COMPARISON OF COLOUR PROPERTIES OF CROSSBRED ELDERBERRY GENOTYPES

Lilla Szalóki-Dorkó, Nikoletta Molnár, Mónika Máté

Department of Fruit and Vegetable Processing Technology, Institute of Food Science and Technology, Hungarian University of Agriculture and Life Sciences, H-1118 Budapest, Villányi út 29-43., Hungary
e-mail: Szaloki-Dorko.Lilla@uni-mate.hu

Abstract
Elderberry (*Sambucus nigra L.*) is a good source of anthocyanins, therefore, a preferred source of natural food colourant in the food industry to adjust food colour. Today, the growers have a strong intention to cultivate elderberries with high pigment and water-soluble solid content which are the value-determining properties. In this study four different crossbred genotypes (Haschberg×Samocco, Haschberg×Wild, Haschberg×Sampo, Sampo×Wild) were examined in two ripening stages from the aspects of colour properties. HSc genotypes had the highest total anthocyanin concentration above 800 mg CGE/100 g in both ripening stages. The lowest pigment values were measured in SW elderberry samples furthermore the ripening had significant ($p<0.05$) effect on this hybrid because ca 33% more total anthocyanin was found in the ripening stage 2. Finally, crossbred elderberry genotypes can have better colour properties than the elderberry varieties alone, but the ripening process can influence the measured parameters. Furthermore, it is necessary to examine the samples of the following vintages also to establish more comprehensive conclusions.

Introduction
Today, utilization of natural plant pigments is becoming more preferred as an alternative of synthetic food colourants in the food industry. Among them anthocyanins are suitable for food colouration with a low pH level such as soft drinks, water ice cream, sauce, confectionery, table jellies, conserves because anthocyanin molecules are more stable in acidic medium [1–3]. The source of anthocyanins can be including black currant, sour cherry, elderberry, purple wheat, and blood orange etc. Elderberry can be a potential natural colouring food because of high amount of anthocyanins [4–5] and it is easy to grow in plantation in Hungary. Many cultivars of elderberries are planted in Europe, the most common is the 'Haschberg' cultivar with several selections, which are mainly grown for fruit [4]. Globalization of the market for juice or concentrate resulted that new genotypes with different quality characteristics have appeared, but their colouring properties are less known.
Therefore, the aim of this study is to evaluate the new crossbred elderberry genotypes grown in Hungary as a potential source of natural food colourant considering the different ripening stages.

Experimental
Elderberry fruit (*Sambucus nigra* L.) samples were harvested in 2022 from mid-August (ripening stage 1) and at the end of August (ripening stage 2). Four different crossbred elderberry genotypes, namely Haschberg×Samocco (HSc), Haschberg×Wild (HW), Haschberg×Sampo (HS), Sampo×Wild (SW) were sampled growing location of Nagyvenyim (46°570 N, 18°510 E), Hungary.
After crushing the berries total water-soluble solid content (Brix%) using digital refractometer (ATAGO PAL-3) was measured in triplicates while prior the other measurements extraction

step was done. Extraction solvent was 60% (v/v) aqueous methanol containing 1% (v/ v) formic acid. Samples were extracted for 30 min at the room temperature and 15 min in an ultrasonic bath. After extraction, samples were centrifuged at 4180 *g* for 5 min at room temperature. The supernatant was used for the measurements.

Colour parameters (L*, a*, b*) were determined with digital colorimeter (CR-400 Chroma Meter, Konica Minolta) and the colour difference values (ΔE*) were calculated from them based on this equations: $\Delta E^*_{ab}=((\Delta a^*)^2+(\Delta b^*)^2+(\Delta L^*)^2)^{½}$. Total anthocyanin concentration (TAC) was assessed using the pH differential method at 520 and 700 nm [6] The values were expressed in mg cyanidin-3-glucoside (CGE)/100g.

T-test was used for analysis of difference between the elderberry samples and the ripening stages in case of Brix values and TAC. Significant difference was considered when *p* value was <0.05.

Results and discussion

The Brix values of the samples can be seen in the Table 1. Using elderberry concentrate as a colouring food is evaluation of the total soluble solid content is very important from the economical aspect because during the evaporation technology the higher Brix value of the fresh fruit, the less water should be evaporated to reach the targeted concentrate.

The Brix values of the samples were between 12.03 and 16.23 Brix% in the case of the first ripening stage while data of the later-harvested samples varied between 10.9 and 14.17 Brix%. According to the statistical analysis there is significant difference between the ripening stage of 1 and 2 in case of HW and SW (p=0.002 and p=0.007).

Table 1. Total water soluble solid content of crossbred elderberry genotypes during ripening

Brix%	Ripening stage	
Elderberry sample	1	2
HSc	12.33 ± 0.29	10.90 ± 0.87
HS	12.03 ± 0.91	13.13 ± 0.35
HW	16.23 ± 0.51	11.07 ± 0.46
SW	12.13 ± 0.23	14.17 ± 0.67

Total anthocyanin concentration of crossbred elderberry genotypes in the Figure 1. HSc had the highest values (816.61 and 864.25 mg CGE/100g) in both ripening stages which was expected due to the high pigment content of Samocco Danish variety alone based on our earlier study [7], furthermore the maximum maturity stage of this hybrid was not found. SW1 had the lowest TAC, however in the next ripening stage ca. 33% more anthocyanin content was measured. The effect of ripening was not detected clearly in elderberry samples of HW1 because almost the same TAC was observed (500.22 and 491.97 mg CGE/100g). Sampo Danish variety crossbred with Haschberg had 542.86 and 422.97 mg CGE/100g. According to our results Samocco and Wild elderberries can enhance the pigment content of hybrid with Haschberg variety. Significant differences were found in case of HS and SW elderberries (p=0.007 and p<0.000) considering the ripening stages.

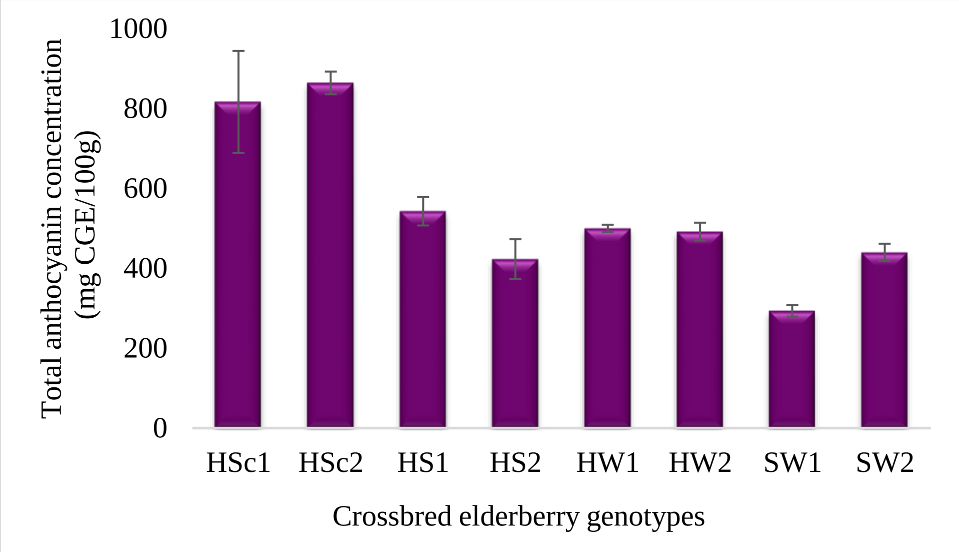

Figure 1. Total anthocyanin concentration of crossbred elderberry genotypes

As regard the colour parameters, the calculated colour difference values (ΔE*) were varied between 0.20 to 3.60 (Table 2.). It can be seen, there was no visible difference between the HSc1 and HSc2 samples. In the case of the HS1 and HS2, as well as the SW1 and SW2 samples, there was barely noticeable difference between the two ripening stages. The well visible difference was detected between HW2 and HSc samples. There is only a noticeable or barely visible difference between the other samples based on maturity and genotypes.

Table 2. The colour difference values (ΔE*) between the crossbred elderberry genotypes

ΔE*	**HSc1**	**HSc2**	**HS1**	**HS2**	**HW1**	**HW2**	**SW1**	**SW2**
HSc1		0.23	1.69	2.11	1.23	3.60	1.95	2.14
HSc2	not visible		1.57	2.04	1.16	3.49	1.92	2.08
HS1	visible	visible		0.62	0.57	1.96	0.87	0.74
HS2	visible	visible	barely visible		0.88	1.56	0.69	0.20
HW1	barely visible	barely visble	barely visible	barely visible		2.39	0.89	0.93
HW2	well visible	well visible	visible	visible	visible		2.10	1.64
SW1	visible	visible	barely visible	barely visible	barely visible	visible		0.54
SW2	visible	visible	barely visible	not visible	barely visible	visible	barely visible	

Conclusion

Elderberry fruit is used for natural food colourant in the food industry because of high anthocyanin content. The growers have an increasingly demand for new crossbred genotypes with higher value-determining values. Among the examined hybrid elderberries Haschberg×Samocco had the highest anthocyanin concentration however the water-soluble solid content was lower. Sampo and Wild can be also promising with Haschberg variety due to the high Brix value and pigment concentration, mostly in case of ripening stage 2. Our results revealed that crossbred elderberry genotypes can have better colour properties than the elderberry varieties alone, however the ripening can influence the measured parameters which have effect on the quality of elderberry. Furthermore, it is necessary to examine the samples of the following vintages also to establish more comprehensive conclusions.

Acknowledgements
The authors wish to thank Elderberry Grower Cooperative (Vál, Fejér megye, Hungary) for providing elderberry genotypes.

References
[1] P. Bridle, C.F. Timberlake, Food Chem. 58 (1997) 103–109.
[2] X. Luo, R. Wang, J. Wang, Y. Li, H. Luo, S. Chen, X. Zeng, Z. Han, *Foods 11* (2022) 2166.
[3] B. Alappat, J. Alappat, *Molecules* 25 (2020) 5500.
[4] R. Veberic, J. Jakopic, F. Stampar, V. Schmitzer, Food Chem. 114 (2009) 511– 515.
[5] L.S.M. Jakobek, M. Medvidovic-Kosanovic, I. Novak, Dtsch. Lebensmitt. Rundsch. 103 (2007) 58–64.
[6] J. Lee, R.W. Durst, R.E. Wrolstad, *J. AOAC Int.* 88 (2005) 1269–1278.
[7] L. Szalóki-Dorkó, M. Stéger-Máté, L. Abrankó, Int. J. Food Sci. Technol. 50 (2015) 1317–1326.