Influence of Processing on Bioactive Substances Content and Antioxidant Properties of Apple Purée from Organic and Conventional Production in Poland

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Abstract

The organic food market is developing dynamically in many European countries and therefore studies concerning the nutritive value of organically produced foods are becoming increasingly important. It was found appropriate to conduct studies on selected bioactive substances and antioxidant properties of apple preserves prepared from organic vs. conventional apples. Three apple cultivars, Lobo, Boskoop and Cortland, were grown in organic and conventional orchards in the Mazovia region in Poland. Dry matter, total phenols, vitamin C, total flavones and antioxidant activity were determined in fresh and pasteurized apple purée. The apple purée prepared from the organic apples contained significantly more total phenols, vitamin C, total flavones and showed a higher antioxidant capacity than the preserves prepared from conventional apples. Processing had a negative effect on both antioxidant capacity and bioactive substances. After pasteurization, the content of vitamin C, total phenols and flavones and antioxidant properties have decreased in the apple purée from both agricultural systems (organic and conventional).

Introduction

The organic food market in Poland is developing dynamically, but in comparison to other European countries, it is still relatively small. The German organic food market is the good example - it is the second largest in the world after the USA (Meier - Ploeger 2005). Buying organic food is part of an ecological life style and tends to reflect the ideology and value system which encompasses caring about family health and protection of the environment (Wandel and Bugge 1997).

Organic preserves are an important group of products for consumers who want to eat according to the organic rules. The fruit preserves (e.g. purée) can contain larger quantities of bioactive substances in comparison to fresh fruits. For example the antioxidant activity of the blueberry fruit concentrate was considerably higher in comparison to fresh juice (Ścibisz et al. 2004). According to epidemiological data the intake of flavonoids is inversely correlated with the risk of coronary heart disease and cancer. Apple purée has recently been described as a good source of polyphenols, procyanidins and quercetin glycosides, which have been found to exert strong antioxidant activity. Considerable evidence is available that processing of fruits causes a decrease in the bioactive substances in the final products such as juice or purée. During the processing of the blueberry fruit, anthocyanins and phenolic compounds are destroyed by oxidation processes. Fresh organic apples were found to contain

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more flavonoids, anthocyanins and vitamin C in comparison to conventional ones (Rembiałkowska et al 2004). Furthermore organic apple purée and juice had a higher antioxidant capacity and higher levels of bioactive substances in comparison to conventional products (Rembiałkowska et al 2005).

Materials and Methods

Three apple cultivars, Lobo, Cortland and Boskoop, were produced in two pairs of orchards. The first pair comprised a certified organic and a conventional orchard located in Mazowia region (geographical location 51°42'N and 20°44'E) and were 10 km apart. The second pair comprised two orchards (51°45'N and 19°28'E) and were 7 km apart. In both of pairs of orchards the soil was loamy and sandy. In the organic system all the recommended rules for fertilization, plant protection and rotation were followed. Organic chicken manure was used as a fertilizer, applied at a rate of 6 t/ha at the beginning of the season and only every 4th year. Each year a green manure was used as an additional fertilizer. In the organic orchards the methods and compounds used for plant protection were liquid paraffin, pheromone traps, and mixed copper sulphate with liquid lime. In the conventional orchards chemical fertilizers and plant protection products were used. The liquid fertilizers Wuksal and Florowit containing nitrate and phosphate were applied. For plant protection the pesticides Kaptan 50 WP, Merpan 80 WG, Topsin 500 SC, Syllit 65 WP were used. The apple purée was prepared from 10 kg of apple samples from the two pairs of orchards (organic and conventional). From each overall sample, 5kg of apples were washed, crushed and boiled to a pulp for 20 minutes. The hot apple pulp was then passed through a sieve and put to a glass jar, then cooled to a room temperature. Chemical analysis were done on the fresh prepared apple purée (pulp) and after being pasteurized (20 min at 70°C).

The following parameters were determined in the apple preserves: dry matter by the scale method (PN-90 A 75101/03), vitamin C by Tillman's method (PN-90 A - 75101/11), total flavones by the Christ – Müller's methods (Strzelecka et al. 1978), total phenols by a colorimetric method (Singleton and Rossi 1965), antioxidant activity by colorimetric methods, described by Re et. al. (1999). The results of these qualitative characteristics of fruit were statistically calculated using Statgraphics 5.1 program specifically Tukey's test at $\alpha = 0.05$.

Results

The results of the chemical analysis are presented in table 1. The organic apple preserves contained more total flavonoids than the conventional preserves. The purée made from organic Boskoop contained the highest level of flavonoids (tab.1). The conventional apple purées contained twice less flavonoids in comparison to the organic ones. In the conventional apple purée the highest level of flavonoids was found in the cultivar Cortland. The pasteurization process decreased the level of total flavonoids in all the samples. In the organic and conventional apple purées the flavonoids level was 25% and 52% lower than before processing.

The results showed that organic apple purée contained slightly more polyphenols (4.6%) in comparison to those cultivated in conventional orchards. It should be noticed that the cultivar Boskoop was the richest in phenolic compounds in comparison to all the other cultivars, both organic and conventional (tab.1). Thermal processing, such as pasteurization, had a negative effect on the polyphenols content in the final apple product. After pasteurization the organic and conventional purée contained 23% less

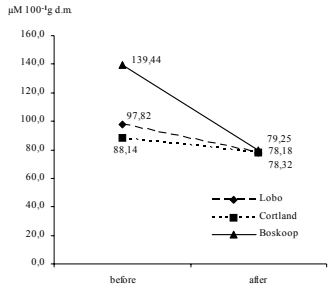
polyphenols than before processing (tab.1). The level of vitamin C before pasteurization was significantly higher in the organic apple purée (+ 97%) than in the conventional product; after pasteurization the difference was much smaller but the vitamin C level in the organic purée was still higher (tab. 1). It was found that the organic apple purée prepared from the cultivar Boskoop contained the highest vitamin C content among all the other apple cultivars. Among the conventional apple purées, the cultivar Lobo contain the highest level of bioactive substances. The pasteurization process decreased the level of ascorbic acid in apple purées. It was noticed that organic apple purées showed a higher decrease – 53.21%, while in conventional purées it was only 33.68%. The organic apple purées showed higher antioxidant activity than conventional ones (fig. 1,2).

Table 1: Content of bioactive substances in organic and conventional apple puree

Tabele. 1. Content of bioactive substances in organic and conventional apple puree (mg·100g^{-1}d.m) before and after pasteurization, respectively

	Before pasteurization				After pasteurization		
	flavonoids	polyphenols	vitamin C		flavonoids	polyphenols	vitamin C
organic				organic			
Lobo	59.49	342.78	83.6	Lobo	7.62	337.29	26.32
Cortland	56.29	490.31	71.09	Cortland	5.04	420.91	51.80
Boskoop	71.44	640.01	119.43	Boskoop	5.56	375.81	50.14
	62.4	**491.03**	**91.37**		**6.08**	**378.01**	**42.75**
convent.				convent.			
Lobo	27.92	313.86	78.28	Lobo	19.88	233.09	23.05
Cortland	39.26	473.45	57.24	Cortland	31.53	525.41	55.37
Boskoop	21.95	617.96	39.84	Boskoop	6.85	361.47	38.85
	29.71	**468.43**	**58.45**		**2.68**	**361.47**	**38.76**
HSD/0.05/ method	8.07	n.s.	11.72				
HSD/0.05/ cultivar	18.06	132.01	n.s.				
HSD/0.05/ meth x cult.	7.28	58.88	10.12				

The results showed that organic apple purée contained slightly higher levels of polyphenols in comparison to those cultivated in conventional orchards. It should be noticed that the cultivar Boskoop was the richest in phenolic compounds in comparison to all other cultivars, both organic and conventional (table 1). After pasteurization, the organic and conventional purées contained 23% less polyphenols than before processing (table 1). The level of vitamin C was before the pasteurization significantly higher in the organic apple purée than in conventional one; after the pasteurization a difference was much smaller but still more vitamin C was found in the organic purée (table 1). It was found that organic apple purée prepared from the cultivar Boskoop contained most vitamin C compared all the other apple cultivars. Among the conventional apple purée, the richest cultivar was Lobo. Pasteurization decreased the level of ascorbic acid in all the apple purées. It was received that the organic apple purées showed a higher relative decrease – 53.21%, while in conventional purées it was only 33.68%. The organic apple purées showed a higher antioxidant activity than the conventional produce, and it was 108.47 μM 100g^{-1}d.m. and 62.1 μM 100g^{-1}d.m. respectively (fig. 1,2). In general, thermal processing decreased the antioxidant activity of organic apple purée about 27.8% in organic and about 6.7% in conventional pulp.



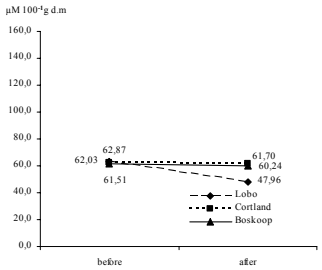


Fig.1. Influence of pasteurization on antioxidant activity of apples purée from organic cultivation

Fig.2. Influence of pasteurization on antioxidant activity of apples purée from conventional cultivation

Disscusion

Polyphenols have been shown to be important components for human health and the antioxidant properties of apple polyphenols have been extensively examined (Ju and Bramlage 1999; Robards et al. 1999, Lu and Foo 2000).

In previous studies, our research found that organic fruits contained more bioactive substances as polyphenols, flavones and vitamin C than conventional fruits (Rembialkowska et al. 2004, 2005). There has been only one previous experiment, also by Rembialkowska et al. (2005), which showed that organic apple preserves contained more polyphenols and had a higher antioxidant activity in comparison to conventional ones. In the present study, organic apple purée contained 50% more flavones and 36% more vitamin C than conventional products. We could demonstrate 47% higher antioxidant activity in organic purées compared to the conventional products (fig. 1,2). Thermal processing of apple pulp decreased the polyphenolic compounds in the final products. Bober (2005) showed that apple juice prepared from the cultivar Idared contained 121.8 mg·100g^{-1}d.m of polyphenols, however Rembiałkowska et al. (2005) observed much higher polyphenols, 366·mg·100g^{-1}d.m., in apple juice from organic cultivation. This was possibly due to the fact that fresh organic apples contained more bioactive compounds than conventional ones, so even after thermal processing more polyphenols remained in the final product. Polyphenolic compounds have 10 – 30 times more potent antioxidant status than witamin C (Lu and Foo 2000). This indicates the potential dietary importance of organic of apple preserves in anticancer prevention.

Conclusions

The organic apple purée contained more bioactive substances – total phenols, flavonoids and vitamin C – in comparison to conventional apple preserves. Out of the three organic apple purées the cultivar Boskoop contained the most flavonoids, phenol compounds, and highest vitamin C level. The results showed that among conventional apple purées the Lobo cultivar was the richest in vitamin C, while the Boskoop cultivar contained the highest level of other bioactive substances. Pasteurization had a

negative effect on bioactive substance content and also antioxidant activity. Organic apple preserves can be recommended as valuable fruit products, which can contribute to a healthy diet and for meeting the organic consumers' demands for quality processed products.

References

1. Bober I. (2005) Optymalizacja procesu otrzymywania soków jabłkowych zasobnych w polifenole i ich ocena. Mat. X Jub. Sesji Nauk. SMKN PTTŻ. Poznań 2005, 25.
2. Ju Z., Bramlage W. J. (1999) Phenolics and lipid-soluble antioxidants in fruit cuticle of apples and their antioxidant acivities in model systems. Post. Biol. Techn., 16, 107–118.
3. Lu Y., and Foo Y. (2000) Antioxidant and radical scavenging activities of polyphenols from apple mousse. Food Chem. 68, 81–85.
4. Meier-Ploeger A. (2005) Organic farming, food quality and human health. NJF Seminar, Sweden, 2005
5. PN-90/A-75101/03 Polish Norm for dry matter analysis published by Polish Quality Committee, 1994
6. PN-90 A -75101/11 Polish Norm for vitamin C analysis published by Polish Quality Committee, 1994
7. Re R., Pellegrini N., Proteggente A., Pannala A., Yang M., Rice-Evans C., 1999. Antioxidant activity applying an improved ABTS radical cation decolorization assay. Free Rad. Biol. Med. 26, (9/10), 1231-1237.
8. Rembiałkowska E. Adamczyk M., Hallmann E. (2004). Porównanie wybranych cech wartości odżywczej jabłek z produkcji ekologicznej i konwencjonalnej. Bromat. Chem Tok-sykol. Suppl., 201-207.
9. Rembiałkowska E., Wasiak-Zys G., Hallmann E., Lipowski J., Jasińska U., Owczarek L. (2005). Comparison of selective features sensory quality and antioxidant properties of apple mousse and juice from organic and conventional cultivation. Selected organic aspects in modern World. Monograph, PIMR, 264-274.
10. Robards, K., Prenzler, P. D., Tucker, G., Swatsitang, P., Glover, W. (1999) Phenolic compounds and their role in oxidative processes in fruits. Food Chem., 66, 401–436.
11. Singleton V.L., Rossi J.A., Colorimetry of total phenolics with phosphomolybdic-phosphotungstic acid reagents. Am. J. Enol. Vitic. 1965, 16, 144-158.Strzelecka H., Kamińska J., Kowalski J., Wawelska E.: Chemiczne metody badań roślinnych surowców leczniczych, PZWL Warszawa, 1978, 55 – 56.
12. Ścibisz I., Mitek M., Serwinowska K. 2004. Aktywność przeciwutleniająca soków i półkoncentratów otrzymanych z owoców borówki wysokiej (*Vaccinium corymbosum* L). Żywność, 3(40), 196-203.
13. Wandel, M., Bugge, A. (1997) Environmental concern in consumer evaluation of food quality. Food Qual. Pref. 8: 19-26.