

## THE RESEARCH OF TOTAL POLYPHENOLS CONTENT AND THEIR CHANGES IN DIFFERENT VARIETIES OF POTATOES

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### ABSTRACT

Polyphenols are secondary metabolites of plants with antioxidant properties. In this work we research the changes in the content of total polyphenols in five varieties of potatoes (Rumelia, Arwen, Megan, Malvína, Erídia). Potatoes were grown at the stage of full maturity from Matejovce nad Hornádom, region of Poprad. Total polyphenols we determined in whole peeled potatoes; in the outside part of peeled potato tubers (1 cm); in inside part of potato tubers (mean 2 cm) and in the whole peel-boiled potatoes. The total polyphenols content was determined by spectrophotometry ( $\lambda = 765$  nm) and it was used lyophilized samples in ethanol extracts. In whole peeled potatoes was the content of total polyphenols in the range from 243.34 mg.kg<sup>-1</sup> DM (cv. Rumelia) to 446.38 mg.kg<sup>-1</sup> DM (cv. Megan), in the outside part of peeled potato tubers was content in the range from 190.45 mg.kg<sup>-1</sup> (cv. Rumelia) to 446.84 mg.kg<sup>-1</sup> DM (cv. Malvína) and in inside part of potato tubers from 245.51 mg.kg<sup>-1</sup> to 446.26 mg.kg<sup>-1</sup> DM (Arwen < Rumelia < Megan < Erídia < Malvína). In the whole peel-boiled potatoes was the lowest content of total polyphenols in variety Rumelia (252.5 mg.kg<sup>-1</sup> DM) and the highest content in variety Megan (440.54 mg.kg<sup>-1</sup> DM). Results were statistically evaluated by the Analysis of Variance (ANOVA – Multiple Range Tests, Method: 95.0 percent LSD) using statistical software STATGRAPHICS (Centurion XVI.I, USA) and the regression and correlation analysis (Microsoft Excel) was used.

**Keywords:** Potatoes, total polyphenols, variety, locality

### INTRODUCTION

Potato (*Solanum tuberosum* L.) is the fifth of most important crop worldwide after sugar cane, maize, wheat and rice with a production of  $x > 329$  million tons in 2009. Potato is recognized as a source of carbohydrates, high-quality proteins, vitamin C, vitamin B6, vitamin B3 and minerals such as potassium, phosphorous and magnesium (Andre *et al.*, 2007). Besides these basic nutrients, some potato varieties contain polyphenolic compounds. Polyphenols are secondary plant metabolites and are important determinants of the sensory and nutritional qualities of fruits, vegetables and other plants. Even though their high antioxidant capacity, polyphenols may have possible beneficial implications on human health, such as in the treatment and prevention of cancer, cardiovascular disease and other pathologies, and should be an important research area in recent years (Ignat *et al.*, 2011). Camire *et al.* (2009) declare that polyphenols also contain important amounts of polyphenols, a class of secondary plant metabolites, although fruits, vegetables, cereals, chocolate and drinks (red wine, coffee and fruit juices) are the main sources of polyphenols in our diet (Manach *et al.*, 2004; Scalbert *et al.*, 2005). The polyphenol content of potatoes is worth exploring since potato consumption is highly compared to other vegetables in Europe. Brat *et al.* (2006) investigated the total phenolic content of 29 vegetables consumed in France and their contribution to the total phenolic uptake based on *per capita* consumption data. Polyphenols are plant secondary metabolites. They have diverse structure, molecular mass as well as varied physical, biological and chemical properties. They occur in plant parts including flowers, fruit, seeds, leaves, roots, bark and its wooden parts. Polyphenolic compounds in plants participate not only in their reproduction and growth but also affect the sensory qualities of plant-derived processed foods such as taste, colour or texture (Perla

*et al.*, 2012). Polyphenolic exceed biological activity in the human body, among others they take active part in the removal of free radicals, metal ion chelation as well as affect enzyme activity and protein availability. Even though their health beneficial properties, polyphenolic compounds prevent, among others, coronary heart disease, cancer, inflammatory diseases (Lachman *et al.*, 2013).

### MATERIAL AND METHODS

For analyses we used the samples of five different potato varieties: very early variety – Erídia; early varieties – Malvína, Rumelia and middle early varieties – Megan and Arwen. Analysis of potatoes: From potatoes we made an extract. Total polyphenols (TP) were determined by the method of Lachman *et al.* (2003) and expressed in mg eq. gallic acid per kg fresh matter. Gallic acid is usually used as a standard unit for phenolics content determination because a wide spectrum of phenolic compounds. The TP 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. Samples of the plant material, we collected at the stage of full maturity from Matejovce, region of Poprad. Soil from this area have been weakly alkaline, with central supply humus, very low content of phosphorus, high content of magnesium and good potassium content (Bielek, 1996) (Tab.1)

**Table 1** Characteristics of the soil and nutrient content (mg.kg<sup>-1</sup>)

Point of delivery	pH (KCl)	Nutrient content					
		C <sub>ox</sub>	mold	P	K	Ca	Mg
Matejovce	5.75	1.56	2.69	36.27	191.03	2689.50	168.0

In soil samples we set the agrochemical characteristics of the soil (the soil exchange reaction pH/KCl, Cox (%) – oxidimetry % of the translation method as

Ťurin and % mold – of Cox) and nutrient contents. Nutrient contents (P, K, Ca, Mg) we set by Mehlich method (Mehlich II), analytical method for the

determination of output was AAS (AAS Varian AA Spectr DUO 240FS/240Z/UltrAA).

**RESULTS AND DISCUSSION**

Potato tuber is growing for its rhizone tubers, which is known as potatoes. Potatoes filled in human nutrition mainly for volume function, than eating function and protective function. Potatoes are an important food, industrial raw materials, feed and a major agricultural crops with high yield potentially useful biomass (Frančáková, 2001). Potato tubers in human nutrition represent a significant source of antioxidants. The main antioxidants in potatoes are polyphenolic compounds (Lachman et al., 2008). Polyphenols are accumulated in the healthy tissue which is fitting to potato tissue as reaction on pathogen attack, while also acknowledging the synergies between phenolic compounds with similar structure and protect against some (but not all) phytopathogens (Krištůfek et al., 2001). In our work, we watched changes total polyphenols content in different parts of potatoes. We analysed inside part of peeled potatoes, outside part of peeled potatoes, whole peel-boiled potato and whole peeled potatoes. Determined values in variety Eridia were: inside part of peeled potatoes 402.32 mg.kg<sup>-1</sup> DM to 409.60 mg.kg<sup>-1</sup> DM; in outside part of peeled potatoes 383.64 mg.kg<sup>-1</sup> DM to 430.80 mg.kg<sup>-1</sup> DM; in whole peel-boiled potatoes 405.00

mg.kg<sup>-1</sup> DM to 426.20 mg.kg<sup>-1</sup> DM and in whole peeled potatoes from 420.52 mg.kg<sup>-1</sup> DM to 436.28 mg.kg<sup>-1</sup> DM. Determined values in variety Arwen were: inside part of peeled potatoes 215.24 mg.kg<sup>-1</sup> DM to 278.60 mg.kg<sup>-1</sup> DM; in outside part of peeled potatoes from 324.40 mg.kg<sup>-1</sup> DM to 374.60 mg.kg<sup>-1</sup> DM; in whole peel-boiled potatoes 258.20 mg.kg<sup>-1</sup> DM to 265.52 mg.kg<sup>-1</sup> DM and in whole peeled potatoes 247.32 mg.kg<sup>-1</sup> DM to 309.00 mg.kg<sup>-1</sup> DM. In variety Rumelia total polyphenol content were: inside part of peeled potatoes 238.64 mg.kg<sup>-1</sup> DM to 339.20 mg.kg<sup>-1</sup> DM; in outside part of peeled potatoes from 161.76 mg.kg<sup>-1</sup> DM to 221.72 mg.kg<sup>-1</sup> DM; in whole peel-boiled potatoes from 219.60 mg.kg<sup>-1</sup> DM to 277.16 mg.kg<sup>-1</sup> DM and in whole peeled potatoes from 229.20 mg.kg<sup>-1</sup> DM to 259.12 mg.kg<sup>-1</sup> DM. In variety Megan total polyphenol content was: inside part of peeled potatoes from 336.48 mg.kg<sup>-1</sup> DM to 412.40 mg.kg<sup>-1</sup> DM; in outside part of peeled potatoes from 375.16 mg.kg<sup>-1</sup> DM to 439.24 mg.kg<sup>-1</sup> DM; in whole peel-boiled potatoes from 422.12 mg.kg<sup>-1</sup> DM to 464.76 mg.kg<sup>-1</sup> DM and in whole peeled potatoes from 421.16 mg.kg<sup>-1</sup> DM to 471.96 mg.kg<sup>-1</sup> DM and in variety Malvina total polyphenols content was: inside part of peeled potatoes from 428.36 mg.kg<sup>-1</sup> DM to 465.00 mg.kg<sup>-1</sup> DM; in outside part of peeled potatoes from 422.24 mg.kg<sup>-1</sup> DM to 472.56 mg.kg<sup>-1</sup> DM; in whole peel-boiled potatoes from 363.24 mg.kg<sup>-1</sup> DM to 434.00 mg.kg<sup>-1</sup> DM and in whole peeled potatoes from 430.80 mg.kg<sup>-1</sup> DM to 447.80 mg.kg<sup>-1</sup> DM.

**Table 2** Total polyphenols content

Total polyphenols content (mg.kg <sup>-1</sup> )					
variety	inside part of peeled potatoes	outside part of peeled potatoes	whole peel-boiled potatoes	peel-boiled	whole peeled potatoes
Eridia	402.32 ± 3.27	383.64 ± 20.73	415.88 ± 8.67		420.52 ± 7.76
Arwen	215.24 ± 28.70	324.40 ± 25.67	258.20 ± 4.40		247.32 ± 30.74
Rumelia	238.64 ± 8.88	161.76 ± 31.41	219.60 ± 27.87		229.20 ± 13.86
Megan	336.48 ± 31.17	375.16 ± 27.25	422.12 ± 18.14		421.16 ± 23.19
Malvina	428.36 ± 15.95	422.24 ± 23.74	363.24 ± 33.66		408.32 ± 16.22

**Table 3** ANOVA T table for inside part of peeled potatoes by variety

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Between groups	110430.0	4	27607.4	31.02	0.0000
Within groups	13350.3	15	890.019		
Total (Corr.)	123780.	19			

**Table 4** Multiple Range T tests for inside part of peeled potatoes by variety, Method: 95.0 percent LSD

variety	Count	Mean	Homogeneous Groups
Arwen	4	245.51	X
Rumelia	4	290.93	X
Megan	4	377.27	X
Eridia	4	406.99	XX
Malvina	4	446.26	X

Statistically significant differences in the content of total polyphenols in inside part of peeled potatoes are between varieties Arwen – Rumelia, Megan, Eridia, Malvina; Rumelia – Arwen, Megan, Eridia, Malvina; Megan – Arwen, Rumelia,

Malvina; Eridia – Arwen, Rumelia, Malvina and between varieties Malvina – Arwen, Rumelia, Megan and Eridia.

**Table 5** ANOVA T table for outside part of peeled potatoes by variety

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Between groups	164560.	4	41139.9	60.83	0.0000
Within groups	10144.0	15	676.27		
Total (Corr.)	174704.	19			

**Table 6** Multiple Range Tests for outside part of peeled potatoes by variety, Method: 95.0 percent LSD

variety	Count	Mean	Homogeneous Groups
Rumelia	4	190.45	X
Arwen	4	351.72	X
Eridia	4	403.6	X
Megan	4	413.76	XX
Malvina	4	446.84	X

Statistically significant differences in the content of total polyphenols in outside part of peeled potatoes are between varieties Rumelia – Arwen, Eridia, Megan, Malvina; between Arwen – Rumelia, Eridia, Megan, Malvina; Eridia – Rumelia,

Arwen, Malvina; Megan – Rumelia, Arwen, Malvina and between varieties Malvina – Rumelia, Arwen, Megan and Eridia.

**Table 7** ANOVA T table for whole peel-boiled potato by variety

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Between groups	124750.0	4	31187.4	66.80	0.0000
Within groups	7003.2	15	466.88		
Total (Corr.)	131753.0	19			

**Table 8** Multiple Range T tests for whole peel-boiled potato by variety, Method: 95.0 percent LSD

variety	Count	Mean	Homogeneous Groups
Rumelia	4	252.5	X
Arwen	4	263.36	X
Malvina	4	390.77	X
Eridia	4	415.95	XX
Megan	4	440.54	X

Statistically significant differences in the content of total polyphenols in whole peel-boiled potatoes are between varieties Rumelia – Malvina, Eridia, Megan, between Arwen – Malvina, Eridia, Megan; between varieties Malvina – Rumelia, Arwen, Megan; between Eridia – Rumelia, Arwen, Megan and between varieties Megan – Rumelia, Arwen, Malvina and Eridia

Burgos et al. (2013) studied the effect of boiling on concentrations of total phenolics (TP) in four native Andean accessions. In their study boiled potatoes had higher total polyphenols content than whole peeled potatoes. Total

polyphenol content was in range 596 – 4196 mg.kg<sup>-1</sup> DM in whole peeled potatoes. In boiled potatoes was content from 915 – 4525 mg.kg<sup>-1</sup> DM. So we can declare, although cooking method can influence the total polyphenol content positively, still is very important variety influence. Our results are in corresponding with Blessington et al. (2010) total polyphenols content in their study was in the range from 340 mg.kg<sup>-1</sup> DM to 470 mg.kg<sup>-1</sup> DM. According to another authors Deußer et al., (2012) total polyphenol content was in range of 667±161 mg.kg<sup>-1</sup>DM.

**Table 9** ANOVA T table for whole peeled potatoes by variety

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Between groups	150500.0	4	37625.0	94.12	0.0000
Within groups	5996.33	15	399.755		
Total (Corr.)	156496.0	19			

**Table 10** Multiple Range Tests for whole peeled potatoes by variety, Method: 95.0 percent LSD

variety	Count	Mean	Homogeneous Groups
Rumelia	4	243.34	X
Arwen	4	274.72	X
Eridia	4	427.25	X
Malvina	4	429.64	X
Megan	4	446.38	X

Statistically significant differences in the content of total polyphenols in whole peeled potatoes are between varieties Rumelia – Arwen, Eridia, Malvina, Megan; between Arwen – Rumelia, Eridia, Malvina, Megan; between varieties Eridia – Rumelia, Arwen; between Malvina and Rumelia, Arwen and between varieties Megan – Rumelia and Arwen.

Between the content of total polyphenols in whole peeled potatoes and in whole peel-boiled potatoes in variety:

- Arwen there is a strong positive statistically significant correlation (R= 0.961; P-value (0.038) < 0.05). Variability of total polyphenols content in whole peel-boiled potatoes and whole peeled potatoes of selected regression line explained 92.5% (R<sup>2</sup> = 0.925),
- Rumelia there is a strong positive statistically significant correlation (R= 0.969; P-value (0.030) < 0.05). Variability of total polyphenols content in whole peel-boiled potatoes and whole peeled potatoes of selected regression line explained 94.0% (R<sup>2</sup> = 0.940),
- Megan is positive statistically significant correlation (R= 0.954; P-value (0.045) < 0.05). Variability of total polyphenols content in whole peel-boiled potatoes and whole peeled potatoes of selected regression line explained on 91.1% (R<sup>2</sup> = 0.911),
- Malvina there is not statistically significant correlation (R= 0.831; P-value (0.16) > 0.05). Variability of total polyphenols content in whole peel-boiled potatoes and whole peeled potatoes of selected regression line explained on 69.1% (R<sup>2</sup> = 0.691),
- Eridia there is not statistically significant correlation (R= 0.904; P-value (0.095) > 0.05). Variability of total polyphenols content in whole peel-boiled potatoes and whole peeled potatoes of selected regression line explained on 81.7% (R<sup>2</sup> = 0.817).

**CONCLUSION**

In our work we deal with the research of changes to the total polyphenols content in different varieties of potatoes. Total polyphenolic content we determined by spectrophotometry in inside part of peeled potatoes; outside part of peeled potatoes; in whole peel-boiled potatoes and in whole peeled potatoes. The highest total polyphenols content in inside part of peeled potatoes was in variety Malvina 465.00 mg.kg<sup>-1</sup> DM and the lowest content in variety Arwen 215.24 mg.kg<sup>-1</sup> DM. In outside part of peeled potatoes was TPC in variety Rumelia 161.76 mg.kg<sup>-1</sup> DM and the highest content in variety Malvina 472.56 mg.kg<sup>-1</sup> DM. In whole peel-boiled potatoes the total polyphenols content was in variety Rumelia 219.60 mg.kg<sup>-1</sup> DM and the highest content was in variety Megan 464.76 mg.kg<sup>-1</sup> DM. In whole peeled potatoes was the highest content in variety Megan 471.96 mg.kg<sup>-1</sup> DM and lowest content in variety Rumelia 229.20 mg.kg<sup>-1</sup> DM. The effect on variety in the total polyphenols content was in all cases highest statistically significant between content of polyphenols. There confirmed the

weak variety dependence in inside part of peeled potatoes and in outside part of peeled potatoes.

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