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CRANBERRY AND STRAWBERRY JUICES – INFLUENCE OF METHOD PRODUCTION ON ANTIOXIDANTS CONTENT AND ANTIOXIDATIVE CAPACITY

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Key words: juices, cranberry, strawberry, antioxidants, DPPH• radical scavenging.

Abstract

The objective of this study was to analyze fresh and pasteurized cranberry and strawberry juices, based on the content of polyphenols, anthocyanins and ascorbic acid, as well as DPPH• radical scavenging capacity. Significant differences were found between the investigated juices, dependent on both fruit species and the technological process. Cranberry juices were characterized by higher concentrations of the tested compounds, except for anthocyanins, and by greater DPPH• radical scavenging capacity. Pasteurization was found to exert a significant, destructive effect on the properties of the examined juices, particularly on the anthocyanin content of strawberry juice.

SOKI Z ŻURAWINY I TRUSKAWKI – WPŁYW SPOSOBU OTRZYMYWANIA NA ZAWARTOŚĆ ZWIĄZKÓW PRZECIWUTLENIAJĄCYCH I POJEMNOŚĆ PRZECIWUTLENIAJĄCĄ

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Słowa kluczowe: soki, żurawina, truskawka, przeciwutleniacze, zmiatanie rodników DPPH•.

Abstrakt

W pracy oceniano soki świeże oraz utrwalone przez pasteryzację z owoców żurawiny błotnej i truskawki pod względem zawartości polifenoli, antocyjanów, kwasu askorbinowego oraz zdolności zmiatania rodników DPPH•. Wykazano istotne różnice zależne zarówno od gatunku owoców, jak i od procesu technologicznego. Większą zawartością analizowanych związków, poza antocyjanami, oraz większą zdolnością zmiatania rodników DPPH• charakteryzowały się soki z żurawiny. Stwierdzono znaczący, destrukcyjny wpływ pasteryzacji, zwłaszcza na antocyjany soku z truskawki.

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Introduction

Cranberries and strawberries are grown in temperate climates. Cranberry and strawberry fruits are excellent raw materials for juice production, as they contain numerous antioxidants including phenolic compounds, vitamin C, minerals and many other. Their health-promoting properties include antioxidative activity (HANNUM 2004, SZAJDEK, BOROWSKA 2008, BOROWSKA et al. 2009a). Apart from the genetic characters of raw materials, also the conditions of the technological process exert a significant effect on the concentrations of antioxidants in juices and on their final properties (DIETRICH et al. 2004, LANDBO, MEYER 2004, BOROWSKA et al. 2009b). The release of antioxidants into the juice is considerably affected by the parameters of unit operations during processing, such as fruit crushing and mash heating, as well as by the type of enzymatic preparation used for mash maceration, and juice pressing conditions (OSZMIAŃSKI, SOŻYŃSKI 1989, PŁOCHARSKI, MARKOWSKI 2003, LANDBO, MEYER 2004, BAGGER-JØRGENSEN, MEYER 2004, BUCHERT et al. 2005, SZAJDEK et al., 2009). Of particular note is fruit mash maceration prior to juice pressing. Under industrial conditions, fruit mash is subjected to thermal processing or is treated with highly specific enzymes that act upon cell wall polysaccharides (HELBIG 2001, HILZ et al. 2005, URLAUB 2005). The application of enzymatic preparations facilitates juice extraction and improves the extractability of phenolic compounds. However, enzymes often contribute to the destruction of antioxidants, followed by a decline in antioxidant capacity and undesirable changes in color and flavor (KADER et al. 1999, SKREDE et al. 2000).

The objective of this study was to analyze fresh and pasteurized cranberry and strawberry juices, based on the content of polyphenols, anthocyanins and ascorbic acid, as well as DPPH$^{\bullet}$ radical scavenging capacity. The analyzed juices differed with regard to the method of fruit mash treatment prior to pressing. It should be stressed that enzymatic preparations were not used for mash maceration in this experiment, which means that juices of that type can be produced directly at eating places and in agritourism farms.

Materials and Methods

Cranberries were picked up from their natural habitat near Olsztyn, and strawberries cv. Senga Sengana were purchased on a plantation near Olsztyn. The juices used in the study were produced under laboratory conditions. Fruits were crushed in a laboratory food processor (type ZM Mesko), and the mash was divided into two parts. One part was subjected to juice pressing with a laboratory hydraulic press (ZPBB Bydgoszcz), to obtain fresh control juice (I, I'). Half volume of the juice was pasteurized in jars with twist-off caps at a temperature of 100°C for 10 min., to obtain pasteurized juice (II, II'). The other part of fruit mash was heated at a temperature 85°C for 5 min. before juice pressing. The further procedure was the same as above. Non-pasteurized juice after mash treatment (III, III') and pasteurized juice after mash treatment (IV, IV') were obtained.

Juice samples were assayed for the content of: total phenolic compounds (as gallic acid equivalent) – as described by SINGLETON and ROSSI (1965), anthocyanins (as cyanidin-3-glucoside) – by the method proposed by WROLSTAD (1976), ascorbic acid – according to the Polish Standard (Przetwory owocowe... PN-90/A-75101/11) and DPPH• radical scavenging capacity (as μmol trolox/ml juice) – as described by BRAND-WILLIAMS et al. (1995). All analyses were performed in triplicate.

The results were verified statistically by a one-factor analysis of variance and Duncan's test, at a significance level of $P<0.05$, using STATISTICA 8.0 software.

Results and Discussion

Significant differences were found between cranberry and strawberry juices, regarding the concentrations of the analyzed antioxidants and DPPH• radical scavenging capacity (Table 1). Cranberry juices, produced

Table 1

Antioxidants and DPPH• radical scavenging of cranberry and strawberry juices

Type of juice	Total phenols (mg/l)	Anthocyanins (mg/l)	Ascorbic acid (mg/100 g)	DPPH• radical scavenging (μmol trolox/ml)
Cranberry juices				
Fresh – control (I)	$1272^{a} \pm 13$	$134.6^{c} \pm 1.1$	$17.5^{b} \pm 0.2$	$10.66^{b} \pm 0.13$
Pasteurized (II)	$1256^{a} \pm 14$	$86.3^{a} \pm 0.8$	$9.6^{a} \pm 0.2$	$10.34^{a} \pm 0.10$
Non pasteurized – after mash treatment (III)	$1883^{c} \pm 29$	$170.2^{d} \pm 1.3$	$25.6^{d} \pm 0.6$	$14.92^{d} \pm 0.18$
Pasteurized – after mash treatment (IV)	$1542^{b} \pm 17$	$116.4^{b} \pm 1.9$	$20.7^{c} \pm 0.3$	$11.94^{c} \pm 0.09$
Strawberry juices				
Fresh – control (I')	$640.2^{B} \pm 8$	$320.8^{C} \pm 1.7$	$12.6^{D} \pm 0.3$	$4.05^{B} \pm 0.03$
Pasteurized (II')	$541.2^{A} \pm 12.4$	$103.0^{A} \pm 2.1$	$4.6^{A} \pm 0.2$	$3.94^{A} \pm 0.01$
Non pasteurized – after mash treatment (III')	$801.7^{C} \pm 13$	$235.2^{B} \pm 1.0$	$10.5^{C} \pm 0.3$	$4.35^{D} \pm 0.02$
Pasteurized – after mash treatment (IV')	$632.9^{B} \pm 6.3$	$121.8^{A} \pm 1.7$	$5.1^{B} \pm 0.2$	$4.23^{C} \pm 0.03$

Mean values in the same column having different small letters for cranberry juices (*a*, *b*, *c*…) and different large letters for strawberry juices (*A*, *B*, *C*...) are significantly different at $P<0.05$

under identical technological conditions as strawberry juices, were characterized by a significantly higher content of polyphenols and ascorbic acid, a lower anthocyanin content and greater DPPH$^{\bullet}$ radical scavenging capacity. These differences resulted primarily from a different qualitative and quantitative composition of materials used for juice production (HANNUM 2004, BOROWSKA, SZAJDEK 2005, SZAJDEK et al. 2008). Compared with other berry fruit species, cranberries have an average polyphenols content and a low anthocyanins content. Proanthocyanidins and phenolic acids are known for their strong antioxidative properties (VATTEM et al. 2005, BOROWSKA et al. 2009a). Strawberry fruits contain less total phenolics and more anthocyanins than cranberry fruits (SZAJDEK et al. 2008).

The heat processing of fruit mash, preceding juice pressing, leads to partial degradation of polysaccharides (pectins, cellulose) and decreases the system's viscosity. This, in turn, improves the extractability of antioxidants (HILZ et al. 2005). The heat treatment of cranberry mash caused a statistically significant ($P < 0.05$) increase in the concentrations of all tested compounds and in the DPPH$^{\bullet}$ radical scavenging capacity of juice (III), in comparison with control juice (I). Strawberry juice (III') made from heat-treated mash was marked by a significantly ($P < 0.05$) lower content of anthocyanins and ascorbic acid than fresh control juice (I') – Table 1. The results of our previous experiments with juices from other berry fruit species (BOROWSKA et al. 2009b, SZAJDEK et al. 2009) and the findings of other authors (LANDBO, MEYER 2004, BUCHERT et al. 2005) show that both juice yield and the extractability of compounds may be enhanced by thermal and enzymatic maceration of fruit mash. On the other hand, research results pointed to the low thermal stability of anthocyanins in strawberry fruits during processing. The degradation of strawberry anthocyanins resulting from fruit crushing and mash treatment was reported, among others, by SKREDE et al. (1992). According to VERSARI et al. (1997), anthocyanins may be converted into aglycones which may then form brown-colored polymers.

In the present study, the thermal processing of cranberry and strawberry juices had a destructive influence on the evaluated properties (Table 1, Figure 1). As a result of juice pasteurization, the greatest losses were noted with respect to anthocyanins and ascorbic acid. In strawberry juices, the content of ascorbic acid and anthocyanins decreased by 41–53% and 60–70% respectively. In cranberry juices, total anthocyanin loss did not exceed 40%. Less pronounced changes were observed in total phenolic compounds, thus pointing to higher stability of polyphenol components other than anthocyanins. As indicated by numerous studies conducted on berry fruit juices, changes in composition during the technological process are largely determined by fruit species (BOYLES, WROLSTAD 1993, LANDBO, MEYER 2004, BUCHERT et al. 2005, BOROWSKA et al. 2009b).

Despite a high decrease in the concentrations of studied compounds during pasteurization, changes in the DPPH$^{\bullet}$ radical scavenging capacity

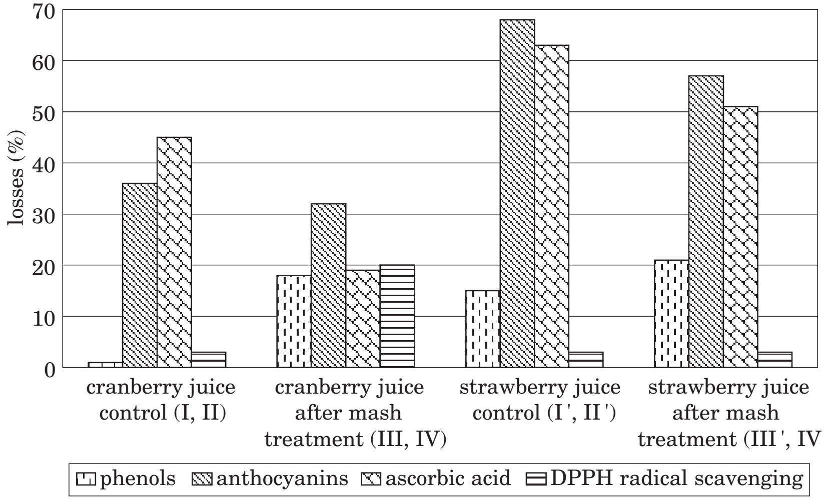

Fig. 1. The influence of pasteurization on antioxidants and DPPH• radical scavenging of juices: I, I' – fresh juice control; II, II' – pasteurized juice; III, III' – after mash treatment juice; IV, IV' – pasteurized – after mash treatment juice

of juices were relatively small (Figure 1). This may suggest that the compounds formed as a result of processing also exhibit antioxidant activity (OSZMIAŃSKI, SOŻYŃSKI 1989, GRAJEK 2003).

Conclusions

An analysis of cranberry and strawberry juices revealed that they differed significantly with regard to composition and antioxidant properties. Particular attention should be paid to the approximately twofold higher DPPH• radical scavenging capacity of cranberry juices. Heat treatment of cranberry mash, prior to juice pressing, contributed to higher concentrations of the studied components in the final product. As regards strawberry juices, both the heat treatment of fruit mash before pressing and juice pasteurization had a destructive effect on the levels of anthocyanins and ascorbic acid.

It should be stressed that juices produced without the use of commercial enzymatic preparations for fruit mash maceration can be offered as fresh, non-pasteurized products. According to market research reports, increased consumer awareness has contributed to growing demand for unprocessed products, including fresh juices characterized by a high content of antioxidants and organoleptic properties similar to those of raw materials.

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