Agronomic and alimentary evaluation of elder (*Sambucus nigra* L.) genotypes selected from natural populations of Hungary

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Summary: The black elder (Sambucus nigra L.) is a native plant in Hungary represented by extended and very variable populations. Cultivation of elderberry started during the late 90-ies because of the growing interests of the processing industry. High anthocyanin content, nutritive value of the berries and aromatic compounds of the flowers have been the esteemed constituents.
At the moment, there are about 3000 hectares elder plantations in Hungary, which is more than of any of the other European countries. Unfortunately, the cultures are planted to the Austrian selections of Haschberg, in spite of the fact that about 10–15 other selections of other foreign countries have been registered and planted elsewhere. In addition to that, the wild population of Hungary may offer a precious opportunity of further selection. Since 1970, Aladár Porpáczy at Fertőd and the Department of Fruit Growing of the former University of Horticulture in the 1980-ies started the selection in Hungary too.
The present study deals with 7 genotypes, their morphology of berries and inflorescences. Results are concentrated on four genotypes: Szcs-1, Szcs-2, Szcs-3 and Szcs-5, which are all earlier ripening than the Haschberg varieties, and are superior in characters of fruit and inflorescence.
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Introduction

The black elder is a member of the European flora and of the Caprifoliaceae family, a common shrub occurring as an undergrowth of deciduous and alluvial forests preferring ruderal habitats. Its growth is vigorous, the small tree reaches up to 6 m with procumbent branches in an irregular crown (*Gencsi & Vancsura*, 1992).

The young shoots are angular, green, then become corky with conspicuous warty lenticellae. The buds are conical and loose, rarely formed in the terminal position. The decussate leaves are composed by 5–7 leaflets (*Rápóti & Romváry*, 1990). The veins are elevated with sparse pubescence.

The inflorescence is a cymous pseudo-umbel (actually umbel), branching in a decussate system with around 1100 white or yellowish-white flowers (*Papp & Porpáczy*, 1999). The fruit is a glossy back berry with about 3 seeds, each enclosed by a stony endocarp, and a deeply coloured, juicy mesocarp (*Stoll & Gremminger*, 1997).

Elderberry has been collected and used for food and medicinal purposes, since long, in spontaneous elder stands (*Keipert*, 1981, *Kaack & Kidmose*, 1993, *Sipos*, 1998). Recently, elderberry has been detected by the food industry as a natural dye (*Albrecht, 1993, Stégerné* et al. 1999); and it has been the dynamic development of food industry, which urged the organisation of elderberry cultivation around the late 1990-es.

According to data of the Central Statistical Office (KSH), 1600 hectares of elderberry plantations existed in Hungary, 2000 (KSH, 2002), whereas experts already spoke about 3000 hectares in 2003. The precipitous development is founded on the high prices paid for the ripe fruit being 90–140 Forint per kg in 2003. The plantations in Hungary used the Austrian elderberry selection of *Haschberg* (*Sipos*, 2002).

The main reason of widening the assortment of genotypes was the necessity of lengthening the harvesting season in order to economise harvesting and processing. For that purpose the variability of Hungarian populations has been utilised.

Selected wild genotypes have been evaluated according to their morphology and properties which determine their agronomic and processing quality (*Szabó*, 2002). First, the most conspicuous morphological characters and the concentration of water-soluble substances have been assessed being easily performed in the experimental plantation.

Material and method

The plantation examined is located at Szigetcsép in the experimental farm of the University (BKÁE), where each of the collected clones are represented by 2–4 plants grown to 3 m distance and trained to a small tree with a stem and a crown with a few branches. The morphology has been established in 2000 and 2001. The properties examined are the subsequent ones:

- colour and number of flowers per umbel, diameter of the inflorescence.
- mass of 10 berries,
- size (diameter) of berries,

- number of umbels per plant,
- mass of one umbel,
- fruit yield per plant,
- blooming and ripening dates related to the *Haschberg* selections,
- uniformity of ripening within one umbel,
- ability of sucker formation,
- concentration of water soluble substances in the juice measured by optical refraction (ref%).

Results

The genotypes are described and their measured characteristics are presented. Observations have been collected during the whole growing period between March and the end of September, continuously. Table 1 and Figures 1 and 2 present the data.

Szcs-1

- shoots are purple with a green stripe, slightly hairy becoming later glabrous,
- leaves are relatively small, they resemble to potato leaves,
- leaflets are oval, the edges are serrate, their tip is tapered,
- the annual growth, i.e. the length of shoots was, relatively, the shortest,
- flowers are yellowish white,
- diameter of inflorescences, the pseudo-umbels are small, the number of flowers per umbel was about 900 as a mean, which has been superated by Szcs K1 and Szcs K2 only *(Table 1)*.

Szcs-2

- shoots are light green, vigorously growing, with bursting at earliest dates related to the rest of the genotypes studied,
- leaflets are elongated, lanceolate with wedge-shaped shoulder, strongly acuminate tip, dentate edge. The abaxial surface is initially hairy, later smooth,
- annual growth is medium vigorous,
- flowers are yellowish white,
- diameter of umbels is of medium size, the number of flowers per umbel was in both years more than one thousand *(Table 1)*.

Szcs-3

- shoots have a purplish tinge, buds burst unevenly, apical buds start earlier whereas lateral ones later,
- leaflets are elongate, the edges are serrate, the tips are acuminate, shoulders wedge-shaped,
- annual growth is the second less vigorous after Szcs1, medium robust,
- flowers have a purplish tinge, the number of flowers per umbel was more than thousand in both years *(Table 1)*.

Table 1 Inflorescence characters of black elder types

Types	Diameter of umbels			No. of flowers per umbel		
Years	2000	2001	2002	2000	2001	2002
Szcs-1	19.5	20.1	18.7	682–1150	717–1204	721–1136
Szcs-2	20.2	20.5	17.3	820–1510	693–1501	712–1342
Szcs-3	21.3	21.5	16.4	915–1185	887–1232	873–1125
Szcs-4	21.5	22	16.2	1120–1515	1139–1317	1063–1316
Szcs-5	25	24.5	20.1	995–1610	971–1521	1055–1530
Szcs K-1	20.5	20.4	16.1	645–1095	567–1014	675–1108
Szcs K-2	20.5	20.4	17.6	650–810	675–846	598–778
Haschberg	17.3	15.6	14.2	798–1196	675–1068	892–1208

Szcs-4

- shoots are light green, vigorous, with a purple stripe, bud burst ensues immediately after Szcs2,
- leaflets are tomentose, hard textured, wedge shouldered, narrow oval with long acuminate tip,
- annual growth of the shoots is one of the longest type,
- flowers are white, the umbels are large with more than 1200 flowers,

Szcs-5

- shoots are deep green with a purple stripe, vigorous,
- leaflets are deep green, large broad, almost round with wedge-shaped shoulder and long, acuminate tips,
- annual growth of shoots is the longest among the types studied, they tend to be vertical in position,
- flowers are white, the umbels are the largest among the types with 971 – 1521 flowers per umbel.

Szcs K-1

- shoots are green, thin, and the youngest leafs have a reddish tinge in early spring, whereas the buds of lower position burst but lagging,
- leaflets are decisively elongate, strongly serrate, asymmetric,
- annual growth of the shoots belongs to the medium group,
- flowers are white, umbels have been small in both years.

Szcs K-2

- shoots are light green tending to vertical position,
- leaflets are elongated with serrate edge, the shoulder is wedge-shapes having a relatively short petiole, during the beginning of the growing season yellowish drawings appear on the blades,
- annual growth is long and vigorous,
- flowers are white, the umbels have been the largest in both years, though the number of the flowers per umbel are relatively low *(Table 1)*.

Table 2 Fruit characters of black elder types during three years 2000 – 2002

Types	Mass of umbels (gram)			Number of berries per umbel			Mass of berries (gram per 10 berries)			Diameter of berries (mm)			Yield kg per plant		Number of umbels per plant		
	2000	2001	2002	2000	2001	2002	2000	2001	2002	2000	2001	2002	2000	2001	2000	2001	2002
Szcs-1	75.3	91.3	30.1	564	611	160	1.5	1.3	1.8	6.02	5.46	6.42	9.7	8.2	93	92	–
Szcs-3	95.4	90.8	80.9	511	527	403	1.7	1.6	2.0	6.06	6.00	6.05	9.5	9.4	112	105	120
Szcs-4	80.3	84.3	81.2	423	374	571	2.0	2.0	1.6	6.12	6.60	5.91	9.2	8.2	110	99	106
Szcs-2	98.5	111.9	68	632	933	523	1.2	1.2	1.3	5.41	5.25	5.64	12.6	13.5	156	122	188
Szcs K-1	89.2	96.8	75.8	714	709	486	1.5	1.4	1.7	6.03	5.98	6.53	9.8	10.1	115	108	147
Szcs K-2	106.7	113.2	101	512	584	513	2.0	1.8	1.9	6.44	6.37	6.45	11.0	13.0	110	114	113
Szcs-5	132.3	150.6	55.3	812	857	334	1.8	1.7	1.7	6.56	6.34	6.64	19.8	20.2	245	155	262
Haschberg	129.1	136.2	96.7	886	902	534	1.8	1.83	1.81	6.32	6.28	6.46	28.4	19.8	289	129	136

Table 3 Phenological properties of black elder types

Type	Blooming period	Ripening period	Suckers
Szcs-1	before *Haschberg* 10–12 days	before *Haschberg* 12 days	no suckers
Szcs-2	before *Haschberg* 5–7 days	before *Haschberg* 8–10 days	weak
Szcs-3	before *Haschberg* 5–7 days	before *Haschberg* 6–8 days	no suckers
Szcs-4	together with *Haschberg*	before *Haschberg* 4–5 days	vigorous
Szcs-5	together with *Haschberg*	before *Haschberg* 4–5 days	strong
Szcs K-1	after *Haschberg* 4–6 days	together with *Haschberg*	weak
Szcs K-2	after *Haschberg* 5–7 days	together with *Haschberg*	

Agronomic characters have been observed through 3 years except the yield, which has been successfully assessed at due time in 2002 only, because the berries have been illegally harvested in other years.

Results are presented in *Tables 2, 3, 4* and in *Figures 3, 4, 5*. It is obvious that **Szcs-5** proved to be the best from different points of view. Accumulated yield, mean mass of the umbels with fruit has been superior over the rest of genotypes. Water soluble ingredients have been also among the favourable ones, though the annually measured values of the 3 years were rather variable. Maturity ensues a few days earlier than in the Haschberg selection *(Table 3)*, the berries are large, ripening rather synchronously. Yielding capacity is comparable with that of the Haschberg variety, but outyielded it in 2001. As less favourable traits, the super-vigorous growth and the tendency to grow many basal suckers, are to mentioned.

Among the types studied **Szcs-1** has ripe fruits two weeks earlier than Haschberg *(Table 3)*. Its growth is weak but uniformity of ripening within one umbel is acceptable. Its yield is the lowest in the present experiments *(Table 2, Figure 3)*, and the umbels are small. Water soluble solids are stable in the 3 years *(Table 4, Figure 4)*, there was but little seasonal variation, in two years the best values are achieved. **Szcs-1** and **Szcs-3** did not grow suckers at all.

Szcs K- and **Szcs K-2** are the latest ripening types *(Table 3)*. From the agronomic point of view **Szcs K-2** proved to be superior because of larger umbels, more voluminous berries and yield *(Table 2)*, however, the uniformity of ripening is inferior.

Berries of **Szcs-2** are smaller but the umbels are larger *(Table 2)*, its growing potential is equal with the Haschberg variety. **Szcs-3** is the less vigorous, though its yield was relatively profuse and other properties satisfactory. Both types ripen earlier than the Haschberg variety.

Table 4 Variation of the content in water soluble substances through three years in black elder types

Types / years	Optical refraction%		
	2000	2001	2002
Szcs-1	14.4	16.5	11.4
Szcs-2	12.8	12.1	9.4
Szcs3-	11.6	12.1	9.8
Szcs-4	13.6	14.1	9.6
Szcs-5	18.6	14.6	9.1
Szcs K-1	18.9	13.7	9.0
Szcs K-2	11.2	11.2	8.9
Haschberg	14.2	12.2	9.1

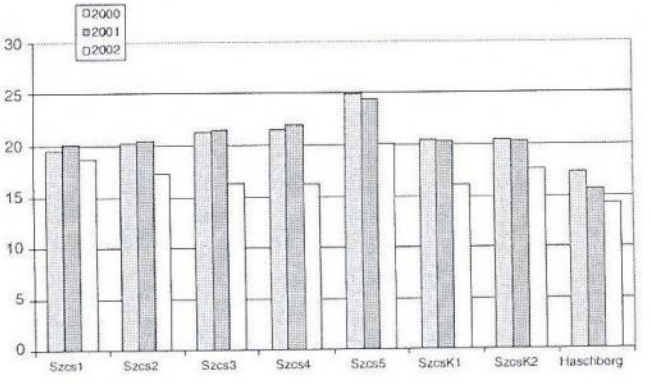

Figure 1 Variation of the diameter (cm) of inflorescences in elder accessions

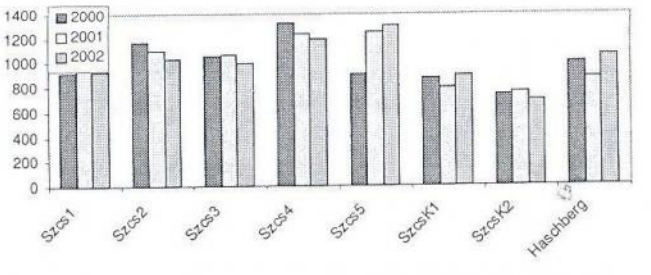

Figure 2 Number of flowers per umbel during three successive seasons

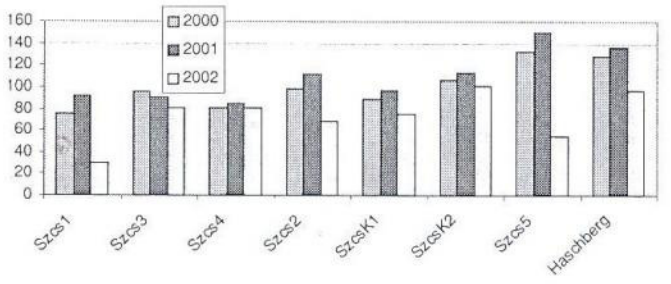

Figure 3 Mass of the umbels with ripe fruit in elder accessions during the three successive seasons (g per umbel)

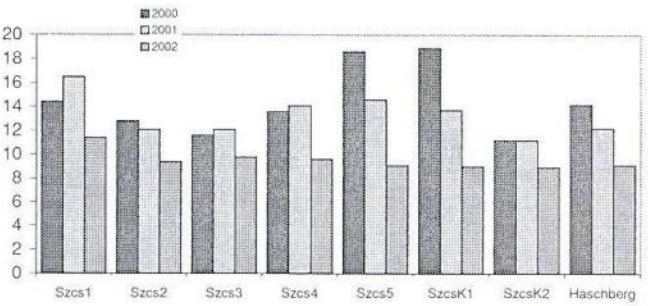

Figure 5 Content of water soluble substances in black elder fruit during the three-year-period measured by optical refraction (%)

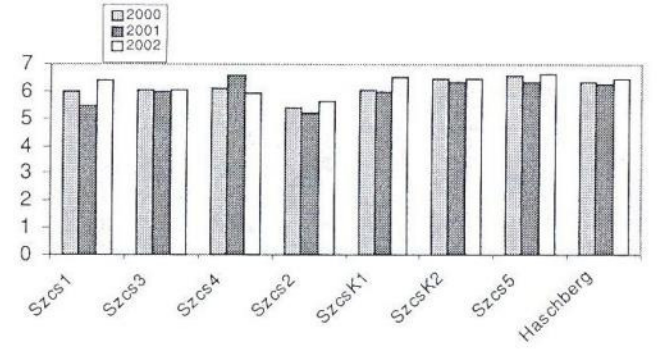

Figure 4 Diameter (mm) of elderberries grown on different accessions during three successive years

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