Danish Research for Plant and soil Science
Research Centre for Horticulture
Institute of Pomology
DK-5792 Årslev

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Juice processing from elderberry (*Sambucus nigra* L.)

Saftfremstilling af hyld (Sambucus nigra L.)

K. KAACK

Summary

By processing of elderberry juice sugars and organic acids are extracted to the juice to a satisfactory degree. The anthocyanin concentration in the juice only was 70% of the content in the raw fruits. Application of enzyme preparations (Pektolase LA, Pectinex Ultra SP, Pectinex BE) in different amounts at 40 °C had no effect on the anthocyanin content of the juice. The result of blending before enzyme treatment was a lower anthocyanin content in the juice. Because of the poor extraction of anthocyanins to the juice the high content of anthocyanins in new elderberry varieties are not utilized satisfactorily. During heating of the juice anthocyanins are degradated according to a first order reaction.

Key words: *Sambucus nigra* L., elderberry, processing, juice, anthocyanin.

Resumé

Ved fremstilling af hyldebærsaft udvindes opløselige sukkerarter og organiske syrer i et tilfredstillende omfang. Derimod er ekstraktionen af farvestoffer kun 70 pct. af indholdet i frugterne. Årsagen til den forholdsvis lave ekstraktionsgrad er ukendt. Anvendelse af forskellige pektinnedbrydende enzympræparater (Pektolase LA, Pectinex Ultra SP, Pectinex BE) i forskellige koncentrationer med varierende holdetider ved 40°C havde ingen virkning på antocyaninekstraktionen. Formaling før enzymbehandling bevirkede en signifikant lavere antocyaninkoncentration i saften.

Den forholdsvis lave ekstraktionsgrad for anthocyaniner medfører desværre, at det høje farvestofindhold, som er opnået i hyld ved forædling og fremavl af nye sorter, ikke bliver udnyttet tilfredsstillende.

Anthocyaniner i hyldebærsaft nedbrydes under opvarmning efter en første ordens reaktion.

Nøgleord: *Sambucus nigra* L., saftfremstilling, anthocyanin.

Introduction

Because elderberry juice is used as a color ingredient, the anthocyanin content has been a very important characteristic when selecting elderberry varieties (3,6).

Table 1. Experimental designs. Enzymation was carried out by use of two enzyme solutions (Pectinex Ultra SP, Pectinex BE).
Forsøgsplaner. Enzymering blev udført ved brug af to enzymopløsninger (Pectinex Ultra, SP, Pectinex BE).

Exp. *Forsøg*	Boling *Kogning* *min*	Grinding *Formaling*	Enzyme solution *Enzymopløsning* *g/ton*	Levels *Forsøgsled*
2	0	+/−	250,500,1000	2×2×3
3	1,2,5,10		500	4×2
4	5		125,250,500,1000	4×2

From observations at industrial plants and the results of earlier work (10) it is obvious that anthocyanin extraction by pressing of the elderberry is rather ineffective.

The aim of this paper was to determine the degree of extraction of anthocyanin, soluble solids and titratable acid during the processing of elderberry juice.

A further aim was to study the effect of heating on anthocyanin degradation.

Materials and methods

Fruits of the variety 'Sambu' harvested in 1987 or 1988 were used.

The experimental design of experiment one encompassed heating of the fruits (300 g) and then a) cooling to 20°C, b) cooling to 20°C and blending, c) cooling to 20°C, blending and treatment with an enzyme solution (50 g/ton, Pektolase).

Table 1 shows the designs of experiment two to four, with use of 200 g of fruits.

Blending was carried out by treatment for one minute in a Waring blender. Two enzyme solutions Pectinex Ultra SP and Pectinex BE (Novo) were applied. The slurries were kept in bottles for 1.5 hours in a water bath at 40°C.

The pressing was carried out using a Tincture Press by increasing the pressure to 200 kg/cm^2 during one hour.

After addition of 0.2% potassium sorbate and 0.2% sodium benzoate and bottling in 100 ml bottles the juice was pasteurized (85°C, 15 min). Finally, the bottles were cooled in tap water (13°C) and stored at 12°C.

Anthocyanin degradation was determined by sequential analyses in two series of juice taken from bottles placed in five water baths at 70, 75, 80, 85 or 90°C respectively. During a total heating time of 270 min samples were taken with appropiate intervals.

The concentration of anthocyanin, titratable acid and soluble solids were determined as de-

Table 2. Content of soluble solids, titratable acid and anthocynin in raw fruits and juice processed by use of three pretreatments after heating of the raw fruits to 90°C. Fruits from 1987 were applied. Experiment 1.
Indholdet af opløseligt tørstof, titrerbar syre og anthocyanin i råvare og saft fremstillet ved brug af tre forbehandlingsmetoder efter opvarmning af råvaren til 90°C. Der blev anvendt frugter fra 1987. Forsøg 1.

Treatment *Behandling*	Soluble solids *Opl. tørstof* g/100 g	Titratable acid *Titrerbar syre* g/kg	Anthocyanin *Anthocyanin* mg/kg
Raw fruits *Råvare*	12.5	8.8	1104
Cooling to 20°C *Afkøling*	12.5	8.2	780
Cooling+blending *Afkøling+formaling*	12.0	7.9	733
Cooling+blending+ enzyme treatment *Afkøling+formaling+* *enzymebehandling.*	12.0	8.4	741

Table 3. Average content of anthocyanin, soluble solids, titratable acid in the juice and the yield of juice by pressing. Fruits from harvest in 1988 were applied. Experiment 2 to 4.
Gennemsnit for indholdet af anthocyanin, opløseligt tørstof, titrerbar syre i saften og saftudbyttet ved presning. Der blev anvendt frugter høstet i 1988. Forsøg 2 til 4.

Experiment *Forsøg*	Anthocyanin *Anthocyanin* *mg/100 g*	Soluble solids *Opl. tørstof* *g/100 g*	Titratable acid *Titrerbar syre* *g/kg*	Juice yield *Saftudbytte* *pct*
2	543	9	13	68
3	540	9	13	68
4	518	9	10	75
Average *Gennemsnit*	534	9	12	70

scribed elsewere (5), and expressed as mg/100 g cyanidin-3-glucoside g/kg citric acid and mg/100 g soluble solids respectively. Analysis of variance were used for the statistical analysis of the results.

Results

Table 2 shows the results from experiment 1 encompassing use of Pektolase LA and three pretreatments before pressing. The juice yields were on average 78%.

In experiment 2 significance of blending was found. The concentration of anthocyanin in juice processed with and without blending were 500 and 587 mg/100 g respectively.

Because of lack of significance for all the other treatments only average values are presented in Table 3.

Average value of pH for all the processed juices were 3.8.

Fig. 1 shows the effects of the heating time and temperature on the concentration of anthocyanin in the juices. During heating of the juice the anthocyanin concentration (c) decreases with the time (t), according to equation 1) where k (1/min) is the rate degradation constant. Linear regression analysis was used to calculate the rate constants at five temperatures (Table 4)

$$\log_e (c) = kg \qquad 1)$$

Discussion

Contents of soluble solids, titratable acids and anthocyanin in the fruits and juices were in accordance with earlier results (1,7,8).

The concentration of soluble solids in the juice was equal to the concentration in the fruits (Table 2). This was expected because of a high solubility of sugars, which make up the main part of the soluble solids detected by refractometry. On average the content of titratable acid in the juice (Table 2) was 8.2% or 93% of the content in the raw fruits. One reason for a higher content of titratable acid in the fruits can be hydrolysis of the methylated carboxylic acid groups in the pectins during the titration.

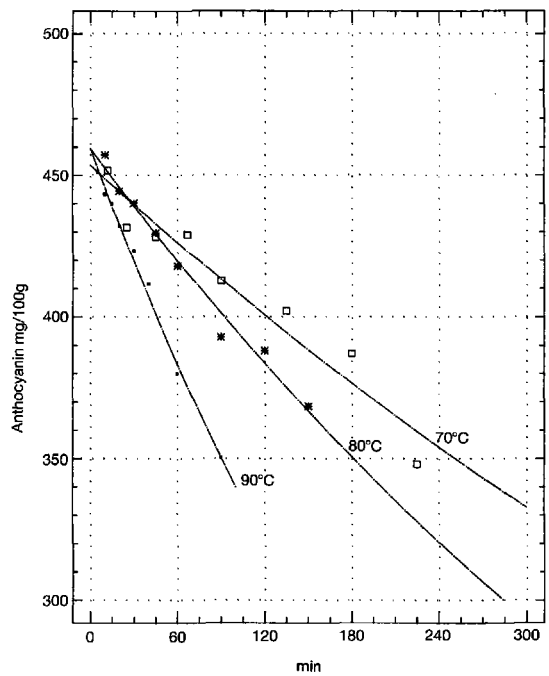

Fig. 1. Concentration anthocyanin in juice heated at 70, 80, and 90°C.
Indhold af anthocyanin i saft, der blev opvarmet ved 70, 80, eller 90°C.

Tabel 4. Anthocyanin rate degradation constants k at five temperatures. Average of two determinations. *Nedbrydningskonstanter for anthocyanin ved fem temperaturer. Gennemsnit af to bestemmelser.*

Temperature *Temperatur* °C	Rate constants × 1000/min *Hastighedskonstant × 1000/min*
70	0.79
75	1.01
80	1.51
85	1.77
90	2.39

An average juice yield of 70% (Table 3) is in accordance with earlier results (9,10,11).

Anthocyanin extraction during pressing can be very difficult (10), as it appears from the results in Table 2. Only 70% was extracted. Application of different enzyme preparations (Pektolase LA, Pectinex Ultra SP, Pectinex BE) in varying concentrations had no effect on the anthocyanin concentration in the elderberry juice. This is in accordance with the results found by *Brønnum-Hansen and Flink* (2). After blending of the fruits a significant lower concentration was obtained. The reason for this may be that the anthocyanins are very strongly adsorbed to other components in the fruit slurry. A detailed study of this require further experiments.

The anthocyanins in the fruits may be degraded during cooking of the fruits before pressing and during pasteurization of the juice. Heating of the fruits to 90–95°C for one minute before pressing is common practice, because this promote the effects of the depectinizing enzymes, and because microorganisms are inactivated. Only a very short heating period 75°C for 10–15 seconds is necessary to obtain sufficient pasteurization. Cooking of the fruits, which has been normal practice, may not be recommended, because aroma substances may be lost (4), and because anthocyanins may be degraded.

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