Journal of Microbiology, Biotechnology and Food Sciences

Bystrická et al. 2013 : 2 (Special issue 1) 1729-1738

REGULAR ARTICLE

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

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ABSTRACT

Potassium (K) is an essential plant nutrient which is influencing on plant metabolism, plant growth, development of the crops quality and crop yield. The present study was aimed to evaluate the influence of the potassium on the content of the total polyphenols and antioxidant activity on the onion *(Allium cepa L.)* variety Mundo. The content of the total polyphenols was determined by using the Folin-Ciocalteu reagent (FCR) according to **Lachman *et al.* (2003**), who was found that the content of polyphenols in his study were (273.51±21.00 to 722. 15±30.01 mg. kg^{-1}). At the end of the study we concluded statistically that the addition potassium in soil had a positive effect between the content of the potassium in the soil and the content of the total polyphenols on the onion, which was led an increase total polyphenols (P-value=2. 17.10^{-3}). On the other hand we found that an the addition the potassium in the soil had negative between the potassium content and values of antioxidant activity on the free radical (DPPH) for onion plant.

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

INTRODUCTION

Consuming vegetables may reduce the risk of chronic diseases, including cardiovascular disease, stroke, neurodegeneration, and type II diabetes. Substantial recent research has been performed to investigate the potential health benefits of antioxidants in food. Antioxidants can inhibit oxidative reactions in vivo, and aid in functional performance of enzyme systems for self-defence mechanisms within cells **(Lee *et al.,* 2004**).
Among all vegetables, onion is a species consumed widely across the world (**Lu *et al.*, 2011**).

Onion is one of the most important vegetable crops, with a world production of about 55 million tones. Its consumption is attributed to several factors, mainly heavy promotion that links flavour and health and the popularity of onion-rich ethnic foods (**Dine *et al.*, 2008**).

Onion bulb is rich on phosphorus, calcium, carbohydrates, polyphenols, flavonoids, antocyanins. It also contains protein and vitamin C. Onion represents a source of cysteine derivatives, which makes it a good antioxidant additive for food (**Ostrowska *et al.,* 2004**). It is well known for its health benefits, numerous therapeutic proprieties have been reported in onion i.e. anticarcinogenic, antibiotic, anti-bacterial, anti-fungal and antioxidant properties (**Benkeblia, 2005**).

Phenolic is one of the major groups of phytochemical that can be found in onion plants. Phenolic compounds are potent antioxidants and free radical scavenger which can act as hydrogen donors, reducing agents, metal chelators and singlet oxygen quenchers (**Chew *et al.,* 2009**).

Onion (*Allium cepa* L.*)* is rich source of phenolic acids which are derived from benzoic acid or cinnamic acid. Phenolic acids form approximately one third of polyphenols in our diet. They can contribute to bitterness, colour, taste and aroma of plant products.

Potassium plays a pivotal role in plant growth and development. Also potassium has a crucial role in the energy status of the plant, translocation and storage of assimilates and maintenance of tissue water relation (**Marschner, 1995**). The high levels of potassium fertilization have been resulted in bulbs with higher quality (**Geetha *et al.*, 1999**).

The objectives of our work were to evaluate the influence of potassium on the content of total polyphenols and antioxidant activity of onion *(Allium cepa L.).*

MATERIAL AND METHODS

In the conditions of growing pots trial were taken of soil from area of Babindol. We characterized Babindol as 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 (%)	Hum. (%)					
	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_4NO_3 ($c = 1\ mol.dm^{-3}$)	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 of Mundo were planted into each container. The experiment was based on four replications.

Table 2 Variants of pot experiments

Variety	**Added amount of K ($mg.kg^{-1}$)**
Control	0
K1	675
K2	900

Determination of total polyphenols

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-Ciocalteau reagent. The Folin-Ciocalteau 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

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 cm^3), then was written 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 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.

$$\text{Inhibition (\%)} = (Ao – At / Ao) \times 100$$

Ao - the initial concentration of DPPH solution in time Ao

At – absorbance the DPPH radical at time 10 (minute)

RESULTS AND DISCUSSION

Onion has a great importance in a human nutrition. It is a source of biologically active phytosubstance such as quercetin, phenolic acids, and kempferol glycosides (**Sellappan and Akoh, 2002**).

In the work we watched the progress of making the total polyphenols content and antioxidant activity in different levels of fertilizer potassium in onion during vegetation. Onion is rich in polyphenolic compounds**. Melo *et al.* (2006**) reported that the total polyphenol content in onion was 821.6 mg kg^{-1} fresh matter. **Al-Mamary** (**2002**) found out lower content 648.6 mg kg^{-1} fresh matter. Our values were in the range from 273.51±21.00 to 722.15±30.01 $mg.kg^{-1}$, with the highest values of total polyphenols were recorded at the beginning of vegetation in all three variants (control, variant I, variant II), and the lowest values in the case of the control variant and in the case of the variant I (incorporation of potassium in quantity of 675 mg $K.kg^{-1}$ soil) at the end of vegetation period. In the case of variant II (incorporation of potassium in quantity of 900 mg $K.kg^{-1}$ soil) at the end of vegetation period we have seen a slight increase in the content of total polyphenols, which represented the value of 441.47 $mg.kg^{-1}$ (Table 3).

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

Variety	I. sampling	II. sampling	III. sampling
control	689.26±67.95	530.54±18.37	288.85±21.06
Added K1	722.15±30.01	390.87±17.84	273.51±21.00
Added K2	458.29±39.66	355.51±24.71	441.47±23.23

There are many scientific works dealing with the influence of potassium fertilizer on the yield and quality of the bulbs, but already the influence of potassium fertilizer on the level of common total polyphenol content are devoted to less works. **El-Bassiouny** (**2006**) found that using potassium fertilization resulted in the highest plant growth (plant length, number of leaves/plant, and fresh weight of leaves) and also the highest yield and bulb quality. Similarly show **Kumar *et al.*** (**2001**), that potassium application significantly increased the dry weight of bulbs and bulb yield. **Kamal *et al.*** (**2008**) found a significant increase in the total polyphenol content of onion potassium treatments. Similarly **Mudau *et al.*** (**2007**) reported that the potassium fertilizers increased quadratically the total polyphenols. At the beginning of the growing season (I. sampling, II. sampling) we found a negative correlation between the content of potassium in soil and the content of total polyphenols (P-value = $5.58.10^{-3}$, P-value = $3.65.10^{-5}$) and at the end of vegetation period we noticed a statistically positive correlation between the content of potassium in the soil and the content of total polyphenols in onion (P-value = $2.17.10^{-3}$) (Figure1, 2, 3).

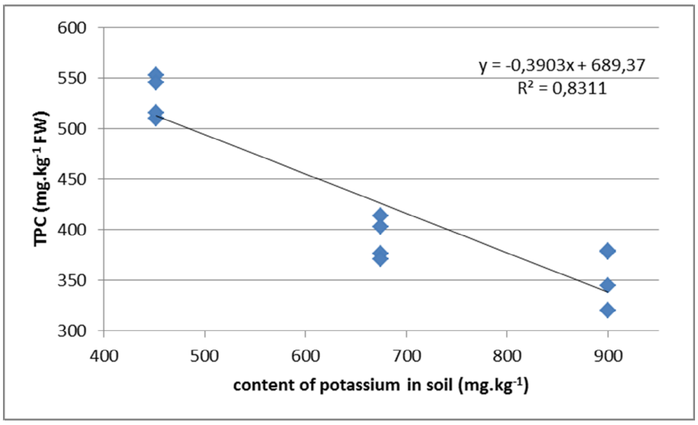

Figure 1 The dependence of the K content in the soil of the TPC (I. sampling)

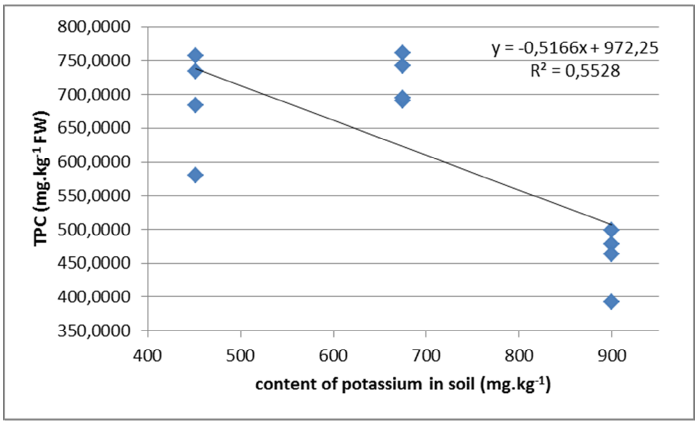

Figure 2 The dependence of the K content in the soil of the TPC (II. sampling)

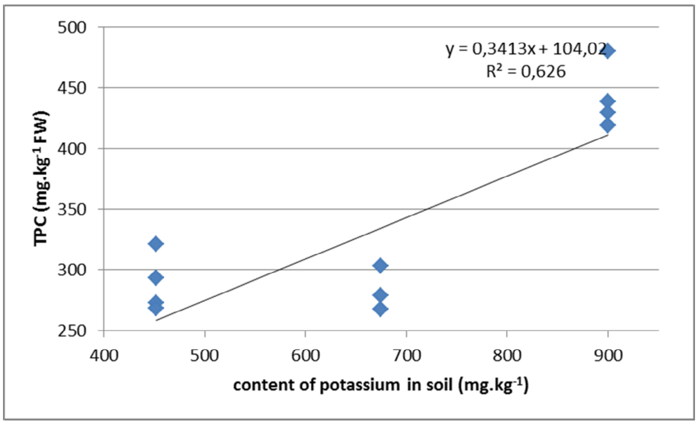

Figure 3 The dependence of the K content in the soil of the TPC (III. sampling)

The content of polyphenols in plants is affected by factors such as cultivar **(Vagen and Slimestad, 2008)**, pathogen infection and pest attack **(Dixon and Paiva, 1995)**, time of harvest, and storage and processing procedures **(Manach *et al.*, 2004)**. The content of nutrients and secondary plant metabolites in food products is also affected by, for example, growth conditions, use of fertilizers, climate **(Dangour *et al.*, 2009)**, and plant nutrient availability **(Fritz *et al.*, 2006)**.

In the work we watched the influence of potassium on antioxidant activity, where values were in interval from 21.52±5.12 to 48.34±2.25% (Table 4).

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

Variety	I. sampling	II. sampling	III. sampling
control	45.30±1.44	37.78±7.62	25.32±0.38
Added K1	48.34±2.25	32.61±5.66	21.52±5.12
Added K2	34.69±2.62	29.60±3.98	33.51±2.76

The influence of using of potassium-based fertilizers also dealing with the authors of the **Engel *et al.*** (**2006**), who referred to the positive effect of using potassium-based fertilizers at the TPC and antioxidant activity. In our results a statistically negative correlation between the potassium content and the values antioxidant activity was confirmed (P-value = $1.19.10^{-2}$) (Figure 4). At the end of the vegetation season, while we have seen a slight increase in the value of the antioxidant activity compared to the control variant, but no statistically significant relationship was not recorded.

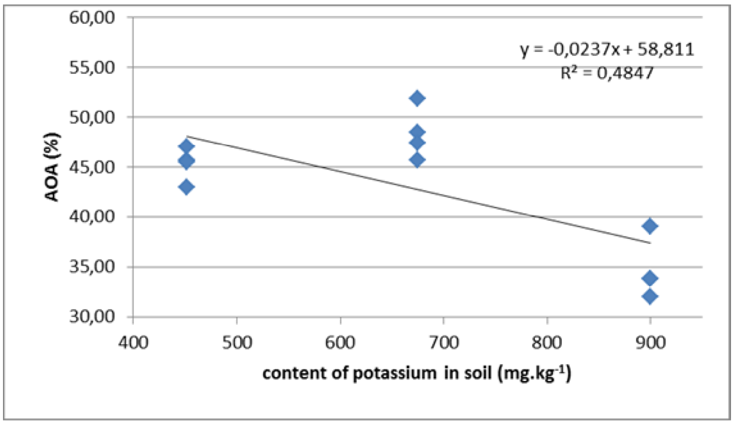

Figure 4 The dependence of the K content in the soil from AOA (I. sampling)

The increasing tendency of polyphenols in onions agrees well with the growing antioxidant activity. At work we have seen a positive correlation between the content of total polyphenols and antioxidant activity (Figure 5).

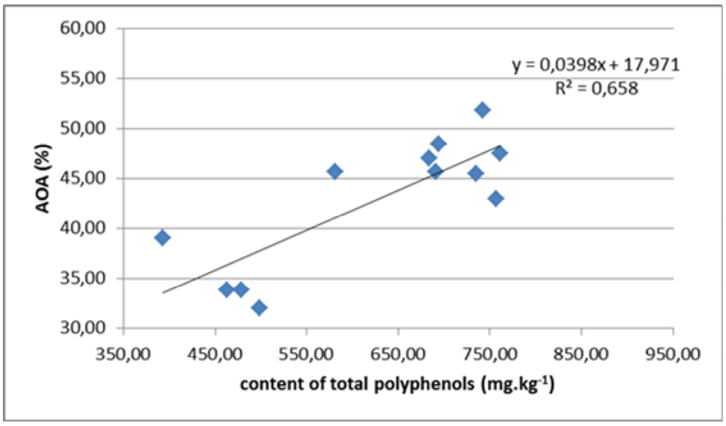

Figure 5 Relationship between total polyphenols content and antioxidant activity

CONCLUSION

The contribution focuses on the impact of benefits on total polyphenol content and content of potassium antioxidant activity in onion (*Allium cepa* L.). To track the impact of potassium we took advantage of growing experiments. The results suggest that doses of potassium did not have unique effects on the treated us total polyphenols and antioxidant activity. It is known that the content of polyphenols affects a variety of factors (variety, growing conditions, and climatic conditions). Antioxidant activity of crops also affects stability of phenolic compounds, pH and other substances which may act synergistically. In the next research of the influence of potassium fertilizer on the bioactive components it should be presented complemented results of the influence of other bulbs of applied doses of potassium and attempts to expand on the small areas cultivation.

Acknowledgments: The work was supported by scientific grant VEGA 1/0084/12, VEGA 1/0456/12 and APVV SK-CZ-0102-11.

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