Impact of enzyme treatment on flavour of aronia juice

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Abstract

Aronia (*Aronia mitschurinii*) is rich in different polyphenolic compounds and sorbitol. Pressed aronia juice has a beautiful colour. The aim of this work was to analyse smell and taste of aronia juices prepared from berries grown in South-West of Finland. Sensory properties were studied using projective mapping with consumers and applying qualitative profiling with experienced sensory panel. Sugar and acid composition was analysed with GC-FID. Based on our results, pectinase treatment had a negative impact on both odour and taste of aronia juice.

Introduction

Berries, in general, are rich in polyphenols and various other bioactive components and their possible health inducing properties are intensively studied. However, some eatible berries such as bilberry (*Vaccinium myrtillus*), lingonberry (*Vaccinium vitis-idaea),* sea buckthorn (*Hippophae rhamnoides*), black currant (*Ribes nigrum), red currant (Ribes rubrum)* have challenging flavour and taste properties which may limit their further utilization despite their healthiness [1-2]. Aronia (*Aronia mitschurinii***)**, also called chokeberry, is a shrub that originates from the eastern part of North America. Aronia is a popular garden decoration also in Europe and in Finland, mainly consumed by birds instead of human consumers. The colour of aronia juice is deep violet and stable and it has high contents of various polyphenols. However, due to the strong and mostly unfamiliar orosensory properties of the berry [3], chokeberries are usually used in blended juices.

The aims of this work were to 1) analyse smell and taste of aronia juices prepared from berries grown in South-West of Finland, 2) study the effect of enzymatic pectinase treatment on odour, taste and flavour, 3) study the effect of sucrose or citric acid addition on the sensory properties of juice.

Experimental

Samples are shown in Table 1 and the protocol is shown in Figure 1. Aronia berries were grown in Turku (Finland) and harvested in 2016. Juices (n = 6) were pressed from crushed berries without (I) and with (II) pectinolytic enzyme (Pectinex Ultra SP-L, Novozymes) treatment applying incubation for 5h at 50°C. Also sucrose (1 %) or citric acid (0.15 %) was added to some samples.

Table 1: Sample set included 6 different juice samples.

Juice samples	*w/o pectinase*	*w pectinase*
Juice	No enzyme	Enzyme
Juice + Sucrose 1 %	No enzyme / added sugar	Enzyme / added sugar
Juice + Citric acid 0.15 %	No enzyme / added acid	Enzyme / added acid

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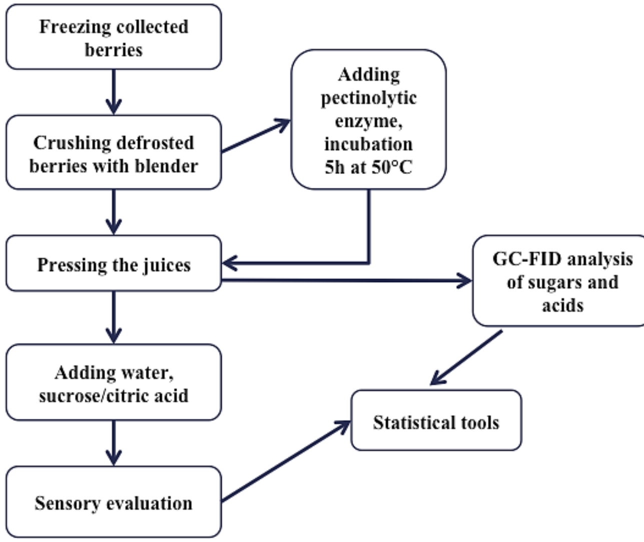

Figure 1: Study protocol for flavour research moving from aronia berries to pressed aronia juices applying enzymatic treatment.

Differences and similarities of all the samples were studied using projective mapping (PM) with volunteer participants (n = 32) in controlled sensory laboratory environment (ISO 8589). Pure juices were diluted with water (carbon-filtrated) 1/2 before the sensory evaluation. Moreover, qualitative descriptive analysis was applied to describe the sensory properties of juices in our sensory laboratory by experienced sensory panellists (n = 7).

In addition, gas chromatography (GC) with flame ionization detection (FID) was applied to determine the sugar and acid contents in juices without any sugar or acid addition. Sugars and acids were measured by GC as trimethylsilyl derivatives [4]. GC-FID was Shimadzu with a column (SPB-1, 30 m x 0.25 mm x 0.25 um, Supelco), temperature of injector: 210 °C, temperature of detector: 290 °C. GC-analysis was 150 °C (hold 2 min), rate 4 °C/min => 210 °C/min, rate 40 °C/min 0 => 275 °C (hold 5 min) with a total time 28.6 minutes).

Results of projective mapping were processed with Principal Component Regression (PCR) and full cross validation using Unscrambler X (Camo, Norway). In PCR-model X-variables were sample coordinates from project mapping and sensory descriptors were defined as Y-variables.

Results and discussion

Our results showed a clear impact of enzyme treatment on smell and taste of aronia juices (Figure 2). Two separate PCR models were created based on odour and flavour evaluations (Figure 2A and 2B, respectively) with sample coordinates by 32 participants as X-data explaining the variances in sensory descriptors data (Y-data) with three validated components in both models. Differences between juices produced with or without enzymes are shown on the first PCs in both models whereas notably less significant components 2 and 3 show the impact of added sugar or acid on the sensory quality. The key odour and flavour descriptors describing the differences between the two juice types are shown in Table 2. In the PM test based on flavour and taste (Figure 2B), juice with added acid locate on lower section of plot on PC-2 together with astringent descriptors as opposed to (loadings plots not shown). In the PM test based on odour, addition either sucrose or citric acid to the juice samples had little impact on the sensory descriptors.

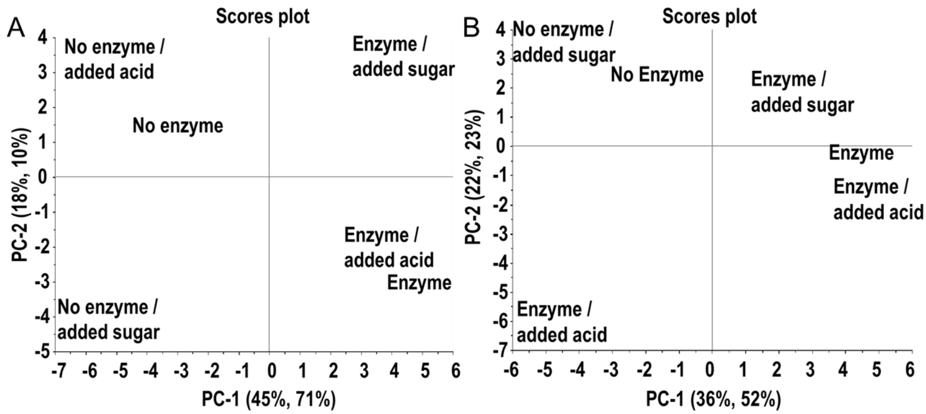

Figure 2: PCR Score plots showing the distributions of six aronia juice samples by the participants in PM test based on odour (A) or flavour and taste characteristics (B).

Most common sensory descriptors for aronia juice samples were “sour”, “sweet” and “astringent”. Juices produced with pectinase were described as “unpleasant” with descriptions such as “almond”, “nutty” and “oat-like” or “grainy” odour and their flavours were “stale” and with various astringent descriptors (Table 2). Somewhat expected notable increase in astringent properties was due to the release of polyphenolic compounds from berry skins by the enzymes [5]. Juices without enzymatic assistance were described as more pleasant with odour attributes such as “forest”, “aronia” and “sweet” and flavours “berry-like” and “sweet”. Addition of low concentration of sucrose or citric acid did not result in notable new odour or flavour descriptors in comparison to descriptor differences between juice treatments.

Table 2: Odour and flavour or taste properties for diluted juice samples.

Odour w/o pectinase	*Odour w/ pectinase*	*Flavour and taste w/o pectinase*	*Flavour and taste w/ pectinase*
Aronia	Earthy	Berry-like	Almond
Forest	Fermented	Fermented	Astringent
Fresh	Nutty	Leaf-like	Mouth-drying
Pleasant	Stale	Sweet	Puckering
Sour	Unpleasant	Bitter	Stale
Sweet	Oat/grain		Watery
Feed			Berry

Based on GC-analyses main sugars were glucose, sorbitol and fructose, and main acids were malic and quinic acid (Table 3) in both juices (w/ and w/o pectinase). Also there were no differences in concentrations of sugars and acids. Although in some berries and berry products the ratio between sugars and acids is a critical predictor of flavour [1-

2,6], we may conclude that flavour differences between pectinase treated and natural juice could be better explained by other compounds than original sugars and acids.

Table 3: Sugar and acid composition (mg/100 ml) of juice samples

mg/100ml	*Juice w/o pectinase*	*Juice w/ pectinase*
Succinic acid	1.39±0.3	1.57±0.3
Malic acid	421±15	416±10
Isocitric acid	20.8±4.8	22.2±4.0
Citric acid	3.0±2.6	2.9±3.6
Quinic acid	142±7.2	147±7.4
Fructose	1150±130	1120±160
Glucose	10900±760	10000±1200
Sorbitol	2550±52	2490±85
Sucrose	358±270	404±370
Sugar-acid ratio	25.4	23.8

Inclusion of pectinolytic enzyme to the juice pressing process gave the aronia juices in this study very strong odour and flavour characteristics different from juices without enzymatic assistance. Enzyme treatments used in food industry will typically contribute to yields of pressed juice instead of focusing on flavour. However, in the case of aronia, they may also create flavours, which may be considered as undesired and unpleasant by consumers.

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