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## Biocompounds content in organic and conventional raspberry fruits

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Raspberry fruits are a source of vitamin C, phenolic acids and flavonoids, including anthocyanins. There is scientific evidence that allows to assume that organic fruit and vegetables contain more bioactive compounds with antioxidant properties than plant crops from the conventional farming. The aim of the presented studies was to compare the contents of antioxidant compounds in two varieties of raspberries fruits came from certified organic and conventional production. The vitamin C content was determined using the titration method and spectrophotometry, and the content and composition of polyphenols (flavonols, anthocyanins and phenolic acids) was determined by HPLC method, with identification of individual phenolic compounds according to the Fluca and Sigma Aldrich standards. Significant differences were found between raspberry fruits in the content of the analyzed compounds. Organic raspberries contained more flavonols, phenolic acids and anthocyanins in comparison to conventional ones. The applied method of cultivation did not impact the content of vitamin C in raspberries tested. The results show that the cultivation system is one of the factors influencing the content of certain substances with antioxidant character in raspberry fruits. However, there is a need for further detailed research, especially research carried out in similar growing conditions.

**Keywords:** raspberries, organic fruits, flavonoids, phenolic acids, vitamin C

### 1 Introduction

Berry fruits, including raspberries, are a source of many bioactive substances, as the flavonols, anthocyanins, phenolic acids and vitamin C (Król et al. 2008, Czech et al. 2011). Polyphenol compounds found in berries, especially flavonoids (flavonols and anthocyanins) and phenolic acids are highly desirable in the diet due to their antioxidant properties (Cieślik et al. 2006, Ścibisz et al. 2011). Flavonoids as natural antioxidants play an important role in the prevention of cardiovascular diseases and cancer, as well as participate in conjunction with vitamin C in strengthening blood vessels (Czeczot 2000, Cieślik et al. 2006). Anthocyanins, which are plant pigments merit a special attention among flavonoids. Szajdek and Borowska (2004) has reported that a study carried out in the south of France showed a 5-fold lower mortality due to heart disease in people living in those areas, due to the higher consumption of fruits and vegetables rich in flavonoids and anthocyanins. Anthocyanins are characterized by antibacterial activity, have anti-inflammatory properties, also have a beneficial effect on the eyeball, it improves the ability to see, as well as increase the elasticity of the blood vessels (Szajdek and Borowska 2004; Olejnik et al. 2010). Phenolic acids occurred in berries exhibit anti-atherosclerotic, antitumor and antimicrobial features. They eliminate reactive oxygen species, scavenge free radicals, causing the chelation of metal ions and the inhibition of enzymes from the group of oxidases. Thanks to this the human body is protected against oxidative stress and the development of related diseases (Surma-Zadora and Cieślik 2007). The growing risk from the residues of agricultural chemicals used on a large scale in conventional food production that makes consumers looking for wholesome, healthy and free from contamination products on the market. They choose more often food from organic farming, which is for them synonymous with high healthy and sensory quality as well as safety (Łuczka-Bakuła 2007, Stolz et al. 2011).

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## 2 Material and Methods

Research material consisted of fruits of two cultivars of raspberries (Polka and Polana) from organic and conventional crop production systems. Plants were grown on a certified organic farm in accordance with the EU Regulations No. 834/2007 and 889/2008 and on a nearby conventional farm, in order to ensure similar conditions for soil and climate. Fruits were harvested in maturity phase. Next they were freeze-dried using a Labconco 2.5 freeze-drier (Labconco Corporation, Kansas City, Missouri, USA) at  $-40\text{ }^{\circ}\text{C}$  and a pressure of 10 Pa. A weighed amount of freeze-dried fruit sample (100 mg) was put into a plastic test tube and held at  $-80\text{ }^{\circ}\text{C}$ , in order to prevent loss of biologically active compounds. After carrying out these steps, raspberries were analyzed. The vitamin C content was determined using the titration method and spectrophotometry (PN-A-04019:1998), and the content and composition of polyphenols (flavonoids, anthocyanins and phenolic acids) was determined by HPLC method, with identification of individual phenolic compounds according to the Fluca and Sigma Aldrich standards (HPLC; Shimadzu, USA Manufacturing Inc, USA) (Hallmann 2012).

Three independent replicates of each cultivar of raspberries were taken from each farm and analyzed. The results are presented as mean  $\pm$  standard deviation (SD). Using a statistical programme Statgraphics 5.1. the data were subjected to a one-way analysis of variance ANOVA, using the parametric Tukey's test ( $\alpha = 0.05$ ). The  $p$ -value is given in the table; if the result of the analysis was not statistically significant it was designated as NS.

## 3 Results

The results of the analysis showed significant differences between the raspberries from organic and conventional systems in terms of the content of flavonols, total phenolic acids and anthocyanins. Organic raspberries contained significantly more total flavonols, total phenolic acids and total anthocyanins compared to conventional ones. It was found no differences in the content of vitamin C in organic and conventional raspberries. Raspberry cultivars were different; more total anthocyanins occurred in the fruits of cultivar Polana, and more vitamin C - in the fruits of cultivar Polka (tab. 1).

When the levels of individual phenolic components were compared it was found that organic raspberries contained significantly more of all determined compounds from the anthocyanin group (cyanidin, pelargonidin, delphinidin, malvinidin, peonidin, petunin), most total phenolic acids (caffeic, synapic and *p*-coumaric acids) and most flavonols (rutin, quercetin-D-glucoside, myricetin, quercetin) than conventional raspberries. Some differences in the content of the individual compounds have also been noted between the varieties of raspberries tested.

The chemical composition of fruits and other plant materials is mainly determined by genetic factors (species, cultivar), but it can be also determined by non genetic (external) factors, including the cultivation conditions (growth conditions) and factors related to availability of minerals, especially nitrogen in the soil. A reflection of the impact of these factors is the increased production of certain compounds, as the polyphenolic compounds, with a positive impact on the human health, by the plants growing at a lower availability of this component (Bloksma et al. 2007). Based on a review of research on the effects of nitrogen fertilization on the content of phenolic compounds (total phenolic acids, flavonoids and total anthocyanins) and vitamin C in fruits and vegetables has been found that in most cases there was a negative correlation between the level of fertilization and the level of these components in the plants' organs (Stefanelli et al. 2010).

## 4 Conclusions

The results show that organic cultivation system is positively influencing the content of certain substances with antioxidant character in raspberry fruits. However, there is a need for further detailed research, especially on the factors responsible for the obtained results.

Raspberries, especially those derived from an organic cultivation, are a rich source of prohealthy biocompounds, therefore they may represent an important source of them in the diet and contribute to the promotion of human health.

**Table 1** Vitamin C, total phenolic acids, flavonoids and anthocyanins contents in raspberry fruits from organic and conventional cultivation (mg 100 g<sup>-1</sup> š.m.) (mean ± SD)\*

	Cultivar	Vitamin C	Total phenolic acids	Total flavonoids	Total anthocyanins
Organic cultivation	Polka	47.80 ±2.40	18.64 ±0.93	19.56 ±0.86	173.17 ±8.30
	Polana	34.62 ±2.24	18.04 ±0.88	18.66 ±0.97	176.21 ±7.82
Conventional cultivation	Polka	42.19 ±3.59	15.17 ±0.53	16.21 ±0.56	137.75 ±6.01
	Polana	43.55 ±1.03	16.64 ±0.09	17.89 ±0.17	172.23 ±0.86
Mean	Organic	41.21 ±7.26	18.34 ±0.81	19.11 ±0.85	174.69 ±7.40
Mean	Conventional	41.74 ±1.87	15.89 ±0.96	14.57 ±1.09	109.59 ±18.12
P	Production system	NS*	0.0026	0.0011	0.0034

\* – not significant statistically at the 0.05% level of probability

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