

POTASSIUM AND ITS EFFECT ON THE CONTENT OF POLYPHENOLS IN ONION (*ALLIUM CEPA* L.)

Petra Kavalcová*, Judita Bystrická, Tomáš Tóth, Beáta Volnová, Miriama Kopernická, Ľuboš Harangozo

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

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ABSTRACT

Onion (*Allium cepa* L.) is rich of chemoprotective compounds as polyphenols, flavonoids, anthocyanins, vitamins, sulphur compounds which have potential beneficial properties for human health. Potassium as important mineral abundant plays many vital roles in plant nutrition (reduces respiration, activates enzyme). In generally, potassium increases crop yield and improves quality of onion bulbs. The objectives of this work were to compare and evaluate the impact of potassium on the content of total polyphenols and antioxidant activity of onion (*Allium cepa* L.). The content of the total polyphenols was determined by using the Folin-Ciocalteu reagent (FCR). The absorbance was measured at 765 nm of wave length against blank. Antioxidant activity was measured using a compound DPPH[·] (2,2-diphenyl-1-picrylhydrazyl) at 515.6 nm in the spectrophotometer. The content of total polyphenols in samples of onion during vegetation period moved in the range from 505.6 mg GAE/kg \pm 25.18 to 621.49 mgGAE/kg \pm 13.41. In this work was watched also the influence of potassium on antioxidant activity, where values were in interval from 32.20 % \pm 0.58 to 44.67 % \pm 0.68.

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

INTRODUCTION

Among all vegetables, onion is a species consumed widely across the world. Onion (*Allium cepa* L.) is one of the most important vegetable crops with a world production of about 55 million tonnes. Its consumption is attributed to several factors, mainly heavy promotion that links flavour and health and the popularity of onion-rich ethnic foods **Dini et al., (2008)**. Onion (*Allium cepa* L.) is medical herb and belongs to the family *Alliaceae*. Onion (*Allium cepa* L.) is a rich source of flavonoids, polyphenols, organic sulphur, saponins and many other secondary metabolites which are mainly responsible for its medical activities **Sohail et al., (2011)**.

Onion (*Allium cepa* L.) is an old cultivated plant with edible bulb and has been reported for its antimicrobial, hypolipodemic, cardioprotective, antidiabetic and antioxidant activities **Akerreta et al., (2007)**. Polyphenols represent a large class of chemical substances which are found in vegetables and fruits. Phenolic compounds are potential antioxidants and may also contribute to color, bitterness, flavor and aroma of food **Joseph et al., (2005)**. Dietary antioxidants are important components because they protect the human body against free radicals, such as reactive oxygen species. Free radicals are known to be the major contributors to degenerative diseases of aging and are recognised as major factors causing cancer, cardiovascular disorders and diabetes **Dini et al., (2008)**. Potassium plays a crucial role in the regulation of enzyme activities, in adjusting the electrical membrane potential and the cellular turgor, in regulating cellular homeostasis and in the stabilization of protein **Sharma et al., (2013)**.

Potassium also plays significant roles in enhancing crop quality. High levels available K improve the physical quality, disease resistance and shelf life of fruits and vegetables **Cakmak, 2010**. If potassium is deficient or not supplied in a dequate amounts, growth is stunted and yields are reduced. Potassium stimulates early growth, increases protein production, improves the efficiency of water use. It is vital for stand persistence, longevity, improves resistance to diseases and insects of onion (*Allium cepa* L.) **Rehm et al., (2002)**.

The objectives of this work were to compare and evaluate the effect of potassium fertilizer on the content of 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 locality of Babindol. Babindol is located in the middle of Žitavská upland. The attitude of the village is of 205 m. n. m. Babindol belongs to the relatively warm climatic zone with average annual temperature 9.7 °C and annual rainfall 580 mm. Babindol is locality relatively pure from point of view of content forms of risk elements (heavy metals) (Tab. 1).

Into plastic bowl – shaped pots (average of 20 cm and height of 25 cm) was weighted six kilograms of soil from area of Babindol. Into each container were planted eight yellow onion variety of *Mundo*. *Mundo* is the world variety of onion flat- cycle and yellow gold colour. The flesh is white, firm, slightly sharper taste. These varieties are well storable with good consumer values. The average weighted of onion is 64 g. It is grown most often from stecklings. Basic nutrients were applied in the form of aqueous solution. Potassium was applied in the form of K₂CO₃ (potassium carbonate) in two variants (Tab. 2).

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 used for prepare extract: 25 g of onion were extracted by 50 ml of 80% ethanol sixteen hours. These extracts were used by analyze. The experiment was carried out in replications.

Determination of total polyphenols

Total polyphenols were determined by the method of **Lachman et al., (2003)** using Folin- Ciocalteu assay and expressed as mg gallic acid equivalent per kg fresh mater. The Folin- Ciocalteu phenol reagent (Merck) was added to a volumetric flask containing 100 μ L of onion extract. The content was mixed and 5 ml a sodium carbonate solution (Sigma Aldrich) (20 %) was added after 3 min. The volume was adjusted to 50 mL by adding of distilled water. After 2 hours, the absorbance was measured at 765 nm of wave lenght against blank.

Table 1 Agrochemical characteristic of soil substrate from Babindol (mg/kg)

Agrochemical characteristic	pH (H ₂ O)	pH (KCl)	Cox (%)	Humus (%)					
	7.75	6.60	1.19	2.05					
Nutrients	N	K	Ca	Mg	P				
	1225	285.80	3091.4	265.70	195				
Heavy metals	Zn	Cu	Mn	Fe	Cr	Cd	Pb	Co	Ni
Aqua regia	71.00	20.00	640.00	22785	22.6	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	0.20	0.04	0.22	0.11	0.15
Critical value	2.0	1.0	-	-	-	0.1	0.1	-	1.5

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

**Critical value for NH₄NO₃ (c= 1 mol/dm³)- law no. 220/2004 Z.z.

-not applicable.

Cox (%) - oxidizable carbon

Table 2 Variants of pots experiments

Variant	Added amount of K (mg/kg)
Control	0.00
K 1	675
K 2	900

Determination of antioxidant activity

Antioxidant activity was measured by the **Brand and Williams et al., (1995)** method-using a radical DPPH' (2,2-diphenyl-1-picrylhydrazyl) (Merck). 2,2-diphenyl-1-picrylhydrazyl (DPPH') was pipetted to cuvette (3.9 m³), then was wrote the value of absorbance, which corresponded to the initial concentration of DPPH' solution in time A₀. Then 0.1 cm³ of onion extract was added. Solution in the cuvette was mixed and then was immediately started to measure the dependence A = f (t). The absorbance after 1, 5 and 10 minutes was measured 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 and was calculated by following formula- Inhibition (%) = (A₀ - A_t / A₀) x 100.

RESULTS AND DISCUSSION

Polyphenols can be divided into at least 10 different classes based upon their chemical structure, ranging from simple molecules (phenolic acids) to highly polymerized compounds (tannins). Flavonoids constitute the most important group with a common structure of diphenylpropanes (C6-C3-C6), consisting of two aromatic rings linked through three carbons that usually form an oxygenated heterocycle. Flavonoids can be subdivided into eight major subclasses, including flavonols, flavones, isoflavones, flavanols, anthocyanins, proanthocyanidins and tannins **Pietta et al., (2003)**.

In the work we watched the progress of making the total polyphenols content in different levels of fertilizer potassium in onion during vegetation seasons. In the experiment we determined also the influence of potassium on antioxidant activity. **Nuutila et al., (2003)** reported that the total polyphenol content in onion was 845 mg/kg - 2075 mg/kg. **Armand et al., (2012)** referred that the content of polyphenols in onion was 620 mg/kg. Our values of polyphenols were in the range from 505.6 mg GAE/kg ±25.18 to 621.49 mg GAE/kg ±13.41. The highest values of total polyphenols were recorded in control variant (621.49 mg GAE/kg ±13.41) at the end of vegetation period (III. sampling). The lowest values (505.38 mg GAE/kg ±25.18) of polyphenols content were determined at the beginning of vegetation period in variant I). In the case of variant K1 (incorporation of potassium in quantity of 675 mg/kg K) the content of polyphenols during vegetation period had high character (505.38 mg GAE/kg ±25.18 - 558.05 mg GAE/kg ±7.83). In the case of variant K2 (incorporation of potassium in quantity of 900 mg/kg K) the content of total polyphenols had also high character (546.45 mg GAE/kg ±28.93 - 607.99 mg GAE/kg ±9.54) (Tab. 3).

Table 3 Dynamics of changes TPC (mg GAE/kg) after application potassium in onion (*Allium cepa* L.)

Variant	I. sampling	II. sampling	III. sampling
control	508.16±27.59 a	615.73±20.15 b	621.49±13.41 b
Added K1	505.38±25.18 a	506.45±13.82 a	558.05±7.83 a
Added K2	546.45±28.93 a	607.99±9.54 b	575.03±16.11 b
HD _{0,05}	43.6439	23.8779	20.6644
HD _{0,01}	62.6993	34.3032	29.6938

LSD Test on the significance: value α: <0.05

Patil et al., (1995) reported that growing area and its agrochemical composition is an important environmental factor involved in the production of polyphenolic substances of onion (*Allium cepa* L.). Many authors found positive influence in the highest plant growth and also the highest yield and bulb quality. **Delgado et al., (2004)** reported that the potassium fertilizers significantly increased the total polyphenols. **Ruan et al., (1999)** said that with the increased concentration of potassium was content of total polyphenol increased. **Mudau et al., (2007)** found positive correlation between potassium dose and values of total polyphenols.

Between the content the potassium in the soil and total polyphenols (TPC) we have seen a slight positive correlation (P- value= 0,113) ((Figure 1).

In this work was found weak correlation between the content of total polyphenols and the values of antioxidant activity in II. sampling (P- value= 0,1563) and III. sampling (p-value=0,2256) (Figure 2, 3).

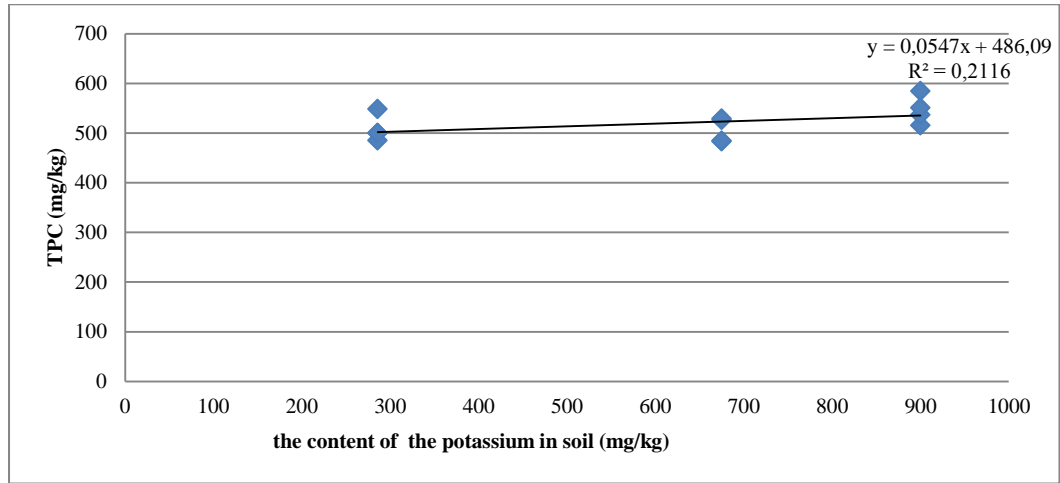


Figure 1 The dependence of the K content in the soil of the total polyphenols content (I. sampling)

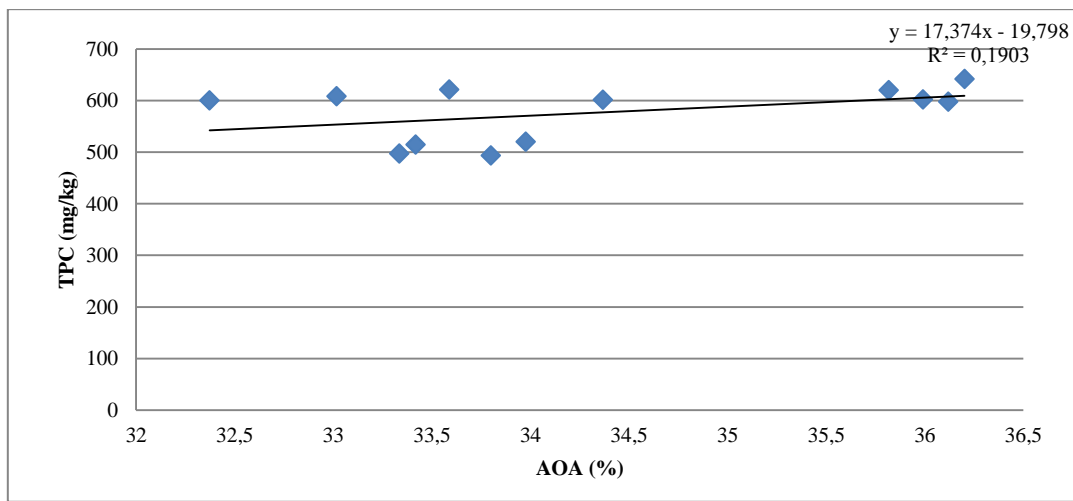


Figure 2 Relationship between the content of total polyphenols and the values of antioxidant activity (II. sampling)

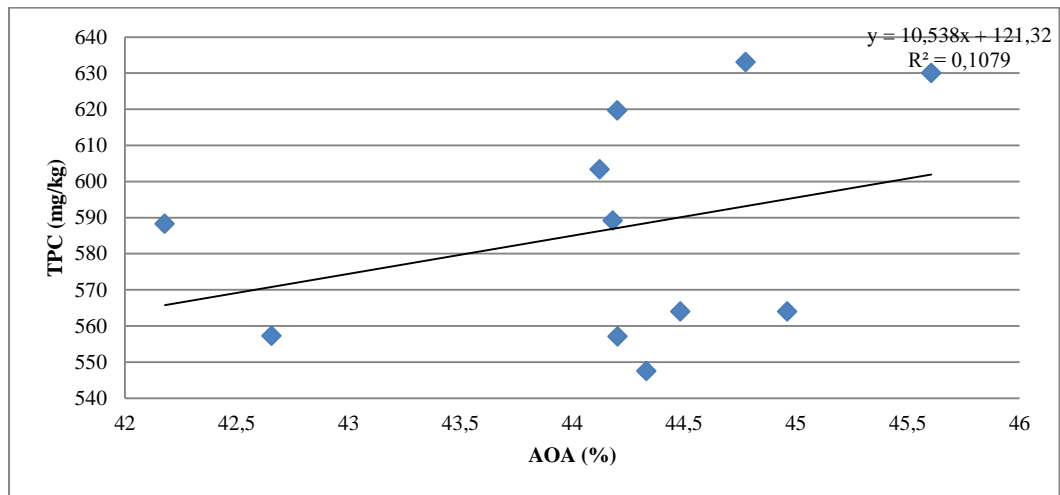


Figure 3 Relationship between the content of total polyphenols and the values of antioxidant activity (III. sampling)

Mohomed *et al.*, (2001) reported that the content of quercetin (flavonoids) in onion was 1497.5 mg/kg, kaempferol 832 mg/kg and luteolin 391 mg/kg. Flavonoids are one of the major components in onion (*Allium cepa* L.). Manach *et al.*, (2004) referred that the content of quercetin in onion was in interval from 350 mg/kg to 1200 mg/kg.

In this work was watched the effect of potassium on antioxidant activity. Andrejiová *et al.*, (2011) reported that values of antioxidant activity of onion were 15 – 80 %. Our values were in interval from 32.20 % ±0.58 to 44.67 %±0.68 (Tab. 4).

Table 4 Dynamics of changes AOA (% inhibition) after application potassium in onion (*Allium cepa* L.)

Variant	I. sampling	II. sampling	III. sampling
control	36.43±0.66 b	36.03±0.16 c	44.67±0.68 c
Added K1	32.20±0.58 a	33.63±0.30 b	44.49±0.33 b
Added K2	33.14±0.82 a	33.33±0.84 a	42.67±0.89 a
HD _{0,05}	1.11864	0.846729	1.08586
HD _{0,01}	1.60705	1.21642	1.55996

LSD Test on the significance: value α : <0.05

The highest values of antioxidant activity were recorded in control variant (44.67 % \pm 0.68) at the end of vegetation period (III. sampling). The lowest values (32.20 % \pm 0.58) of antioxidant activity were determined at the beginning of vegetation period in variant K1.

In the case of variant K1 values of antioxidant activity during vegetation season had high character (32.20 % \pm 0.58-44.49 % \pm 0.33). In the case of variant K2 value of antioxidant activity had also high character (33.14 % \pm 0.82-42.67 % \pm 0.89). Many scientific work referred that natural polyphenols have antioxidant potential. Polyphenols are the most abundant antioxidants in the human diet. The availability of potassium to the plant is highly variable. The molecules that signal low K⁺ status in plants include reactive oxygen species and phytohormones, such as auxin, ethylene and jasmonic acid. Apart from up-regulation of transport proteins and adjustment of metabolic processes, potassium deprivation triggers developmental responses in roots Ashley, et al., (2005). Potassium (K) is an essential macronutrient for plants involved in many physiological processes. It is important for crop yield and quality of edible parts of crops. Potassium deficiency affects many essential physiological and metabolic processes, determines the profile and distribution of primary metabolites in plant tissues Amtmann et al., (2012). Plants with higher levels of potassium show higher resistance to drought stress conditions. Drought stress leads to production of oxygen radicals, which results in increased lipid peroxidation (MDA biomarker) and oxidative stress in the plant Soleimanzadeh et al., (2010).

CONCLUSION

In this work we evaluated and compared the effect of potassium in the soil on content of total polyphenols and antioxidant activity in onion (*Allium cepa* L.). The results suggest that increasing doses of potassium decreasing values of total polyphenols and antioxidant activity. Total polyphenols in onion may be influence by variety of onion, growing and climatic condition (altitude, annual rainfall, and annual temperature), but also the agrochemical composition of soil (humus of content, nutrients). It is know that potassium increases crop yield and quality of the bulbs onion. The results obtained in this work provide further information about the impact of potassium fertilizers of total polyphenol content and antioxidant activity of onion.

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