

SELENIUM AND ITS INFLUENCE ON THE CONTENT OF POLYPHENOL COMPOUNDS IN ONION (*ALLIUM CEPA* L.)

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ABSTRACT

Onions (*Allium cepa* L.) are important source of bioactive compounds including polyphenols and have potential beneficial properties for human health. Selenium (Se) is an essential micronutrient that is required in small amounts. The aim of the research was to find out how selenium (Se) treatment affects on the quality of onion (*Allium cepa* L.). 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 Se treatment increased the content of total polyphenols (TCA) and antioxidant activity (AA). The content of total polyphenols in samples of onion during vegetation period moved in the range from 508.16±27.59 to 607.56±23.15. In this work was watched also the influence of potassium on antioxidant activity, where values were in interval from 25.90±0.47 to 39.72±2.64.

OPEN ACCESS

Keywords: Selenium, onion, total polyphenols, antioxidant activity

INTRODUCTION

Onion (*Allium cepa* L.) belongs to the *Allium* family in common with leek (*Allium porrum*) and garlic (*Allium sativum*), they are highly valued for their flavour and for the nutritional value. Onions are one of the most consumed vegetables with very diverse uses. It can be consumed raw in salad or cooked.

Many studies have suggested (Rio-Del *et al.*, 2010; Geetha *et al.*, 2011; Bernaert *et al.*, 2012) that regular consumption *Allium species* has a beneficial effects on the human health. The protective effect of vegetables from *Allium* family against certain diseases such as cancers, cardiovascular disease, has been attributed to the presence of organosulphur compounds as well as polyphenol substances which are located in onion (Han *et al.*, 2013).

Nutrient management for onion production have a significant effect on postharvest behaviour of the produce (Kumar *et al.*, 2007). Different types of soils have different characteristics that influence growth and yield of crops. The type and value of fertilizer and the level of application directly influence plant physiology and the biosynthesis of secondary compounds in plants (Naguib *et al.*, 2012).

Selenium is a trace element that is essential to good health but is required in small amounts. *Allium* species have the capability to accumulate high Se levels (Shah *et al.*, 2004). Selenium plays an important role in human and animal nutrition. Its essential component of the number antioxidant enzymes (Kápolna, Fodor, 2006). Selenium is needed to prevent oxidative damage and to support hormone balance in human and animal cells (Fairweather-Tait *et al.*, 2011).

The main purpose of this study was to determine of sulphure on the content of the total polyphenols as well as antioxidant activity of onion.

MATERIAL AND METHODS

Soil substrate

In the conditions of growing bowl-shaped pots we were taken of soil from area of Babindol. Babindol is located in the middle of Žitavská upland. Babindol belongs to the relatively warm climatic zone with average annual temperature 9.7 °C and annual rainfall 580 mm. Agrochemical characteristic of soil in that region shown in the Table 1.

Table 1 Agrochemical characteristic of soil substrate in mg.kg⁻¹

Agrochemical characteristic	pH (H ₂ O)	pH (KCl)	Cox (%)	Hum. (%)					
	7.75	6.60	1.19	2.05					
Nutrients	N	K	Ca	Mg	P				
	1225	285.80	3091.4	265.70	195.80				
Heavy metals	Zn	Cu	Mn	Fe	Cr	Cd	Pb	Co	Ni
<i>Aqua regia</i>	71.0	20.0	640.0	22785	22.60	0.72	21.20	12.40	29.20
Limit value	100.0	60.0	-	-	70.0	0.4	70.0	15.0	40.0
NH ₄ NO ₃ (c = 1 mol.dm ⁻³)	0.05	0.07	0.21	0.20	0.02	0.04	0.22	0.11	0.15
Critical value	2.0	1.0	-	-	-	0.1	0.1	-	1.5

Legend: *Limit value for Aqua regia - law no. 220/2004 Z.z.

**Critical value for NH₄NO₃ (c = 1 mol.dm⁻³) - law no. 220/2004 Z.z.

- not applicable.

Six kilograms of soil was weighted into plastic bowl-shaped pots with average of 20 cm and height of 25 cm with foraminated bottom. Basic nutrients were added in the form of aqueous solution. 8 yellow onion variety of Mundo were planted into each container. Onions of varieties Mundo are flat- cycle and yellow gold colour. The flesh is white, firm, slightly sharper taste. These varieties are well storable with good consumer values. The experiment was based on four replications. Basic nutrients were applied in the form of aqueous solution. Selenium was applied in the form Na₂SeO₄. Variants of pot experiments are given in Table 2.

Table 2 Variants of pots experiments

Variety	Added amount of Se (mg.kg ⁻¹)
control	0
Added Se1	0.150
Added Se 2	0.225
Added Se 3	0.300

Sample preparation

Samples of fresh onion we collected at the beginning, in the middle and end of vegetation period. Samples of onion were homogenized and we prepared an extract: 25 g cut onion extracted by 50 ml 80% ethanol according sixteen hours. These extracts were used by analyze. The experiment was based on four replications.

Determination of total polyphenols (TCP)

Total polyphenols were determined by the method of **Lachman et al. (2003)** and expressed in mg eq. gallic acid 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-Ciocalteu reagent. The Folin-Ciocalteu phenol reagent was added to a volumetric flask containing an aliquot of extract. The content was mixed and 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 length against blank. The concentration of polyphenols was calculated from a standard curve plotted with known concentration of gallic acid.

Determination of antioxidant activity (AOA)

Antioxidant activity was measured by the **Brand-Williams et al. method (1995)**, using a compound DPPH (2,2-diphenyl-1-picrylhydrazyl) (Merck). 2,2-diphenyl-1-picrylhydrazyl (DPPH) was pipetted into cuvettes (3.9 cm³), then was written the value of absorbance, which corresponded to the initial concentration of DPPH solution in time A₀. Then 0.1 cm³ of the followed solution was added and then was immediately started to measure the dependence A = f(t). The solution in the cuvettes were 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 the followed compound is able to remove DPPH radical at the given time.

$$\text{Inhibition (\%)} = (A_0 - A_t/A_0) \times 100$$

Statistical analysis

All determinations were done in six repetitions. The data were analysed using the package Statgraphics (multifactorial analysis of variance, LSD-text contrasts, *p* < 0.05).

RESULTS AND DISCUSSION

Onion is an important ingredient in all dishes around the world. It is known for its antimicrobial activity, antioxidant activity, anticarcinogenic and antimutagenic properties (**Corzo-Martínez et al., 2007**). Onion is one of the rich sources of the polyphenols – quercetin – in human diet. Fertilization plays significant roles in enhancing crop quality. A number of recent studies examined the effect of selenium (Se) on crops including *Alliums* (**Lavu et al., 2012; Pöldma et al.,**

2013; Reilly et al., 2014). Selénium treatment affects plant nutrition and it has a marked effect on the quality of the onion bulbs. 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 (**Zegener, Alsin 2008**).

In the current experiment the process of the formation of the total polyphenol content after application of different selenium levels was studied in onion (*Allium cepa* L.) during vegetation period. In the work we watched also the influence of selenium treatment on the antioxidant activity.

Table 3 shows the progress of making the total polyphenolic content in different levels of selenium fertilization in onion during vegetation.

Table 3 Dynamics of changes TPC (mg.kg⁻¹) in onion after selenium application

Variety	I. sampling	II. sampling	III. sampling
control	508.16±27.59 a	545.0±19.9 ab	599.88±18.54 a
Added Se1	560.31±7.59 b	566.83±9.59 bc	588.03±12.94 a
Added Se 2	587.58±15.27 b	584.53±17.77 c	607.56±23.15 a
Added Se 3	519.09±17.24 a	531.59±17.8 a	584.42±16.35 a

Legend: *Multiple Range Tests, Method: 95,0 percent LSD

Our values of total polyphenolic content during vegetation period were in range from 508.16±27.59 to 607.56±23.15. The highest values of total polyphenols (607.56±23.15) were recorded in variant II (incorporation of selenium in quantity of 0.225 mg Se.kg⁻¹ soil) at the end of vegetation period (III. sampling), but statistically significant relationship was not recorded (*p-value* > 0.05). The highest values of total polyphenols were recorded at the end of vegetation period in all variants. The slight decrease in the value of the total polyphenols against control variant (about 1.98%) was recorded in I. variant (588.03±12.94) (incorporation of selenium in quantity of 0.15 mg Se.kg⁻¹ soil) and in variant III (584.42±16.35) (incorporation of selenium in quantity of 0.30 mg Se.kg⁻¹ soil), these decreases compared to the control treatment were not statistically significant. Our results are in good accordance with **Motomura et al. (2008)**, who referred to the positive effect of using selenium fertilizers on the total polyphenol content. **Xu et al., (2003)** reported that the selenium fertilizers significantly increased the total polyphenols. As is known the content of polyphenols is affected by factors such as cultivar, location, agronomic, environmental conditions and use of fertilizers (**Yang et al., 2004; Dangour et al., 2009**).

In this work we watched the effect of selenium on the antioxidant activity. Our values were in interval from 25.90±0.47 to 39.72±2.64 (Table 4)

Table 4 Dynamics of AOA (%) in onion after selenium application

Variety	I. sampling	II. sampling	III. sampling
control	27.92±3.36 a	32.37±1.68 ab	32.36±0.62 a
Added Se1	29.86± 6.65 ab	30.20±6.26 a	34.87±2.10 a
Added Se 2	36.11±4.70 b	36.03±3.68 b	39.72±2.64 b
Added Se 3	25.90±0.47 a	27.20±1.17 a	38.74±1.62 b

Legend: *Multiple Range Tests, Method: 95,0 percent LSD

The highest value of antioxidant activity (39.72±2.64 %) were recorded in variant II (incorporation of selenium in quantity of 0.225 mg Se.kg⁻¹ soil) at the end of vegetation period (III. sampling). This increase compared to the control variant was statistically significant (*p-value* = 5.10⁻⁴). In our results we have seen a slight decrease in the value of the antioxidant activity (against control variant) in III. variant (incorporation of selenium in quantity of 0.300 mg Se.kg⁻¹ soil) in first, and second sampling, but statistically significant relationship was not recorded (*p-value* > 0.05).

Few studies have been reported about the association between selenium content and antioxidant activity plants. **Xu et al., (2004)** found the positive relationship between the selenium content and the antioxidant activity. Between the content of the selenium in the soil and antioxidant activity (in III. sampling) we have seen a slight positive correlation (*p-value* = 2.10⁻⁴) (Figure 1).

At work we have found positive correlation between the content of the total polyphenols and antioxidant activity (*p-value* = 6.10⁻³). Results are shown in Figure 2.

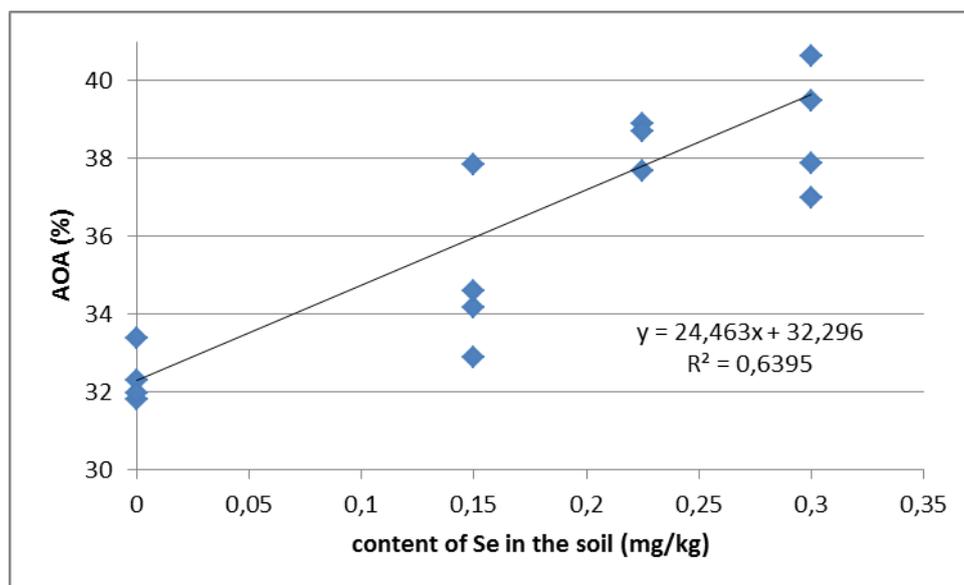


Figure 1 The dependence of the Se content in the soil of the AOA (III. sampling)

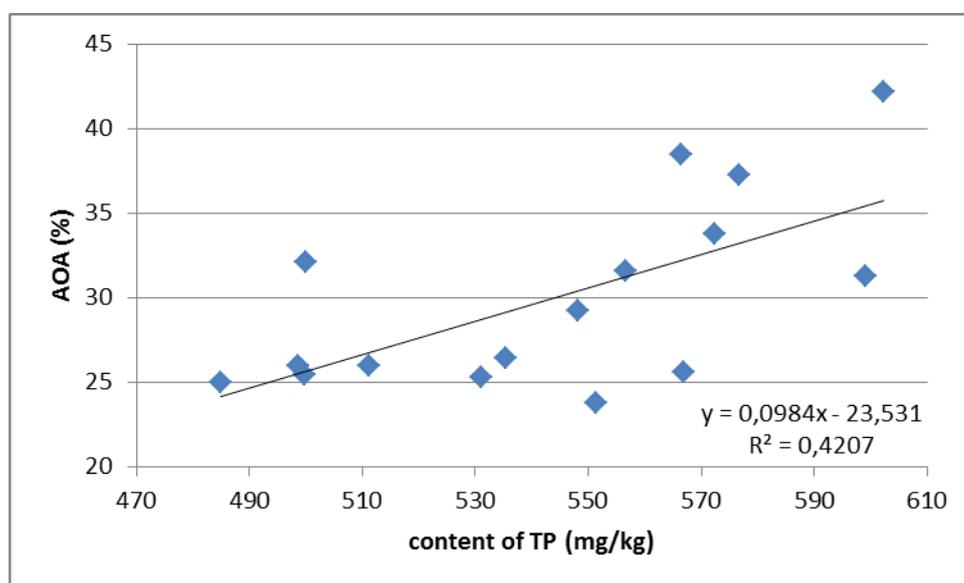


Figure 2: Relationship between TCP and AOA (I. sampling)

CONCLUSION

Onion (*Allium cepa*, L.) is one of the most important vegetable crops grown in Slovak Republic. It is a rich source of polyphenols, organic sulphur compounds and saponins. To track the impact of selenium we took advantage of growing experiments. 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. Application of selenium in quantity of $0.225 \text{ mg Se.kg}^{-1}$ soil resulted in the highest content of the total polyphenols and the highest value of antioxidant activity. In the next research of the influence of selenium on the bioactive components it should be presented complemented results of the influence of other bulbs of applied doses of selenium and attempts to expand on the small areas cultivation.

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