JOURNAL OF FRUIT AND ORNAMENTAL PLANT RESEARCH

VOL. X
2002

SKIERNIEWICE, POLAND

Jadwiga Waźbińska, Urszula Puczel
University of Warmia and Mazury
Department of Horticulture
Prawocheńskiego 21, 10-957 Olsztyn, POLAND

FRUIT CHARACTERISTICS OF ELDERBERRY (*Sambucus nigra* L.) GROWN ON TWO DIFFERENT SOILS

ABSTRACT. In 1998-2000 a field experiment was conducted to compare four Danish cultivars of elderberry (‘Alleso’, ‘Korsor’, ‘Sampo’ and ‘Samyl’) with its wild-growing form from the vicinity of Olsztyn, and also to compare two different sites of cultivations. The noble cultivars of elderberry and its wild-growing form differed from each other with respect to morphological features of fruits. A distinct difference in the morphology of umbels and fruits between plants grown at two sites was observed. Bushes grown in the soil rich in plant nutrients, class IV had more umbels and larger fruits.

Key words: elderberry, umbels, fruits

INTRODUCTION. In recent years, there has been a growing interest in alternative plants as a result of an improvement in crop technology

(Nalborczyk, 1999; Olejniczak and Rybiński, 1999). It may be then assumed that new plants in the near future will replace those traditionally grown in horticulture (Waźbińska, 1998a; 2000).

The plant which has high perspectives as an alternative in horticulture is elderberry (*Sambucus nigra* L.). Almost all its parts (bark, roots, leaves, flowers and fruits) have medicinal properties. On account of a relatively high content of poliphenolic and also flavonoidic compounds, according to the latest reports, the raw material of elderberry is considered a source of antioxidative and anticancer substances (Abuja et al., 1998; Moszczyński, 1996; Obidowska, 1998; Oszmiański and Lamer-Zarawska, 1995). The content of macro- and microelements in fruits is also important (Waźbińska et al., 1998). In the food industry, puree from elderberry constitutes a natural dye and its juice is used in biomedicine for making pharmaceutic syrups. In households, elderberry – based products such as jelly, juice, gum, jams and syrup are used (Waźbińska et al., 1996).

In spite of so many advantages, elderberry is not grown in Poland. Raw material used in the food industry and herbs are gained from wild-growing bushes. At present in many European countries this plant is grown on plantations within special farms from which healthy material is supplied. In Poland there is a lack of such farms. Air pollution as well as, water and soil contamination limit resources of the material and efforts for establishing ecological plantations, particularly in non-polluted regions (Endler et al., 1989; Trętowska et al., 1998). From the economic point of view the production of healthy material should be profitables, therefore an extent of the crop is also crucial (Waźbińska, 1998b).

The objective of this experiment was to evaluate four Danish cultivars of elderberry (‘Alleso’, ‘Korsor’, ‘Sampo’ and ‘Samyl’) and its wild-growing form from the vicinity of Olsztyn, and also to compare two different sites of cultivations.

MATERIAL AND METHODS. The research was carried out in 1998 - 2000 in the Experimental Garden of the University of Warmia and Mazury, Olsztyn from the 3rd to the 5th year after the plantation was established. The experiment was set in a randomized block design

and located at two sites differing in soil complexes, indicated as Kortowo I and Kortowo II. Four Danish cultivars of elderberry: 'Alleso', 'Korsor', 'Sampo' and 'Samyl' and one wild-growing form of this species coming from the vicinity of Olsztyn were tested. One-year-old bushes of elderberry were planted in the autumn of 1995 at a spacing of 1.5 x 3.0 m, which gave 2200 plants per hectare. At each site, the research was carried out on 9 plants of each variety, 3 plants in 3 replications. Black fallow was kept in rows and grass in alleyways (1 m). Grass was systematically mown.

Kortowo I was a site located at the foot of a slope of southern exposure. Soil was deluvial, developed from light silt on light sandy loam, pH 6.5, class IV a. Kortowo II was situated on a slope of western exposure, developed from sandy loam on a very heavy rusty clay, pH 4.7, class V. Before the experiment was set up, in 1995, both soils were analysed for some available nutrients in the samples taken from the top layer (Tab. 1).

Table 1. Content of bioavailable forms of some macroelements in the top soil layer (0-20 cm) at Kortowo I and Kortowo II, prior to the experiment – 1995

Site	Content [mg/100 g soil]				
	$N\text{-}NO_3$	P	K	Mg	Ca
Kortowo I	1.84	33.80	30.70	12.30	244.00
Kortowo II	2.58	35.90	14.90	8.00	100.00

From 1995 no mineral fertilizers were used, and at planting a single, organic fertilization was applied as well-decomposed manure at a rate of 13.5 kg per bush, which amounted to 30 t/ha.

Harvesting was conducted manually by cutting bunches with a pruning hook. During fruit harvesting the following measurements were taken:

- weight of one umbel and weight of 100 fruits as basic indexes of yield quality. These measurements were performed on a randomly chosen sample from 3 plants in 3 replications (9 plants). A sample consisted of 30 umbels randomly taken from typical stems of the plant, ten umbels per bush;

- number of fruits per umbel determined in a similar way as described above;
- diameter of fruits.

The data were statistically analysed using the Duncan`s t - test at P=0.05.

RESULTS AND DISCUSSION. Before the experiment was set up, in 1995, the content of macroelements in the top soil was high at both sites (Tab. 1). The quantities of phosphorous, potassium and magnesium were rated high (Sadowski, 1995). The amount of nitrogen prevailed at Kortowo II, however, at Kortowo I, the soil was more than twice richer in a non-mineralized humus which due to its gradual mineralization, released nitrogen. Calcium content was over 100% higher at Kortowo I, which was associated with the soil pH.

In 2000, the content of some available soil macroelements was estimated again. As compared to the pre-treatment analysis, the level of nitrogen, phosphorus, potassium and magnesium considerably decreased, while the calcium content remained similar. The quantity of available macroelements was still relatively high at Kortowo I. The other site was characterized by a considerably lower content of available forms of phosphorus, potassium and magnesium. At Kortowo II nitrogen level considerably decreased while at Kortowo I, due to a gradual mineralization of humus, such a decline was much smaller. Utilization of N by plants was very good, for the same quantity was in both studied layers (the elderberry roots shallow under soil surface).

The results obtained in 1998-2000, showed significant differences in fruit morphology between the cultivars of elderberry and its wild-growing form with regard to the weight of an umbel, fruit number per umbel and weight and size of fruits.

In 1998-2000, the mean number of fruits per umbel ranged from about 100 to over 300 (Tab. 2). Umbels the poorest in fruits were produced by bushes of wild-growing elderberry. Significantly more fruits were found in umbels of the cultivars, particularly ‘Sampo’ and ‘Samyl’. Similar results were obtained by Porpaczy and Laszlo (1984), who analysed several dozen bushes of elderberry, recording from 207 to 925 fruits per umbel.

T a b l e 2 . Number of fruits per umbel of noble cultivars and wild-growing form of elderberry, 1998-2000

Parameter	Cultivar/ form	Site**	1998	1999	2000	Mean for cultivar/form x site		Mean for cultivar/form
Number of fruits per umbel	'Alleso'	I II	330 170	295 180	298 215	I II	307.7 b 188.3 d	248.0 b
	'Korsor'	I II	350 153	225 210	157 90	I II	244.0 c 151.0 e	197.5 c
	'Sampo'	I II	380 190	310 260	306 143	I II	332.0 a 197.7 d	264.8 a
	'Samyl'	I II	360 210	340 230	310 152	I II	336.7 a 197.3 d	267.0 a
	wild-growing form	I II	220 100	215 165	161 110	I II	198.7 d 125.0 f	161.8 d
Mean for site x years		I II	328.0 a* 164.6 e	277.0 b 208.4 d	246.4 c 142.0 f	LSD $_{p=0.05}$ for year (1) – 8.61 LSD $_{p=0.05}$ for cultivar (2) – 11.11 LSD $_{p=0.05}$ for site (3) – 7.03 LSD $_{p=0.05}$ 1 x 2 – 20.01 LSD $_{p=0.05}$ 2 x 3 – 15.71 LSD $_{p=0.05}$ 1 x 3 – 12.17 LSD $_{p=0.05}$ 1 x 2 x 3 – 27.22		
Mean for site		I II	283.8 a 171.9 b					
Mean for years			246.3 a	242.7 a	194.2 b			

* Means followed by the same letter do not significantly differ at P=0.05 according to Dunkan`s t - t test

** I – Kortowo I
II – Kortowo I

The literature data indicate that the mean weight of an umbel may vary and depends mainly on cultivar and growing conditions and particularly on the amount of plant nutrients (Kaack, 1989; 1997; Porpaczy and Laszlo, 1984; Waźbińska, 1999). Thus, some umbels weighed from 32.1 to 186.2 g (Porpaczy and Laszlo, 1984) while others from 51 to 112 g (Kaack, 1997). In the present experiment the umbel weight was from 29.9 g to 67.4 g (Tab. 3). The smallest umbels were produced by bushes of wild-growing elderberry, which was also reported by Waźbińska (1999). Among the studied cultivars, the heaviest umbels were formed by 'Alleso', 'Sampo' and 'Samyl' while for 'Korsor' their weight was significantly lower. Similar results were obtained by Kaack (1989).

In all the years of the present study, bushes planted on the soil richer in nutrtiens at Kortowo I produced heavier umbels than those at Kortowo II. A large weight of umbels combined with a large weight of fruits makes their harvest easier and quicker, thus less labour-consuming (Kaack, 1989). In this experiment the highest weight of 100 fruits (33 g) was found for 'Sampo' and 'Samyl' cultivars. In general, the examined cultivars of elderberry produced heavier fruits than its wilde-growing form (Tab. 4). Kaack (1989) found that the weight of 100 fruits in particular cultivars and ecotypes varied from 15 to 31, while Porpaczy and Laszlo (1984) recorded even a higher fluctuation – from 9 to 45 g.

Elderberry cultivars and ecotypes differ from each other in the size of fruits. In the present study the fruit diameter averaged from 4.92 to 6.46 mm within the cultivars while for the wild-growing form it was 3.31 mm (Tab. 5). For comparison, Kadarova (1986) reports fruit diameter of 4.70-7.54 mm.

It appeared that the local form of wild-growing elderberry tested in this experiment was characterised by exceptionally small fruits and this was reflected in yield. Also, elderberry cultivars grown in acidic soil of class V, poorer in plant nutrients, produced relatively low yields and their fruits showed reduced parameters. Better results, however, can be achieved by raising the pH and applying additional fertilization.

T a b l e 3 . Weight of 1 umbel [g] of noble cultivars and wild-growing form of elderberry 1998-2000

Parameter	Cultivar/ form	Site**	1998	1999	2000	Mean for cultivar/form x site		Mean for cultivar/form
Weight of 1 umbel [g]	'Alleso'	I II	58.1 42.2	70.4 65.4	71.7 51.7	I II	66.8 a 53.1 bc	59.9 a
	'Korsor'	I II	60.3 40.2	49.7 40.5	41.6 26.8	I II	50.5 bc 35.8 d	43.2 b
	'Sampo'	I II	70.3 50.1	66.2 61.3	65.7 39.2	I II	67.4 a 50.2 c	58.8 a
	'Samyl'	I II	64.8 56.4	64.2 62.1	63.3 46.6	I II	64.1 a 54.4 b	59.3 a
	wild-growing form	I II	36.9 30.1	33.7 28.6	42.2 30.9	I II	37.6 d 29.9 e	33.7 c
Mean for site x years		I II	57.4 a* 43.4 c	56.8 a 51.9 b	56.9 a 39.0 d	$LSD_{p=0.05}$ for year (1) – 2.06 $LSD_{p=0.05}$ for cultivar (2) – 2.66 $LSD_{p=0.05}$ for site (3) – 1.69 $LSD_{p=0.05}$ 1 x 2 – 4.82 $LSD_{p=0.05}$ 2 x 3 – 3.93 $LSD_{p=0.05}$ 1 x 3 – 2.92 $LSD_{p=0.05}$ 1 x 2 x 3 – 6.53		
Mean for site		I II	57.3 a 44.9 b					
Mean for years			50.2 b	54.2 a	48.0 c			

*,** Explanation – see Table 2

T a b l e 4 . Weight of 100 fruits [g] of noble cultivars and wild-growing form of elderberry, 1998-2000

Parameter	Cultivar/ form	Site**	1998	1999	2000	Mean for cultivar/form x site		Mean for cultivar/form
Weight of 100 fruits [g]	'Alleso'	I II	24.0 18.1	30.0 25.1	24.3 23.0	I II	26.1 b 22.1 c	24.1 b
	'Korsor'	I II	21.0 17.6	23.0 19.2	23.0 22.0	I II	22.3 c 19.6 d	21.0 c
	'Sampo	I II	33.0 27.1	27.4 24.0	31.0 27.1	I II	30.5 a 26.1 b	28.3 a
	'Samyl'	I II	28.3 19.4	31.0 26.2	33.0 30.0	I II	30.8 a 25.2 b	28.0 a
	wild-growing form	I II	19.0 15.0	15.2 13.2	16.2 16.0	I II	16.8 e 14.7 f	15.8 d
Mean for site x years		I II	25.1 a* 19.4 d	25.3 a 21.5 c	25.5 a 23.6 b	LSD $_{p=0.05}$ for year (1) – 0.51 LSD $_{p=0.05}$ for cultivar (2) – 0.66 LSD $_{p=0.05}$ for site (3) – 0.42 LSD $_{p=0.05}$ 1 x 2 – 1.14 LSD $_{p=0.05}$ 2 x 3 – 0.93 LSD $_{p=0.05}$ 1 x 3 – 0.72 LSD $_{p=0.05}$ 1 x 2 x 3 – 1.62		
Mean for site		I II	25.3 a 21.5 b					
Mean for years			22.3 c	23.4 b	24.6 a			

*,** Explanation – see Table 2

Table 5. Fruit diameter [mm] of noble cultivars and wild-growing form of elderberry, 1998-2000

Parameter	Cultivar/ form	Site**	1998	1999	2000	Mean for cultivar/form x site		Mean for cultivar/form
Fruit diameter [mm]	'Alleso'	I II	5.10 4.30	6.65 3.17	6.61 5.90	I II	6.12 b 4.46 e	5.29 c
	'Korsor'	I II	5.80 4.80	5.30 3.04	5.70 4.90	I II	5.60 d 4.25 f	4.92 d
	'Sampo'	I II	7.10 6.00	6.95 5.10	6.80 5.50	I II	6.95 a 5.53 d	6.24 b
	'Samyl'	I II	7.05 5.60	7.10 5.90	6.80 6.30	I II	6.98 a 5.93 c	6.46 a
	wild-growing form	I II	3.07 2.80	3.00 2.97	4.20 3.80	I II	3.42 g 3.19 h	3.31 e
Mean for site x years		I II	5.60 c* 4.70 e	5.80 b 4.04 f	6.02 a 5.28 d	$LSD_{p=0.05}$ for year (1) – 0.083 $LSD_{p=0.05}$ for cultivar (2) – 0.108 $LSD_{p=0.05}$ for site (3) – 0.068 $LSD_{p=0.05}$ 1 x 2 – 0.186 $LSD_{p=0.05}$ 2 x 3 – 0.152 $LSD_{p=0.05}$ 1 x 3 – 0.118 $LSD_{p=0.05}$ 1 x 2 x 3 – 0.264		
Mean for site		I II	5.81 a 4.67 b					
Mean for years			5.15 b	4.92 c	5.65 a			

*,** Explanation – see Table 2

CONCLUSIONS

1. Cultivars of elderberry and its wild-growing form differed from each other in morphological features of fruits.
2. The largest mean weight of both umbels and fruits was found for 'Sampo' and 'Samyl' cultivars and the lowest for the wild-growing form.
3. Elderberry bushes grown in the soil rich in plant nutrients, class IV (Kortowo I) produced more umbels and larger fruits than those on acidic, poor soil of class V (Kortowo II).

REFERENCES

Abuja P. M., Murkovic M., Pfannhauser W. 1998. Antioxidant and prooxidant activities of elderberry (*Sambucus nigra*) extract in low-density lipoprotein oxidation. J. AGRIC. FOOD CHEM. 46: 4091-4096.

Endler Z., Markiewicz K., Michalczyk J. 1989. Zawartość metali ciężkich w liściach, kwiatach i owocach bzu czarnego. WIAD. ZIEL. 2: 5-6.

Kaack K. 1989. New varieties of elderberry (*Sambucus nigra* L.). DANISH J. PLANT SOIL SCI. 93: 59-65.

Kaack K. 1997. 'Sampo' and 'Samdal', elderberry cultivars for juice concentrates. FRUIT VARIETIES J. 51: 28-31.

Kadarova S. 1986. Študium ekotypov bazy čiernej. Vedeckě Prace Vyskumneho Ustavu Ovocnych a Okrasnych Drevin v Bojniciach, pp. 83-85.

Moszczyński P. 1996. Jak zmniejszyć ryzyko zachorowania na miażdżycę. Cz. IV. WIAD. ZIEL. 6: 13-14.

Nalborczyk E. 1999. Rośliny alternatywne rolnictwa XXI wieku i perspektywy ich wykorzystania. ZESZ. PROBL. POST. NAUK ROL. 468: 17-30.

Obidowska G. 1998. Substancje pochodzenia roślinnego w profilaktyce nowotworów. PRZEG. PIEKAR. CUKIER. 7: 2-4.

Olejniczak J., Rybiński W. 1999. Rola i możliwości wykorzystania roślin alternatywnych na przykładzie krajów Unii Europejskiej. ZESZ. PROBL. POST. NAUK ROL. 468: 31-45.

Oszmiański J., Lamer-Zarawska E. 1995. Naturalne flawonoidy w profilaktyce chorób układu krążenia. WIAD. ZIEL. 7/8: 27.

Porpaczy A., Laszlo M. 1984. Evaluation of elderberry (*Sambucus nigra* L.) clones based on the quality of the fruit. ACTA ALIMENTARIA 13: 109-115.

Sadowski A. 1995. Odżywianie mineralne roślin sadowniczych. In: S.A. Pieniążek (ed.), Sadownictwo, PWRiL Warszawa, pp. 178-220.

Trętowska J., Oprządek K., Syrocka K. 1998. Zawartość biopierwiastków i metali toksycznych w liściach i owocach bzu czarnego (*Sambucus nigra*) z Siedlec i okolic. Bromat. CHEM. TOKSYKOL. XXXI: 61-66.

Ważbińska J. 1998a. Nowe rośliny w uprawach sadowniczych północno-wschodniej Polski. Mat Konf. Nauk.-Promoc., "Lepsza Żywność", Olsztyn 27 czerwca 1998, pp. 255-260.

Ważbińska J. 1998b. Plonowanie bzu czarnego w pierwszym roku owocowania w warunkach Olsztyna. ZESZ. NAUK. AR W KRAKOWIE 333: 637-640.

Ważbińska J. 1999. Niektóre cechy morfologiczne odmian i ekotypów bzu czarnego (*Sambucus nigra* L.). Mat. VIII Ogólnopol. Zjazd. Nauk. "Hodowla Roślin Ogrodniczych u progu XXI wieku", AR w Lublinie, pp. 303-306.

Ważbińska J. 2000. Rośliny alternatywne w uprawach ogrodowych i parkowych północno-wschodniej Polski. BIUL. NAUK. 8: 309-315.

Ważbińska J., Kawecki Z., Majewska E. 1998. Zawartość związków mineralnych w owocach bzu czarnego u odmian szlachetnych i form dziko rosnących. XXXVII Ogólnopol. Nauk. Konf. Sad., Skierniewice 25-27 sierpnia 1998, pp. 271-273.

Ważbińska J., Nesterowicz J., Rafałowski R. 1996. Przetwory z owoców mało znanych. II Ogólnopol. Symp. nt. "Nowe rośliny i technologie w ogrodnictwie" 1, Poznań 17-19 września 1996, pp. 298-301.