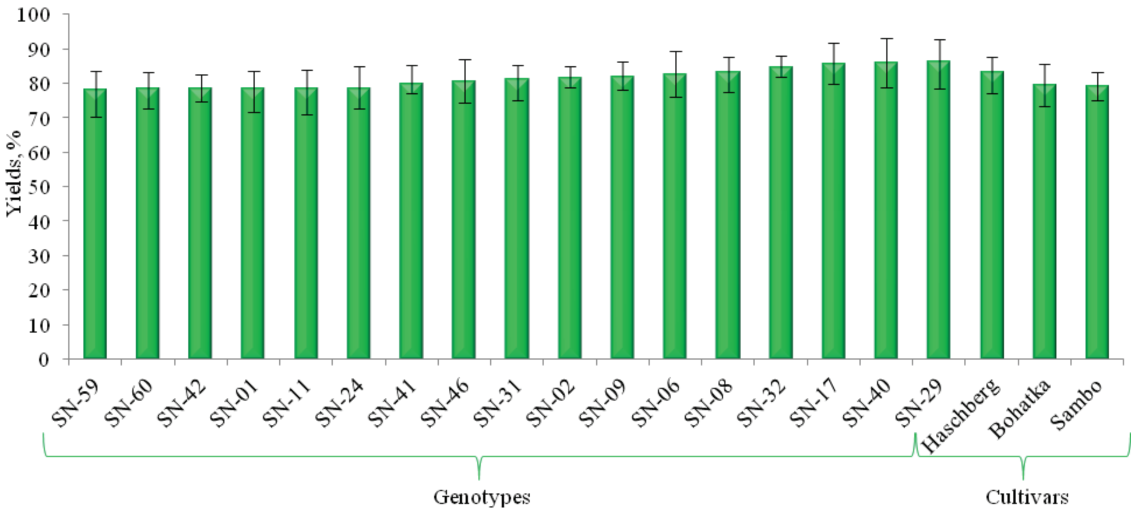

Fig. 4. Comparison of juice yields (%) of wild-growing genotypes and cultivars Hachberg, Bohatka and Sambo (*S. nigra*)

Table 4
Comparison of dry matter content (%) of flowers
of wild-growing genotypes and cultivar Haschberg (*S. nigra*)

Genotype / Cultivar	n	min	max	$\bar{x}$	V
Genotypes with low character values					
SN-80	4	12.6	13.4	13.0	2.5
SN-20	4	16.1	34.8	24.8	37.5
SN-08	4	22.2	22.5	22.3	0.6
Genotypes with high character values					
SN-45	4	52.8	54.2	53.3	1.1
SN-19	4	61.5	70.4	66.4	5.8
SN-12	4	71.0	75.9	73.1	3.3
Cultivar Haschberg					
SN-HA-1	4	14.3	15.8	14.8	4.6
SN-HA-2	4	15.6	17.2	16.3	3.9
SN-HA-3	4	14.1	18.3	16.2	10.6

Notes: n – the number of measurements; min, max – minimal and maximal measured values; $\bar{x}$ – arithmetic mean; V – coefficient of variation (%).

Yield of juices and fruit dry matter content. The yield of juice depends on fruit maturity, genotype and fruit presses used. The juice yield of cultivars was found to be 78.7% (Sambo), 79.3% (Bohatka), 82.9% (Haschberg) and that of wild-growing genotypes ranged 77.9–86.0%. We attempted to process only botanically fully mature drupes, which was much more difficult for wild-growing genotypes (Fig. 4).

Our results show that differences between cultivars and wild-growing genotypes are not statistically significant, even though there is a tendency is to increased yields in the south. However, this trend appears to be related to the determination of optimal botanical maturity, or to the exclusion of unripe drupes, which were commonly found in the wild-growing population. Increased attention was to be paid to selection.

The total dry matter content of the pressed fruit was ranged from 18.0–24.0%, with no statistically significant differences between the cultivars and wild-growing genotypes confirmed by the Dixon's Q-test. We have found that our DQn (0.86) is less than critical Qkr (0.94) at $P < 0.05$ and (0.98) at $P < 0.01$, and therefore the statistically significant difference between cultivars has not been confirmed. Similar results have also been detected for wild-growing genotypes.

Discussion

Fruit is red, later dark-blue to black-violet in colour, rarely greenish (Atkinson & Atkinson, 2002), drupes are of oblong shape and shiny with a small embryo in the oily endosperm (Watson & Dallwitz, 1994), which are formed to the cluster/corymb. They are, according to Atkinson, approximately 4–8 mm in diameter, mostly with three seeds (Atkinson & Atkinson, 2002). According to other data, they are 2–4 x 2 mm in size, egg-shaped, compressed, brown coloured (Pišťanková, 2002; Bolliger, 1999) and contain dark red coloured juice. Vulkanović et al. (2017) determined the weight of 10 drupes for cv. Haschberg (1.3 g) and for genotypes Prigorje (1.2 g), Zagreb (1.1 g) and Korcula (1.1 g). Bošnjaković et al. (2012) indicates an average weight of 10 drupes (1.7 g) for cv. Haschberg and for 10 wild-growing genotypes in Serbia (1.1–7.7 g). Kaack (1989) determined the weight of 100 drupes of cultivars (15–31 g), whereas Porpaczy & Laszlo (1984) recorded a significant variation in this trait (9–45 g). The average number of drupes was determined by Waźbińska & Puczel (2002), Porpaczy & Laszlo (1984) and Mratinić & Fotirić (2007) to be in the range of 100–300 drupes, 207–925 drupes and 131–280 drupes, respectively. Compared with the results obtained by the above-mentioned authors, we selected in the natural populations such genotype as SN-54), in which the highest number of drupes was found to be in the range 520–1208. The results obtained from the evaluated collection correspond to those of the authors.

Cluster/stems without drupes is a part of fruit clusters which is unusable in practice and it is considered as waste in technological processing. In Croatia, cv. Haschberg (92.2%) had the highest berry/stem mass ratio followed by genotype 'Prigorje' (91.7%), genotype 'Korčula' (91.3%) and lowest in genotype 'Zagreb' (89.5%) (Vulkanović et al., 2017). Elderberry fruits are harvested at botanical maturity in August and September and they are pressed either immediately after harvest or after short-term storage. The yield of juice depends on fruit maturity, genotype and fruit presses used. Comparisons of our data with data in the literature indicate that dry matter content of drupes in genotypes has a greater range 13.7–19.2% versus 18.2–18.6% (Kyzlink, 1968; Šťastný & Talajka, 1987). Bošnjaković et al. (2012) reported a dry matter content of 12.8% for cv. Haschberg and 12.3–17.0% for the wild-growing genotypes in Serbia.

The weight of fruit clusters is an economically significant production trait. The production capacity of individuals depends on the number and weight of fruit clusters. For this reason, the cultivation of elderberry in monoculture (Waźbińska & Puczel, 2002) and in landscaping (Waźbińska, 2000) has started to increase in many European countries. Vuković et al. (2017) measured 3 selected genotypes from wild-growing populations and cv. Haschberg in Croatia, where the average weights of fruit clusters were 67.2 g (cv. Haschberg), 56.2 g (Zagreb), 54.0 g (Pigorje) and 23.3 g (Korčula). Bošnjaković et al. (2012) found that the average weight of cv. Haschberg was 121.3 g and that for eight evaluated genotypes from natural populations it ranged from 64.9–241.5 g. Waźbińska & Puczel (2002) tested four Danish varieties (Alleso, Korsør, Sampo, and Samyl) and wild-growing genotypes in Poland for a period of three years (29.9–67.4 g). Hričovský (2001) reports an average weight of 5 fruit clusters (557 g) for cv. Sambo. Pišťanková (2002) determined this trait (62 g) for cv. Bohatka. Porpaczy & Laszlo (1984) determined the average weight in the wild-growing population to be in the range 32.1 to 186.2 g and according to Kaack (1997) 51–112 g. Our experimental results compared with other authors show a certain consistency. However, in the natural populations of Slovakia, we noted individuals with a greater number of fruits (~ 1200) than in other regions of Eastern Europe. Probably, selection in our country should be conducted precisely as the selection of multi-fruit forms. We consider the selection of forms with the largest fruits to be a less promising direction since we did not observe high variability in this character.

S. nigra and its fruits generally give a high yield of juice, and their industrial pressing is not a problem. In the cases of optimal botanical maturity, it is not necessary to use enzymatic preparations, although they are used in the pressing of not completely mature fruit (Balaštík, 2001).

Conclusion

The results distinctly declare that there are natural wild-growing genotypes which form a basis for future cultivars that achieve or exceed the characteristics of registered cultivars with their economic characteristics. For their detection, they need to be searched, evaluated and replicated for practical use. If we want to achieve a bountiful harvest every year, we need to harvest the quality biological material, the more recent useful and ornamental-useful species, the fertile cultivars, and we need to reach out to the latest cultivation technologies and experience.

The publication was prepared with the active participation of researchers in the international network Agrobionet, as a part of the international programme "Agricultural biodiversity to improve nutrition, health and quality of life" within the project ITMS 25 110 320 104 "Innovation of test methods and procedures for the detection of sources of bioactive substances for the improvement of health and quality of life". Experimental activities were realized in laboratories of Centre of Excellence for the Conservation and Use of Agrobiodiversity at the Institute of Biodiversity Conservation and Biosafety at the Faculty of Agrobiology and Food Resources, Slovak University of Agriculture in Nitra. Co-authors (51810109; 51810415) is grateful to the Visegrad Scholarship Fund and Bilateral Scholarship of the Ministry of Education, Science, Research and Sport (Slovak Republic) for the scholarship grant for the research stay during which the presented knowledge was obtained.

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