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REGULAR ARTICLE

CAN BE BLUEBERRIES THE RISK FOOD AND RAW MATERIAL?

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ABSTRACT

Fruits of the highbush blueberries are popular for their beneficial effects on human health and for their excellent sweet-vine taste. Our work is focused on risk assessment of selected elements in relation to the content of bioactive compounds in wild and cultivated of highbush blueberries (*Vaccinium corymbosum* L.). Anthocyanins are polyphenols that are widely distributed in plants, and contribute to the brilliant blue, red or purple colour in leaves, flowers or fruits. In the samples the antioxidant capacity by the method of Brand – Williams using DPPH (2,2–difenyl-1-pikrylhydrazyl) and the content of anthocyanins by the modified method Lapornik in two samples of wild blueberries from different areas of Slovakia (Čertovica and Oravské Veselé) and in 6 cultivated varieties highbush blueberry (Bluejay, Bluecrop, Patriot, Berkeley, Brigitta, Nelson) were determined. The contents of risky elements - Cd, Pb were assessed by AAS method. The contents of Pb were in all observed samples higher than the maximum limit given by the legislation (cultivated: 0.5612 – 0.9912 $mg.kg^{-1}$, wild: 0.792 – 0.874 $mg.kg^{-1}$). The measured content values of Cd were in all samples of blueberries lower than hygienic limit. The highest content of anthocyanins from analysed samples was in wild blueberries from surrouding Čertovica 4870.125 ± 22.803 $mg.dm^{-3}$, but in this sample was simultaneously the lowest antioxidant capacity of 61.15 ± 1.002 %. The highest antioxidant capacity was measured in sample of cultivated variety Bluejay 87.175 ±

0.45 %. It is important to carry out monitoring of heavy metals to consumption of safe food raw materials and foodstuffs.

Keywords: blueberries, antioxidant capacity, DPPH, anthocyanins, heavy metals, AAS

INTRODUCTION

Blueberry is the fruit of the genus *Vaccinium,* which belongs to the *Ericaceae* family. It is recognized for its anthocyanin and flavonoid content, antioxidant activity (**Prior *et al.*, 1998**), and for its potential health benefits (**Smith *et al.*, 2000**). Antocyanins are flavonoids (**Rui *et al.*, 2011**), and colorant candidates (**Maier *et al.*, 2009**), because they are representative pigments widely distributed in nature, and are responsible for the attractive red, purple and blue color in many fruits and flowers (**Xiong *et al.*, 2006**). Anthocyanins also exhibit antioxidant activity (**Malien-Aubert *et al.*, 2001**) and they possess characteristics known to be effective against cancer, heart and inflammatory diseases (**Estupinan *et al.*, 2011**). Heavy metals are among the contaminants, which are characterized by different sources of origin, properties and action on living organisms (**Tóth *et al.*, 2005**). Heavy metals are irreplaceable biological micronutrients (Cu, Zn, Fe) as well as numerous non-essential chemical elements (Cd, Pb, Cr, etc.). Toxic can be also biological irreplaceable microelements, if they exceed a certain concentration (**Tomáš *et al.*, 2001; Tóth *et al.*, 2000**). In terms of content of risk elements is especially high demands on the productive parts of plants that are used in human nutrition.

The aim of this study was on risk assessment of selected elements in relation to the content of bioactive compounds in wild and cultivated of highbush blueberries (*Vaccinium corymbosum* L.).

MATERIAL AND METHODS

The observation group were two samples of wild blueberries from two different areas of Slovakia (Čertovica and Oravské Veselé) and 6 cultivated varieties highbush blueberry (Bluejay, Bluecrop, Patriot, Berkeley, Brigitta, Nelson) from Regional Research Station at Krivá on Orava which is a remote branch of the Grassland and Mountain Agriculture Research Institute in Banska Bystrica.

We were performed analysis of lyophilized samples to determine the concentrations of risk elements after "wet" mineralization by microwave digestion on *MARS X-press* equipment . Analytical extension was atomic absorption spectrometry on the *VARIAN AA 240 FS* equipment.

Antioxidant capacity was determined by the Brand - Williams method (1995), using a compound DPPH (2.2-diphenyl-1-pikrylhydrazyl) (Merck). 2.2-diphenyl-1-pikrylhydrazyl (DPPH) was pipetted to cuvettes (3.9 m^3), then was wrote the value of absorbance, which corresponded to the initial concentration of DPPH solution in time A_0. Then 0.1 cm^3 of the followed solution was added and then was immediately started to measure the dependence A = f(t). The solution in the cuvette was mixed and measured the absorbance of 1, 5 and 10 minutes at 515.6 nm in the spectrophotometer *Shimadzu UV/VIS - 1240*. The percentage of inhibition reflects how is the followed compound able to remove DPPH radical at the given time.

$$\text{Inhibition (\%)} = \frac{A_0 - A_{10}}{A_0} \times 100$$

The content of anthocyanins was determined in fresh samples by the modified method of Lapornik (2005). From blueberries samples 25 g were homogenised and extracted by 50 cm^3 80 % ethanol during 16 hours. Into two tubes 1 cm^3 of extract was pipetted and 1 cm^3 0,01 % HCl in 80 % ethanol was added. Then 10 cm^3 14 % HCl into the first tube and 10 cm^3 McIlvain agens (pH 3,5) into another tube were added. Absorbance was measured at 520 nm against blank sample in the spectrophotometer *Shimadzu UV/VIS -1240.*

RESULTS AND DISCUSSION

Figures 1 and 2 show the content of risk metals Cd and Pb in selected berries cultivated varieties of highbush blueberry and wild blueberries in relation to the maximum limit given by the legislation Codex Alimentarius SR.

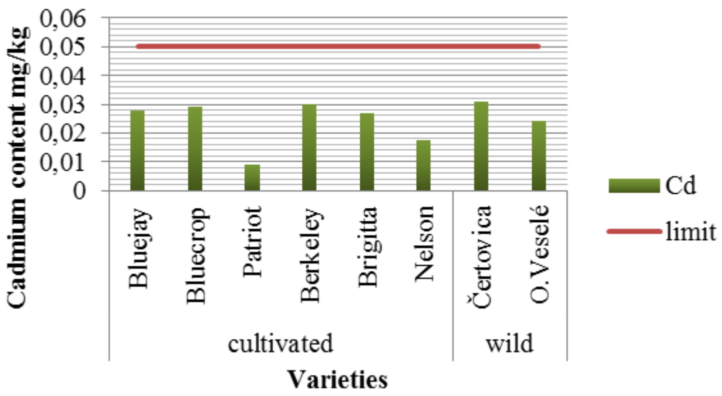

Figure 1 Cd content (mg.kg^{-1}) in selected samples of cultivated and wild blueberries in relation to the hygienic limit

The measured values for the content Cd in observed blueberry fruits did not exceed in either variety the maximum amount of Cd which is defined in the Codex Alimentarius SR (PK SR: Cd 0.05 mg.kg^{-1}). The average content of Cd in observed varieties of blueberries was 0.0244 mg.kg^{-1}. Reimann et al. (2001) in their results indicate even lower values for the content Cd in the fruits of blueberries (0.009 mg.kg^{-1}).

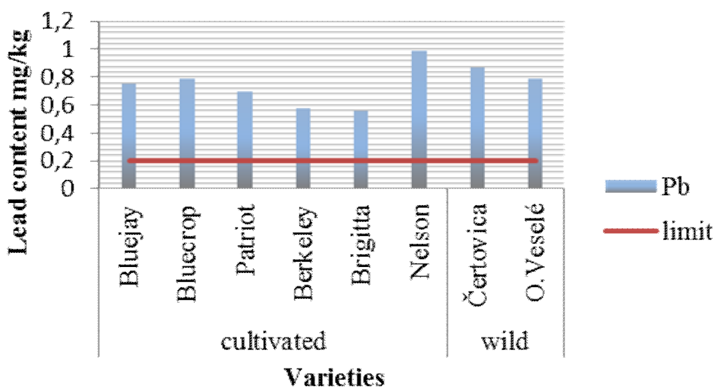

Figure 2 Pb content (mg.kg^{-1}) in selected samples of cultivated and wild blueberries in relation to the hygienic limit

Contents of Pb were in all observed samples higher than the maximum limit given by the legislation (PK SR: Pb 0.2 mg.kg^{-1}) from the 2.5-fold increase in the cultivated variety Brigitta to almost 5-fold increase in the cultivated variety Nelson. Reimann et al. (2001) indicate a significantly lower average content of Pb (0.13 mg.kg^{-1}) than the average content of Pb in our studied varieties of blueberries (0.7538 mg.kg^{-1}).

Figures 3 and 4 present the average contents of anthocyanins and antioxidant capacity in six cultivated varieties of highbush blueberries (*Vaccinium corymbosum* L.) and in two wild blueberries from different areas of Slovakia (Čertovica, Oravské Veselé).

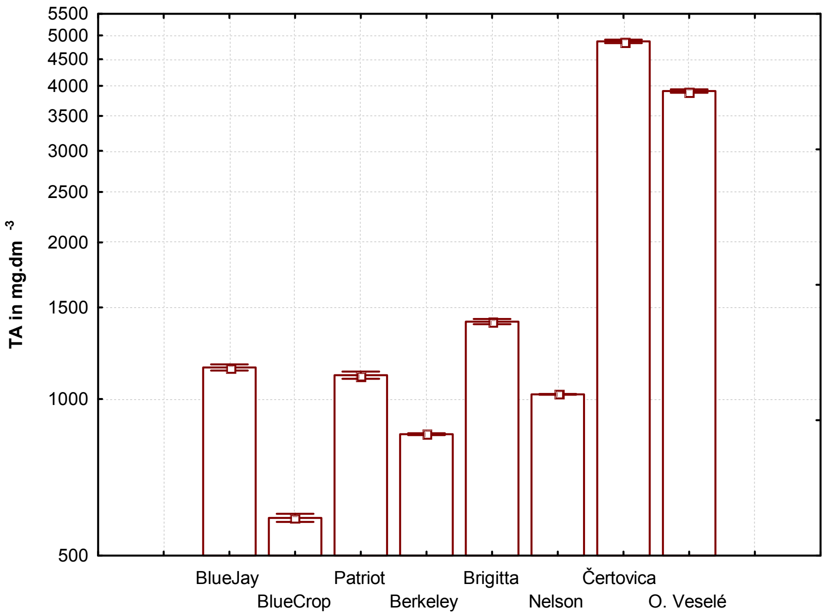

Figure 3 The content of anthocyanins (TA - total anthocyanins) in selected samples of cultivated and wild blueberries ($mg.dm^{-3}$)

Figure 3 shows that the highest content of anthocyanins is in a sample of wild blueberries from the site Čertovica 4870.125 ± 22.803 $mg.dm^{-3}$. Berries wild blueberries are small, dark violet to black, deep a wine sour taste. On the other side the lowest content of anthocyanins in studied samples blueberry variety Bluecrop (591.089 $mg.dm^{-3}$) was determined. Berries of this variety are large to very large, light blue with waxy and full taste. Our results (cultivated varieties: 591.089 ± 6.702 – 1408.94 ± 10.065 $mg.dm^{-3}$) correspond with the findings of the authors Ścibisz a Mitek (2007), to determine the average content of anthocyanins in different varieties of blueberries in the range 450 – 1205 $mg.dm^{-3}$. The contents of anthocyanins in wild blueberries samples 4-fold excess of the upper limit fixed by the interval of the authors.

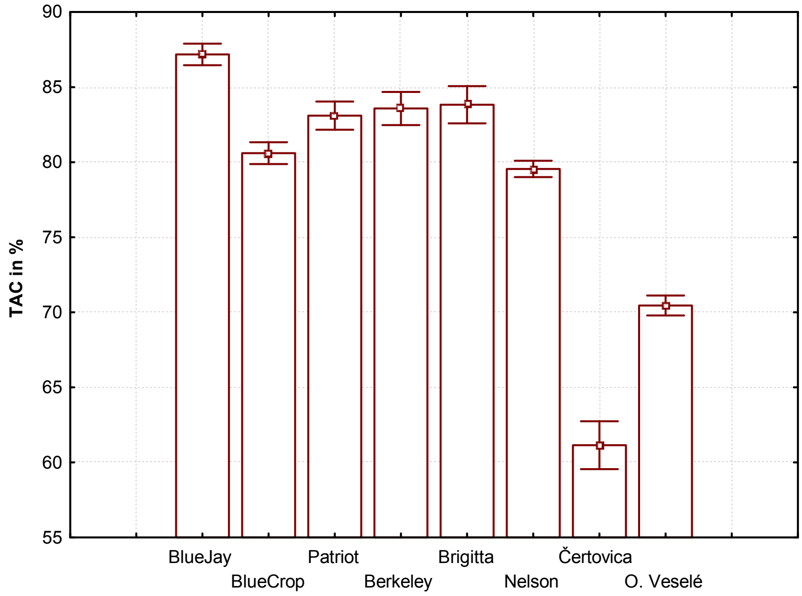

Figure 4 Antioxidant capacity (TAC – total antioxidant capacity) in selected samples of cultivated and wild blueberries, reported as % inhibition

Figure 4 shows the antioxidant capacity in 6 cultivated varieties, and 2 samples of wild blueberries from different areas of Slovakia. The highest antioxidant capacity was measured in the sample of the medium late variety Bluejay 87.175 ± 0.45 %. The lowest antioxidant capacity was measured in the sample of wild blueberries from the area Čertovica 61.15 ± 1.002 %. Su and Chien (2007) in his work determined the antioxidant capacity (60.6%), which corresponds to our findings that blueberries have high antioxidant capacity. Confirming the arguments the authors Smith et al. (2000), the bioactive extracts of wild blueberries, rich in anthocyanins and proanthocyanidins, exhibit antioxidant activity.

CONCLUSION

Blueberries contain bioactive compounds with potential health benefits. They are a rich source of macro and microelements, vitamins and other positive effective phytochemicals. They are also an important source of polyphenolic substances, flavonoids, especially anthocyanins and are characterized by high antioxidant capacity.

On the other side our results confirmed that blueberry fruit can accumulate relatively high content of some risk elements as Pb. In our samples the Pb content exceeded the hygienic limit given by Codex Alimentarius SR (2,5 – 5 fold). This fact can be connected not only with high Pb content in the soil, but also with contamined atmosphere from industrial sources, because wet and dry atmosphere deposition of Pb is one of the most important sources of Pb input into the plant raw materials. The summ of Pb in the plant is significantly influenced by the remote transport.

So, it is necessary to monitor heavy metal content in blueberry fruits to ensure the food safety and to support the significant benefit of this fruit to the human health.

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