Evaluation of elder *(Sambucus nigra)* varieties and candidates for the canning industry
Results of the composition studies

INTERNATIONAL JOURNAL OF HORTICULTURAL SCIENCE
AGROINFORM Publishing House, Hungary

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Key words: Sambucus nigra, ascorbic acid, mineral compounds, composition

Summary: *Sambucus nigra* is a very common elder species in Europe. Due to its excellent composition, natural dye content and healing power it can be considered as a biological active plant. In Hungary the cultivation of *Sambucus nigra* started in the nineties and since that time there is a growing demand for this plant. *Sambucus nigra* is a special fruit due to its sole application for processing industry. Partly fruit products are made of it, partly it is used as a natural dye. In both cases the first step is the knowledge and evaluation of the composition of the various elder varieties and candidates. For that reason composition studies of different elder types were performed in several years at the Department of the Canning Technology of the Szent István University.

The most important sample was the *Haschberg* variety, which is the sole elder type accepted and allowed for propagation by the government. This plant is grown in the Pilot Plant of the Szent István University in Szigetcsép. Among the studied samples there were some varieties cultivated in the Fertőd Research Station. They were the following types: *No. 33, 480* and *481*. Besides elder collected wild in Szigetcsép and the very promising early-ripened *SZ-CS 21–23* variety originated also from Szigetcsép were investigated. One year it was possible to study the Sambu variety, too. Department of the Fruit Culture of the Szent István University helped to obtain the various elder types and candidates. Along our experimental activities, the following components and parameters were studied: the content of pectin, organic acid, carbohydrate, mineral, vitamin C, total acid, aquesoluble dry material, anthocyanin and the pH.

After having obtained a juice, a concentrate from the species has been made and – after freezing – the aquesoluble dry substance and the acid content, as well as the colour parameters were monitored. Studies were performed in two years (1997–98). On the basis of these results classes were established for all compounds, from which an overall ranking was derived.

It was found that in both years the *Haschberg* variety proved to have the best composition. Therefore regarding to the overall series of order the experiments performed in the second year supported the results obtained in the previous year. Results have shown that *Sambucus nigra* has excellent composition beside its curative effect. Its mineral content has surpassed that of the other fruits and it had advantageous acid- and carbohydrate composition. The ascorbic acid content of the *Haschberg* variety is striking. It can be concluded from the experiments that the *Haschberg* type has the most advantageous composition, therefore it is suitable for making special curative and exclusive products.

Introduction

In Hungary the cultivation of *Sambucus nigra* started in the nineties and since that time there is a growing demand for this plant. In 1997 Hungary had 150–180 hectare plantation giving about 1500–2000 tons crop per year. According to some surveys the Hungarian entrepreneurs applied for about 400- hectare land to cultivate *Sambucus nigra* in 1998. Beside grown elder there is a huge amount – about 30–35000 tons – which is collected on wild growing plants, however, its quality is not uniform.

At the I. National Meeting (held on the 4th of December 1998) of the farmers, manufacturers and merchants dealing with *Sambucus nigra* they put the following aim for their association: to substitute the huge amount of elder growing wild with cultivated types.

Sambucus nigra is a special fruit due to its sole application for processing industry. Partly fruit products are made of it, partly it is used as a natural dye.

The elderberry components are very valuable. This fruit contents essential amino acids: threonine, valine, leucine, phenylalanine, lysine and histidine, which very important for infants *(Schmidt*, 1987). Moreover its iron content has a great importance, sometimes occur 14-16 mg/l iron content *(Schmidt*, 1987; *Stoll-Gremminger*, 1986 & *Souci* et. al., 1991). Elderberry has high content of calcium, this value is among 190–500 mg/l *(Weiss & Samann*, 1980; *Souci* et. al., 1994 & *Holland* et. al., 1992).

In this raw material the sugar content mainly come from fructose and glucose, the sucrose occur just in trace, which has a great advantage for human health *(Souci* et. al., 1994). The high quantity of anthocyanins gives the possibility to use this plant as a natural food colorant agent *(Kaack*, 1997).

In both cases the first step is the knowledge and evaluation of the composition of the various elderberry varieties and candidates. For that reason composition studies of different elder types were performed in two years at the Department of the Canning Technology of the Szent István University.

Material and methods

The most important sample was the *Haschberg* cultivar, which is the sole elderberry type accepted and allowed for propagation by the government. This plant is grown in the Pilot Plant of the Szent István University in Szigetcsép. Among the studied samples there were some varieties from the Fertőd Research Station. They were the following: *No. 33, 480* and *481*. Besides elderberry gown wild collected in Szigetcsép and the very promising early- ripened *SZ-CS 21–23* variety originated also from Szigetcsép were investigated. One year it was possible to study the *Sambu* variety, too. Department of the Fruit Production of Szent István University helped to obtain the various elder types and candidates.

Determination of the pectin content. Principle of the method: pectins are extracted by addition of alcohol. All pectins can be determined from the residue. Colorants formed from the extracts by adding carbazole and sulphuric acid are measured by a photometer. The following chemicals are required: 96% and 63% alcohol, 0,75% ammonium oxalate, concentrated sulphuric acid, 0,1% alcoholic carbazole and galacturon acid monohydrate. Procedure of the measurement: 3–4 g of the studied fruit was weighted, then washed by 12 cm^3 distilled water into a graduated conical 50 cm^3 centrifuge tube. It was filled to 40 cm^3 by adding hot 96% ethanol to it and warmed to 85 °C during 10 minutes in water bath, whilst it was stirred continuously. Mixture was filled to 50 cm^3 and centrifuged (for 15 minutes at 50 f/s). The supernatant was decanted and the residue was washed with 63% ethanol in 85 °C water bath for 10 minutes. It was centrifuged again and the supernatant was decanted. Residue was washed in a 100 cm^3 flask, 5 cm^3 of 1M NaOH was added to it and it was filled to scale with distilled water. During the 15 minute holding time the flask was continuously shaken. It was filtered and calorimetric measurement was performed on the filtrate. 1–1 cm^3 of the extract was pipetted to 20 cm^3 polished test tube. 0,5 cm^3 of 0,1% alcoholic carbazole was put in the test tube (at two paralel measurements), while in blank test 0,5 cm^3 of purified ethanol was added. In the sample test tubes white muddy residue was formed. To each test tube 6 cm^3 of concentrated sulphuric acid was added during continuous mixing. Test tubes were immersed immediately in 85 °C water bath for 5 minutes then cooled down during about 15 minutes. Absorbance of the sample compared to the reference solution was measured at 525 nm by a Hitachi U-2000 spectrophotometer. Calibrating curve is necessary to take for the measurements. It can be done by preparing dilution series from galacturon acid monohydrate solution and by measuring absorbances of them.

Calculation can be made by the following formula:

$$\text{Pectin content (mg/g)} = (A \times V_1)/V_2 \times m) \times \text{dilution},$$

where

A: value at the given point of the calibration curve (galacturon acid μg)

V_1: volume of the extract (100 cm^3)

V: volume of the extract applied for colour test (1 cm^3)

m: mass of the sample (g).

Number of the parallel measurements: 5. (Department of dietetics, 1989).

Determination of the total dry content. The essence of the procedure is to evaporate water by warming of the sample and the mass loss is measured. Samples were homogenised in a shaker, then 10 g was weighted in a polished Petri dish and dried to equilibrium mass at 105 °C. It was cooled down in an exsiccator then measured again.

Calculation is made by the following formula:

$$\text{Dry content (\%)} = 100 \times (m_{sza}/m_{na}),$$

where

m_{sza}: mass of the dry material

m_{na}: mass of the weighted material.

Number of parallel measurement: 5. (Hungarian *Standard*, 1980).

Determination of organic acids. Organic acids were determined by high- pressure liquid chromatography (HPLC) in the Central Laboratory of the University of Horticulture and Food Industry. At the measurements CATEX 16-H columns with 250 mm length and 8 mm inner diameter were applied. 0.0006 M sulphuric acid was used as an eluent. The pressure was 47 bar, while the temperatures was 45 °C. The photometer was working in UV range performing measurements at 210 nm *(Vitányi*, 1996).

Determination of carbohydrates. Carbohydrates were determined also by HPLC in the same laboratory as the organic acids. Both measurements were performed on crude elder juice.

Parameters, columns and the filling material were the same as for the organic acids. The two procedures were different in the eluent: for carbohydrates acetone nitrile: water mixture was used in a 20:80 ratio and detection was done by a refractometer. *(Vitányi, 1996)*

Determination of water-soluble solids content. Water-soluble dry content was determined by a Bellingham Stanely LTD RFM 330 refractometer.

Determination of pH. Solutions were diluted to 10% refraction. 10 cm^3 was taken and filled to 100 cm^3 by distilled water. Measurement was performed by a Metrohm 682 type titrimeter with end point indicator. Number of parallel measurement: 5. *(Hungarian Standard, 1985)*

Determination of the total acid content. Elder juice was diluted to 10% refraction, 10 cm^3 of it was weighted and filled to 100 cm^3 with distilled water. Measurement was done also by a titrimeter. Titration is made by means of 0.1 M NaOH by using end point indication determined on pH basis. Results are available in g/litre and are expressed in citric acid. Number of parallel measurement: 5. *(Hungarian Standard, 1983)*

Determination of the mineral content. Amounts of the mineral components were determined by flame photometry. This method is a quantitative spectrometric one using flame excitation. Sample is sprayed into flame, then the intensity of the emitted light is directly measured. The procedure is one type of the emission spectrometry. Inductively coupled plasma (ICP) burners are the most widespread which are working at high frequency current. In these burners plasma is created generally in argon by conducting high-frequency current in a coil with 2–3 turns. After ignition the high-frequency field maintains discharge. The temperature of the plasma is 6000–8000 K. Solution to be studied is atomised into the plasma. Due to the high temperature the components of the solution are dissociated and the high density of electrons creates an almost stationary ionisation. Lines of all the elements present in the sample are emitted simultaneously by the plasma, therefore about 20–40 elements can be simultaneously measured by plasma spectrophotometers. Measurement was performed by an ICP-9000 Thermo Jarell Ash instrument in the Department of Chemistry and Biochemistry of the University of Horticulture and Food Industry. For carrying out the measurement special sample preparation is required as follows:

Raw material has to be shaken, then dried to equilibrium mass. 3 x 0.2 g of this dried matter were weighted in sealed plastic crucible. 2 cm^3 of H_2O_2 and HNO_2 solutions were added to it. It was mixed, closed and left for one day. Next day it was heat treated in cook's. After cooling down it was washed in a 25 cm^3 measuring flask, then filtered. Determination of the mineral content was done from this solution. Number of parallel measurement: 3. *(Hungarian Standard, 1983)*

Evaluation method. Taking into account some important properties of them ranked the various elderberry varieties. At juice yield the 1[st] grade was given to the variety which had the highest juice yield, while the one with the minimum value owned the last place. The reason is that the more juice can be obtained from a given elder variety, the more economic is the processing, therefore the type is more valuable for producing juice. Regarding to the ref. % of the juice, 1[st] grade was given to the type that had the highest water-soluble dry content and the number was increased by decreasing of the ref. %. At the evaluation of carbohydrate content the 1[st] grade was given to the type with the highest values regarding to the glucose and fructose content, too, while the highest numbered class relates to the variety with the minimum carbohydrate content. Evaluation of the ascorbic acid content was done in a similar way. Evaluation of the mineral content was preceded by a preliminary classification, because in this case evaluation of several elements has to be performed together. In the enclosed Tables the final classification is presented. At the evaluation of the pectin content classes were derived by taking into consideration the applicability of the elder varieties for juice production, which corresponds to our aim. To obtain juice the pectin content must be as low as possible, therefore the first class was given to the variety, which had the smallest pectin content.

Taking into account all respects mentioned above did the overall classification.

Results and discussion

Evaluation of the Haschberg variety

This type preceded all the others both in 1996 and 1997 regarding to the total dry – and the water-soluble dry contents. Since *Sambucus nigra* is mainly used for producing juice and concentrate, it is a very important property. The water-soluble dry contents of *Sambucus nigra* were 17.5% and 16.2% respectively, which are striking values *(Table 1)*. According to the studies made in the second year, it occupies the first place by taking into account its carbohydrate-, mineral- and ascorbic acid contents. It exhibited a prominent ascorbic acid content in 1997 (130 mg/100 g), which can be seen in *Table 4*.

Regarding to the pectin content it is in the middle of the ranks. If we take into consideration the other valuable components of *Sambucus nigra* (e.g. its iron contents of 81.2 and 85.8 μg/g, see *Table 5)* and its applicability for juice and jam production, it has to be put to the first place of the overall classification in both years *(Tables 6* and *7)*.

Table 1 Composition of *Sambucus nigra* varieties and candidates (1996–1997)

Variety	Dry materials content (%)				Pectin content (%)				Water soluble dry content (%)				Juice yield (%)	
	1996		1997		1996		1997		1996		1997		1996	1997
	$\bar{x}$	±s	$\bar{x}$	±s	$\bar{x}$	±s	$\bar{x}$	±s	$\bar{x}$	±s	$\bar{x}$	±s		
Haschberg	29.36	0.09	25.08	0.33	0.84	0.021	0.44	0.026	17.5	0.011	16.2	0.014	46	45
F33	25.79	0.074	20.15	0.12	0.91	0.014	0.44	0.023	16.6	0.01	9.2	0.01	40	39
F480	22.78	0.09	20.97	1.65	0.74	0.017	0.31	0.015	11	0.014	9.5	0.01	48	40
F481	18.05	0.12	20.88	0.04	0.75	0.020	0.33	0.015	10.4	0.011	8.5	0.017	58	48
Wild	22.45	0.17	24.02	0.14	0.56	0.018	0.43	0.015	11.5	0.012	8.8	0.019	42	51
Sambu	–	–	19.86	0.06	–	–	0.35	0.030	–	–	10.1	0.02	–	25
SzCs 21–23	–	–	19.93	0.07	–	–	0.53	0.015	–	–	13.2	0.01	–	38

n=5 (number of measurement) – no data

Table 2 Organic acid content (in g/100 g) of *Sambucus nigra* varieties and candidates

Variety	Citric acid				Malic acid				Oxalic acid		Succinic acid	
	1996		1997		1996		1997		1997		1997	
	$\bar{x}$	±s	$\bar{x}$	±s	$\bar{x}$	±s	$\bar{x}$	±s	$\bar{x}$	±s	$\bar{x}$	±s
Haschberg	1.67	0.01	2.05	0.014	0.26	0.014	1.8	0.017	1.45	0.011	0.43	0.014
F33	0.83	0.01	2.29	0.01	0.08	0.015	0.83	0.014	0.49	0.012	0.14	0.012
F480	1.65	0.011	1.49	0.012	0.09	0.014	0.8	0.014	1.5	0.014	0.01	0.012
F481	1.03	0.014	1.68	0.01	0.12	0.014	0.79	0.012	0.76	0.015	0.21	0.011
Wild	0.51	0.012	0.89	0.01	0.05	0.011	0.8	0.011	0.3	0.012	0.04	0.01
Sambu	–	–	0.68	0.010	–	–	0.38	0.01	–	–	–	–
SzCs 21–23	–	–	0.92	0.012	–	–	0.53	0.01	–	–	–	–

n=5 (number of measurement) – no data

Candidate No. 33 from Fertőd

Regarding to the juice production it took the fifth place in both years. The high pectin content of this type *(Table 1)* supported this rank. Therefore it can be suggested to use for production of jam and jelly. This type is disadvantageous due to its low ascorbic acid content (29.5 and 30 mg/100 g, respectively). It has significant amount of carbohydrate content and its low sucrose content is very advantageous *(Table 3)*.

Candidate No. 480 from Fertőd

This species exhibited striking mineral content in the first year *(Table 5)*. It had also high amounts of heavy metals (e.g. Pb (19.3 mg/g), Hg (15.1 mg/g)). Next year it did not have such prominent values.

Regarding to its composition, this variety can be considered to be advantageous, since it occupies the second or third places in the classification. Therefore it can be suggested for industrial processing.

Candidate No. 481 from Fertőd

This variety owns one of the lowest pectin contents, therefore it can be utilised for producing juice. This type gives off the highest amount of juice *(Table 1)*.

Its ascorbic acid content can be classified as medium *(Table 4)*, while regarding to its dry matter and carbohydrate content, it was placed to the bottom of the list.

Table 3 Carbohydrate content (in g/100g) of *Sambucus nigra* varieties and candidates (1996–1997)

Variety	Glucose				Fructose				Sucrose			
	1996		1997		1996		1997		1996		1997	
	$\bar{x}$	±s	$\bar{x}$	±s	$\bar{x}$	±s	$\bar{x}$	±s	$\bar{x}$	±s	$\bar{x}$	±s
Haschberg	0.7	0.01	6.03	0.015	2.41	0.01	5.5	0.014	0.3	0.01	0.5	0.01
F33	1.68	0.012	2.8	0.014	3.44	0.014	2.75	0.015	0.56	0.01	0.5	0.01
F480	1.26	0.011	4.28	0.014	2.75	0.011	3.69	0.014	0.1	0.012	0.5	0.01
F481	0.56	0.01	4.21	0.017	1.79	0.012	3.56	0.012	0.1	0.014	0.5	0.01
Wild	1.12	0.014	4.28	0.014	0.83	0.01	3.49	0.011	0.56	0.012	0.5	0.01
Sambu	–	–	5.33	0.016	–	–	3.35	0.012	–	–	0.5	0.01
SzCs 21–23	–	–	4.28	0.014	–	–	2.89	0.014	–	–	0.5	0.01

n=5 (number of measurement) – no data

Table 4 Ascorbic acid content (in mg/100 g) of Sambucus nigra varieties and candidates

		Haschberg	F33	F480	F481	Wild	Sambu	SZCS 21–23
1996	$\bar{x}$	32.8	29.5	30.3	31.3	35.4	–	–
	±s	2.4	2.54	2.68	3.1	2.98	–	–
1997	$\bar{x}$	130	30	40	40	50	20	20
	±s	3.68	2.14	2.47	2.68	3.04	2.99	1.78

n=5 (number of measurement) – no data

Summarized it can be stated that the elder varieties originated from Fertőd neither have fulfilled the expectation nor surpassed the *Haschberg* type regarding to their composition.

Evaluation of the Sambu variety

Regarding to the juice yield it owns the last place, because it gives off hardly its juice *(Table 1)*. This type is disadvantageous due to its low ascorbic acid content. However it has significant amount of Ca and the highest amount of K, too *(Table 5)*.

Evaluation of elderberry collected wild

This is a type grown and collected wild in Szigetcsép. It is advantageous due to its high iron content and its ascorbic acid content is also worth to mention. Regarding to the other properties it has medium quality. It is also important to mention that this elder has very low acid content *(Table 2)*.

Evaluation of the variety SZCS 21-23

It is advantageous due to its iron content *(Table 5)*. It has the highest amount of pectin and it is the last one regarding to the juice yield *(Table 1)*, therefore it can be suggested to use for making jams and jellies.

Anthocyanin content of various elder varieties

For colouring of foods anthocyanins are widely used, which are present in great quantity in black elderberry (*Sambucus nigra*). Experiments were done to study the anthocyanin content of several varieties and candidates, from which the highest value was found for the *Haschberg* type *(Figure 1)*.

Table 5 Mineral content (in mg/l) of *Sambucus nigra* varieties and candidates

Variety	Aluminium				Calcium				Potassium				Magnesium			
	1996		1997		1996		1997		1996		1997		1996		1997	
	$\bar{x}$	±s	$\bar{x}$	±s	$\bar{x}$	±s	$\bar{x}$	±s	$\bar{x}$	±s	$\bar{x}$	±s	$\bar{x}$	±s	$\bar{x}$	±s
Haschberg	5.59	1.1	4.37	2.14	752.1	3.02	371.2	4.01	5520	2.13	1791	2.11	771.8	2.65	316.8	1.58
F33	4.66	0.9	9.4	1.05	377.6	2.54	576.6	3.82	3680	0.57	1381	1.50	378.1	3.25	217.7	1.63
F480	22.43	1.4	1.57	0.96	670.8	2.57	519.5	5.32	15261	6.37	1118	0.97	378.8	2.14	221.1	0.95
F481	8.09	0.8	1.28	0.58	456	7.93	439.2	4.08	3661	1.83	1247	1.25	415.9	5.2	213.5	2.05
Wild	4.52	1.34	6.24	0.77	394.2	6.93	387.4	6.04	3705	0.693	1699	1.23	291.9	2.7	237.5	2.49
Sambu	–	–	1.09	0.09	–	–	525.3	2.58	–	–	2283	1.57	–	–	229.4	2.35
SzCs 21–23	–	–	3.02	1.02	–	–	289.7	3.14	–	–	1964	2.01	–	–	222.1	0.88

Variety	Sodium				Phosphorus				Iron			
	1996		1997		1996		1997		1996		1997	
	$\bar{x}$	±s	$\bar{x}$	±s	$\bar{x}$	±s	$\bar{x}$	±s	$\bar{x}$	±s	$\bar{x}$	±s
Haschberg	175.1	5.56	82.02	6.2	392	3.61	382	2.55	81.2	7.01	85.84	2.3
F33	47.3	3.25	13.95	4.25	254	0.24	402	2.36	63.3	0.84	81.53	1.47
F480	95.1	3.4	12.7	3.54	451	5.45	403	3.014	73.63	2.1	47.47	2.58
F481	53.5	4.32	18.52	4.55	362	2.7	393	1.58	79.4	2.5	44.36	0.9
Wild	41.5	15.3	13.28	3.14	353	2.83	335	1.7	82.4	0.821	121	5.48
Sambu	–	–	13.82		–		347	2.5	–	–	40.96	0.25
SzCs 21–23	–	–	23.2		–		365	3.1	–	–	70.07	1.43

n=5 (number of measurement) – no dat

Table 6 Classification of elder varieties by their composition (1996)

Variety	Juice yield	Ref. % of the juice	Pectin content	Dry content	Ascorbic acid content	Carbohydrate content	Mineral content	Class
Haschberg	3	1	4	1	2	4	2	1
F33	5	2	5	2	5	1	4	5
F480	2	4	3	3	4	3	1	2
F481	1	5	1	5	3	5	3	4
Wild	4	3	2	4	1	2	5	3

Table 7 Classification of elder varieties by their composition (1997)

Variety	Juice yield	Ref. % of the juice	Mineral content	Dry content	Ascorbic acid content	Carbohydrate content	Pectin (juice, nectar)	Class
Haschberg	3	1	1	1	1	1	5	1
F33	5	5	2	5	5	6	6	5
F480	4	4	3	3	3	2	1	2
F481	2	7	7	4	4	5	2	4
Wild	2	6	5	2	2	3	4	3
Sambu	7	3	4	7	6	4	3	6
SzCs 21–23	6	2	6	6	5	7	7	7

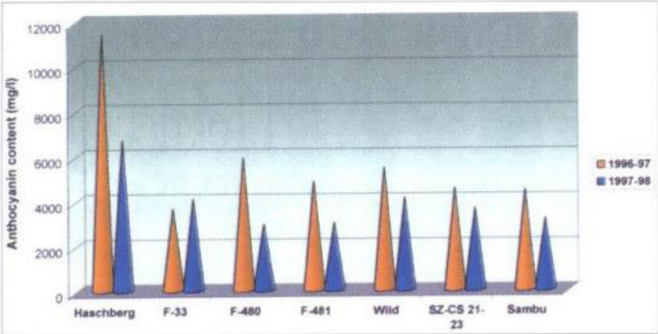

Figure 1 Anthocyanin content (mg/l) of *Sambucus nigra* varieties and candidates

Conclusions

It can be stated that the overall classification of the elder varieties based on their components have resulted in the same ranking in both years. Therefore regarding to the overall series of order the experiments performed in the second year supported the results obtained in the previous year.

Results have shown that *Sambucus nigra* has excellent composition beside its curative effect. Its mineral content has surpassed the mineral content of other fruits and it has advantageous acid- and carbohydrate composition. The ascorbic acid content of the *Haschberg* variety is striking.

It can be concluded from the experiments that the *Haschberg* type has the most advantageous composition, therefore it is suitable for making special curative and exclusive products.

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