JMBFS

Journal of Microbiology, Biotechnology and Food Sciences

International peer-reviewed scientific online journal

Published by Faculty of Biotechnology and Food Sciences

THE INFLUENCE OF SELENIUM ON CONTENT OF TOTAL POLYPHENOLS AND ANTIOXIDANT ACTIVITY OF ONION (*ALLIUM CEPA* L.)

Petra Kavalcová, Judita Bystrická, Pavol Trebichalský, Beáta Volnová, Miriama Kopernická*

Address(es): Ing. Petra Kavalcová,
Slovak University of Agriculture, Faculty of Biotechnology and Food Sciences, Department of Chemistry, Tr. A. Hlinku 2, 949 76, Slovak Republic, phone number: +421376414375.

*Corresponding author: kavalcova.petra@gmail.com

ARTICLE INFO

Received 10. 10. 2013
Revised 30. 10. 2013
Accepted 9. 1. 2014
Published 1. 2. 2014

Regular article

OPEN ACCESS

ABSTRACT

Selenium (Se) is an essential element, which is located in soil and stones, accumulated in plants and input them the food chain. Selenium significantly influences the function nearly of all the components of the immune system. Is also protects the body from the toxic effects of some metals. The content of the total polyphenols was determined by using the Folin-Ciocalteu reagent (FCR). Antioxidant activity was measured using a compound DPPH˙ (2.2-diphenyl-1-picrylhydrazyl).
The content of total polyphenols in samples onion moved in the range from 575.25±33.90 to 695.07±59.91. In this work was watched the influence of selenium on antioxidant activity, where values were in interval from 37.09±1.72 to 63.29±5.14.

Keywords: onion (*Allium cepa* L.), total polyphenols, antioxidant activity, selenium

INTRODUCTION

Onion (*Allium cepa* L.) is botanically included in the *Liliaceae* and species are found in Europe, Asia, North America and Africa. Onions are versatile and are often used as an ingredient in many dishes and are accepted by almost all traditions and cultures **(Griffiths *et al*., 2002).**
Onions (*Allium cepa* L.) are important source of bioactive compounds including flavonoids, fructooligosaccharides (FOS), thiosulfinates and other sulfur compounds, and many of these compounds have potential beneficial properties for human health **(Soinen *et al.*, 2012).**
Polyphenols are the most abundant antioxidants in human diets. The main classes of polyphenols are phenolic acids and flavonoids, anthocyanins and their oxidation products, which account for one- and two-thirds, respectively. Polyphenols are reducing agents, and together with other dietary reducing agents, such as vitamin C, vitamin E and carotenoids, referred to as antioxidants, protect the body's tissues against oxidative stress and associated pathologies such as cancers, coronary heart disease and inflammation. **(Tapiero et al., 2002).**
Polyphenols are reported to *in vitro* inhibit cancer cell proliferation, reduce vascularisation, protect neurons, stimulate vasodilation and improve insulin secretion **(Rio-Del *et al.*, 2010)**
Phenolics are present in significant amounts in many commonly consumed fruits, vegetables, grains, herbal products, and beverages. Over 8000 phenolic compounds have been isolated from different natural products, including flavonoids, phenolic acids, coumarone, and tannins. Flavonoids represent a large class of polyphenolic components that occur in most plant foods; a significant number of flavonoids are purported to have beneficial health effects **(Erdman *et al.*, 2005).**
Selenium is a trace element that is essential to good health but is required in small amounts. Selenium is found in selenoproteins which are important antioxidant enzymes. The antioxidant properties of the selenoproteins prevent cellular damage from free radicals that may contribute to the development of chronic diseases such as cancer, heart disease **(Zegenere *et al.*, 2008).**
The objectives of this work were to evaluate the influence of selenium on the content of total polyphenols and antioxidant activity of onion (*Allium cepa* L.).

MATERIAL AND METHODS

Soil substrate

In the conditions of growing pots trial were taken of soil from area of Babindol. Babindol is area without negative influences, emission sources (carbon), relatively pure from point of view of content permissible forms of risk elements (Table 1, 2).

Table 1 Agrochemical characteristic of soil substrate in mg. kg^{-1}

Agrochemical characteristic	**pH (H_2O)**	**pH (KCl)**	**Cox (%)**	**Humus (%)**					
	7,75	6,52	1,32	2,27					
Nutrients	**N**	**K**	**Ca**	**Mg**	**P**				
	1568	452,5	2730	324	165,6				
Heavy metals	**Zn**	**Cu**	**Mn**	**Fe**	**Cr**	**Cd**	**Pb**	**Co**	**Ni**
Aqua regia	64,2	22,0	624,4	11130	31,6	1,16	22,8	13,8	32,2
Limit value	**100,0**	**60,0**	-	-	**70,0**	**0,4**	**70,0**	**15,0**	**40,0**
HNO_3(c=2 mol.dm^{-3})	10,8	6,1	156,4	277,6	1,8	0,3	9,2		
Reference value A_1	**40,0**	**20,0**	-	-	**10,0**	**0,3**	**30**	-	**10,0**
NH_4NO3 c= 1 mol.dm^{-3}	0,23	0,04	0,08	0,135	0,025	0,048	0,125	0,055	0,10
Critical value	**2,0**	**1,0**	-	-	-	**0,1**	**0,1**	-	**1,5**

Note: *Limit value for Aqua raegia- law no. 220/2004 Z.z., **Critical value for NH_4NO_3 (c= 1 mol.dm^{-3})- law no. 220/2004 Z.z.,
***Reference value A_1 (c= 2 mol.dm^{-3})- Act of MP SR 531/1994-540., - not applicable.

Six kilograms of soil was weighted into plastic bowl-shaped pots with average of 20 cm and height of 25 cm with foraminate bottom. Basic nutrients were added in the form of aqueous solution. The eight yellow onion variety Mundo were planted into each container. The experiment was based on four replications. Mundo is medium-late variety of onion. Onions are cycle and brown color. Mundo is well storable and suitable for the eating. Selenium was applied in the form of Na_2SeO_4.

Table 2 Variants of pots experiments

Variety	Added amount of Se (mg.kg^{-1})
Control	0.00
Se 1	0.25
Se 2	0.38

Sample preparation

Samples of fresh onion were homogenized and we prepared an extract: 25 g cut onion extracted by 50 ml 80% ethanol accourding sixteen hours. These extracts were use by analyze.

Determination of total polyphenols

Total polyphenols were determined by the method of **Lachman *et al*., (2003)** and expressed as mg gallic acid equivalent per kg fresh mater. Gallic acid is usually used as a standard unit for phenolics content determination because a wide spectrum of phenolic compounds. The total polyphenol content was estimated using Folin-Ciocalteau assay. The Folin-Ciocalteau phenol reagent was added to a volumetric flask containing 100 µL of extract. The content was mixed and 5 ml a sodium carbonate solution (20 %) was added after 3 min. The volume was adjusted to 50 mL by adding of distilled water. After 2 hours, the samples were centrifuged for 10 min. and the absorbance was measured at 765 nm of wave lenght against blank. The concentration of polyphenols was calculated from a standard curve plotted with known concentration of gallic acid.

Determination of antioxidant activity

Antioxidant activity was measured by the **Brand** and **Williams *et al.*, (1995)** method-using a compound DPPH˙ (2.2-diphenyl-1-pikrylhydrazyl) (Merck). 2.2-diphenyl-1- pikrylhydrazyl (DPPH˙) was pipetted to cuvette (3.9 m^3), then was wrote the value of absorbance, which corresponded to the initial concentration of DPPH˙ solution in time Ao. 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 antioxidant compound are able to remove DPPH˙ radical at the given time.

Inhibition (%) = (Ao – At / Ao) x 100

RESULTS AND DISCUSSION

Onion (*Allium cepa* L.) is highly valued for its therapeutic properties. The onion has a wide range of beneficial actions on the body and when we eat it (especially raw) on a regular basis will promote the general health of the body. The bulb is anthelmintic, anti-inflammatory, antiseptic, antispasmodic, carminative, diuretic, expectorant, febrifuge, hypoglycemic, hypotensive, lithontripic, stomachic and tonic (**Kumar-Sampath *et al*. 2010**).

In this work was watched the progress of making the total polyphenols content and antioxidant activity in different levels of fertilizer selenium in onion during vegetation. Onion is rich in phenolic compounds and content of many antioxidants. **Andrejiová *et al*., (2011)** reported that the total polyphenol content in onion was 105.19-1347.25 mg.kg^{-1}. Our values were in the range from 595.50±41.29 to 695.07±59.91. The lowest values of total polyphenols were recorded at the beginning of vegetation in all these variants (control, variant I, variant II) and the highest values in the case of control variant and in the case of the variant I (incorporation of selenium in quantity of 0.25 mg.Se.kg^{-1}) at the end of vegetation period. In the case of variant II (incorporation of selenium in quantity of 0.38 mg.Se.kg^{-1}) the content of polyphenols during vegetation period had high character (613.90±42.94-676.00±56.16) (Table 3).

Table 3 Dynamics of changes TPC (mg.kg^{-1}) in onion after selenium application

Variety	I. sampling	II. sampling	III. sampling
Control	645.96±63.06	682.24±53.96	695.07±59.91
Added Se 1	595.50±41.29	600.42±43.28	609. 97±54.84
Added Se 2	613.90±42.94	648.59±43.56	676.00±56.16

There are many scientific works dealing with the influence of selenium fertilizer on the yield and quality of the bulbs, but already the influence of selenium fertilizer on the level of common total polyphenol content and antioxidant activity are devoted to less work. Many authors found positive influence in the highest plant growth and also the highest yield and bulb quality. **Motomura *et al*., (2008)** said, that with the increase concentration of selenium in aqueous and ethanolic extracts was content of total polyphenol increased. **Zegnere *et al*., (2008)** found positive correlation between sodium selenite dose and bulb weight observed for pot grown onion. **Xu *et al*., (2003)** reported that the selenium fertlizers significantly increased the total polyphenols. Application of selenium **Finley *et al*., (2005)** found that there was inhibited production of the most phenolic acid. In the work we not found correlation between the content of selenium in soil and the content of total polyphenols (P-value = 0.2979 I. sampling, P-value = 0.251 II. sampling and P-value = 0.474 III. sampling) (Figure 1, 2, 3).

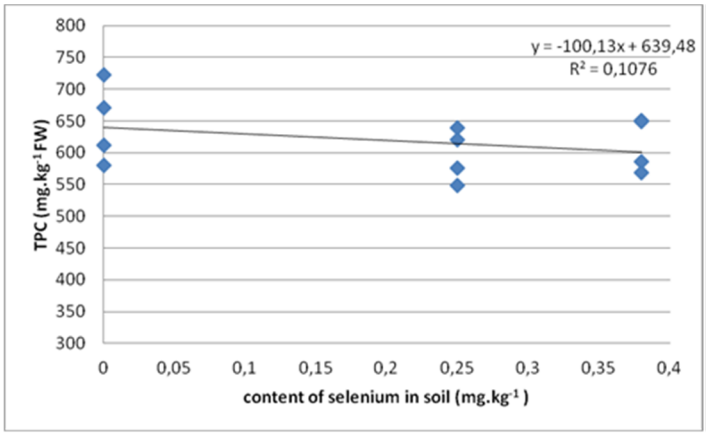

Figure 1 The dependence of the Se content in the soil of the TPC (I. sampling)

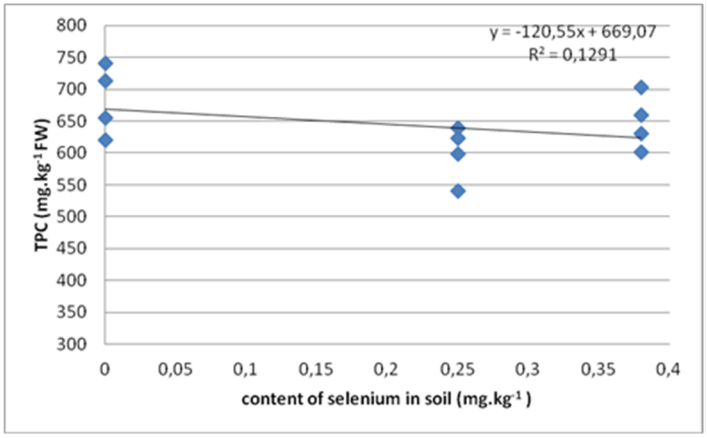

Figure 2 The dependence of the Se content in the soil of the TPC (II. sampling)

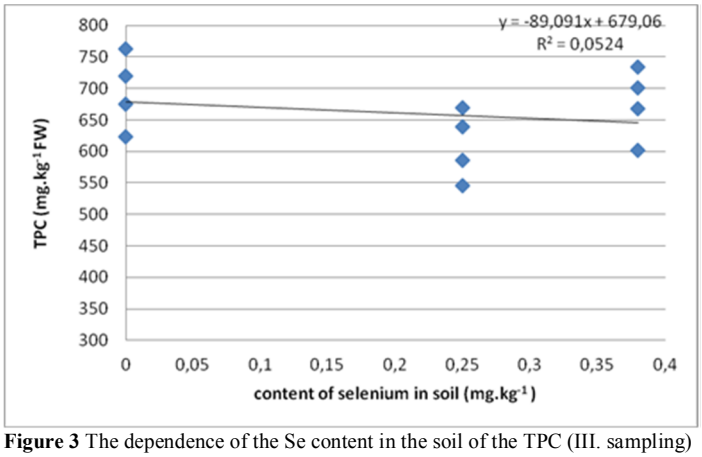

Figure 3 The dependence of the Se content in the soil of the TPC (III. sampling)

Natural polyphenol and their preparations for food and nutritional supplementation or dietary purposes have received increased attention in recent years. The content of polyphenols as antioxidant activity natural substances may by important in supporting the overall physiological health effects of phenol-rich plant foodstuffs (**Kroyer, 2004**).

In this work was watched the effect of selenium on antioxidant activity. Our values were in interval from 37.09±1.72 to 63.29±5.14 (Table 4).

Table 4 Dynamics of changes AOA (mg.kg^{-1}) in onion after selenium application

Variety	I. sampling	II. sampling	III. sampling
Control	49.82±1.39	44.67±2.08	37.09±1.72
Added Se 1	57.02±4.42	51.95±4.80	53.83±3.86
Added Se 2	63.29±5.14	48.29±5.07	51.61±6.37

Few studies have been reported about the association between selenium content and antioxidant activity plants. **Kaklewski *et al.*, (2008)** reffered that the content of selenium to be depending on the species and the growth stage plants. **Xu *et al.*, (2004)** found the positive relationship between the selenium content and the antioxidant activity. In this work was found weak correlation between the selenium content in soil and the values of antioxidant activity at the beginning and the end of the vegetation season (Figure 4, 5). It was no found correlation between the selenium content in soil and the antioxidant activity in the middle of the vegetation season- II.sampling.

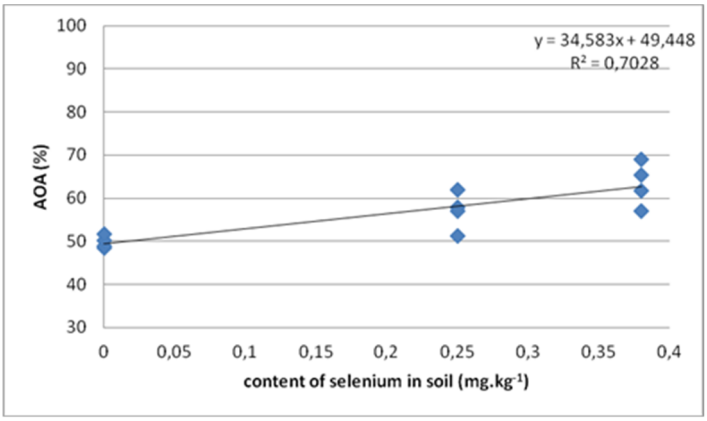

Figure 4 Relationship between content of selenium in soil and antioxidant activity (I. sampling)

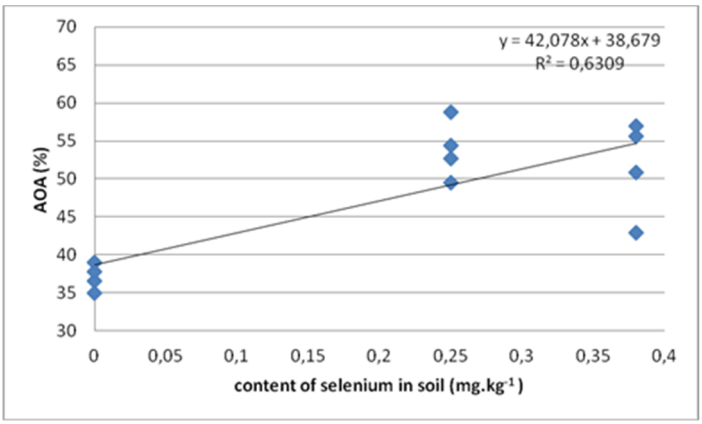

Figure 5 Relationship between content of selenium in soil and antioxidant activity (III. sampling)

CONCLUSION

The contribution focuses on the impact of benefits on the total polyphenol content and content of selenium antioxidant activity in onion (*Allium cepa* L.). The results suggest that doses of the selenium did not have significant effect on the content of polyphenols. In this work was found positive relationship between the content of the selenium in soil and values antioxidant activity. These positive effects of Se are, however dependent on the Se concentration and the age of the onion plant. It is know that selenium is an essential trace element for human heath but is required only in small amounts. Se is found in selenoproteins which are important antioxidant enzymes. Soil application of the selenium can enhance growth, yield and quality of crops. The results obtained in this work provide further information about the effect of selenium fertilizers of polyphenolic content and antioxidant activity.

Acknowledgments: The work was supported by scientific grant KEGA 014SPU-4/2013, VEGA 1/0456/13.

REFERENCES

ANDREJIOVÁ, A. – KÓŇA, J. – BARÁTOVÁ, S. 2011. Vplyv hnojenia a odrody na antioxidačnú aktivitu a obsahu celkových polyfenolov v cibuli kuchynskej (*Allium cepa* L.). *Výživa a zdravie*, 12-17.

BRAND-WILLIAMS, W. – CUVELIER, M. E. – BERSET, C. 1995. Use of a free radical method to evaluate antioxidant activity. *Lebensmittel-Wissenschaft and Technologie*, 28, 25-30.

ERDMAN, J. W. – BALENTINE, D. – ARAB, L. – BEECHER, G. – DWYER, J. T. 2005. Flavonoids and heart health: Proceedings of the ILSI North America flavonoids workshop May 31-June 1. *Journal of Nutrition*, 137, 718-737.

FINLEY, J. K. – SIGRID-KECK, A. – ROBBINS, R. J. – HINTZE, K. J. 2005. Selenium enrichment of broccoli: interactions between selenium and secondary plant compounds. *Journal of Nutrition*, 135, 1236-1238.

GRIFFITHS, G. – TRUEMAN, L. – CROWTHER, T. – THOMAS, B. – SMITH, B. 2002. Onions- a global benefit of health. *Phytotherapy Research*., 16, 603-615.

KAKLEWSKI, K. – NOWAK, J. – LIGOCKI, M. 2008. Effects of selenium content in green parts of plants on the amount of ATP and ascorbate-glutathione cycle enzyme activity at various growth stages of wheat and oilseed rape. *Journal of Plant Physiology*, 165, 1011-1022.

KROYER, G. T. 2004. Red clover extract as antioxidant active and functional food ingredient. *Innovative Food Science &Emerging Technologies*, 5, 101-105.

KUMAR-SAMPATH, P. K. – BHOWMIK, D. – BISWAJIT, CH. – TIWARI, P. 2010. Allium cepa: A traditional medical herb and its health benefits. *Journal of Chemical and Pharmaceutical Reaserch*, 2, 283-291.

LACHMAN, J. – PRONĚK, D. – HEJTMÁNKOVÁ, A. – PIVEC, V. – FAITOVÁ, K. 2003. Total polyphenol and main flavonoid antioxidants in different onion (*Allium cepa* L.) varieties. *Scientia Horticulturae*, 30, 142-147.

MOTOMURA, Y. – REYES-DIAZ, M. – GIL, M. 2008. Effect of selenite on the total polyphenol content and antioxidative activity of aqueous and ethanolic extracts in sprouts of four agronomic species. *Soil Science and Plant Nutrition* , 8, 55-67.

RIO-DEL, D. – COSTA, D. – LEAN, L. G. – CROZIER, M. E. J. 2010. Polyphenols and health: What compounds are involved? *Nutrition, Metabolism & Cardiovascular Diseases*, 20, 1-6.

SOINEN, T. H. – JUKARAINEN, N. – JULKUNEN-TITTO, R. – KARJALAINEN, R. – VEPSALAINEN, J. 2012. The combined use of constrained total-line-shape ^{1}H NMR and LC–MS/MS for quantitative analysis of bioactive components in yellow onion. *Journal of Food Composition*, 25, 208-214.

TAPIERO, H. – TEW, K. D. – MATHÉ, G. 2002. Polyphenols: do they play a role the prevetion of human pathologies? *Biomedicine Pharmacotherapy*, 56, 200-207.

ZEGNERE, L. – ALSIN, A. L. 2008. The effect of selenite on growth and storage of onions. *Journal of Agronomy*, 10, 235-240.

XU, J. –XU, J. – HU, Q. 2004. Effect of foliar application of selenium on the antioxidant activity of aqueous and ethanolic extracts of selenium-enriched rice. *Journal Agricultural and Food Chemistry*, 52, 1759-17636.

XU, J. – YANG, F. – CHEN, L. – HU, J. – HU, Q. 2003. Effect of selenium on increasing the antioxidant activity of tea leaves harvested during the early spring tea producing season. *Journal Agricultural and Food Chemistry*, 51, 1081-1084.