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THE VARIABILITY OF THE TOTAL POLYPHENOLS CONTENT AND THE ANTIOXIDANT ACTIVITY IN THE VARIETIES OF SELECTED LEGUMES

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ABSTRACT

The goal was to determine the variability of the total polyphenols content and the antioxidant activity in varieties of selected dry legume seeds, which were obtained from the soil of Piešťany. The soil in the Piešťany locality had a neutral soil reaction and was moderately humic. Of the risk elements, the total cadmium content exceeded the limit value by the Law No. 220/2004, but did not exceed the threshold value by the European Commission (2006). In the case of mobile forms of lead, the limit value by Law No. 220/2004 exceeded by 180%. The determination of the heavy metal content in legumes was performed using a flame AAS (instrument Varian AA Spectr DUO 240FS/240 Z/UltrAA). Based on the obtained results, we found the achievement of limit value of lead in 3 varieties of chickpea (Maškovský Bagovec, Kráľová from Krajová and Bušinský) and in 3 varieties of beans (Albena, Luna and Sina). For all 3 types of legumes, the difference between the individual varieties was statistically demonstrated when determining the total polyphenols content and the antioxidant activity values. Between species has been confirmed a statistically significant difference. The order of legumes based on the average decreasing content of total polyphenols is lentil>chickpea>bean and on antioxidant activity lentils>beans>chickpeas. The dependence of antioxidant activity on the total polyphenols has been confirmed in lentil varieties, in the case of chickpeas this relationship is statistically insignificant and a lower mean dependence was determined in beans.

Keywords: legumes, polyphenols, antioxidant activity, variability, heavy metals, soil

INTRODUCTION

From point of food safety and therapeutic effects against pathological conditions that subsequently lead to oxidative damage, interest of people in natural antioxidants has recently increased **(Sánchez-Bonet *et al.*, 2021)**. Natural antioxidants in food are increasingly in demand due to the toxicity of synthetic antioxidants **(Asati *et al.*, 2022)** as exemplified by research on various plants, including legumes. Polyphenols are common constituents of foods of plant origin and are major antioxidants in the human diet (**Shem-Tov *et al.*, 2011**). Dry legumes are a source of bioactive polyphenols and also contribute to polyphenol intake from other food; the health benefits of consuming legumes such as antioxidant activity could be effective for the expansion of their food uses (**Heiras-Palazuelos *et al.*, 2013**). Taking into consideration the present health condition of population and prevalence of morbidity and mortality in the Slovak Republic, it is desirable to develop foodstuffs which are natural source of bioactive substances and have positive impact on health of consumers (functional food) (**Bojňanská *et al.*, 2012**, **Umar *et al.*, 2012**). According to **Xu *et al.* (2007)**, phenolic compounds contribute to the overall antioxidant activity of plant foods. Significant positive correlation was observed between phenolics and antioxidant activity by DPPH scavenging activity in the various legume (**Han and Bike, 2008**). Polyphenols exhibit antioxidant activity through various mechanisms, such as chelating transition metal ions (as copper and iron) **(Tian *et al.*, 2022)**, scavenging free radicals such as inhibiting oxidative enzymes. Under certain circumstances, polyphenols can exhibit oxidation reactions by chelating transition metals by increasing their catalytic activity or by reducing metal ions, leading to an increased ability to generate free radicals. The disposition of polyphenols to act as prooxidants can cause a reduction in food quality **(Tian *et al.*, 2022)** under given conditions. **Musilová (2009)** published that growth location, variety type and soil contamination can affect the amount of polyphenols. Also according to **Tian *et al.* (2022**) reported the effect of the concentration of polyphenols on the pro-oxidative or antioxidative activity depends on the environmental conditions. The presence and the action of heavy metals can started up an oxidative stress in plants. Heavy metals can present a threat to the environment, but also to humans. According **Kısa *et al.* (2016)** there are few studies on the relationship between heavy metal and phenolic compounds, no general conclusion about the heavy metal stress on phenolic compound levels.

Therefore, at first we also focused on heavy metals determination in the soil and in selected legume due to the elimination of the influence of heavy metals as stress factors for the formation of polyphenols and their antioxidant activity (**Segev *et al.*, 2010**). The main objective of this study was to determine the variability of the total polyphenols content and the antioxidant activity values in the varieties of chosen legumes, the effect of varieties on the total polyphenols and the antioxidant activity, the dependence of antioxidant activity on total polyphenols, an inter-varietal and inter-species differences.

MATERIAL AND METHODS

Samples

Samples of 9 different white bean (*Phaseolus vulgaris* L.) varieties: Albena, Ema, Fabia, Gesta, Gracia, Luna, Petra, Salva, Sina; samples of 6 different chickpea (*Cicer arietinum* L.) varieties: Kráľová z Krajovej, Maškovský Bagovec, Bušinský, Slovák, Beta, Alfa and 6 lentils (*Lens culinaris* L.) varieties: Slovenská zemplinská, Trebišovská, Slovenská modrá, Hrotovická veľkozrná, Nelka, Renka were investigated. All the varieties originated from the experimental station of the Research Institute of Crop Production in Piešťany – an important cultivation area for crop conservation in Slovakia. Legume samples were collected at full ripeness. The seeds were manually cleaned and stored at the room temperature (normal conditions) for analysis. The sample of soil were collected from the same sampling point as legums samples.

Heavy metals content determination

In soil samples from observed localities the exchangeable reaction (pH/KCl), the available nutrients (potassium, magnesium, phosphorus) and mobile forms of Ca according Mehlich II., and content of humus were determined. Results of soil analysis were evaluated by **Decree of the Ministry of Agriculture and Rural Development of the Slovak Republic No. 151/2016**. Pseudototal content of risk metals (including all residual metal fraction) was assessed in soil extract by *aqua regia* and content of mobile forms of chosen heavy metals in soil extract by NH_4NO_3 (c =1 mol.dm^{-3}).
Plant material - The samples of legumes after their drying, regulation and decomposition by HNO_3 on the microwave digestion were used. Determinations

of metal content were analysed in a Varian AA240Z atomic absorption spectrometer. The graphite furnace technique was used for the determination of Cd and Pb.
The results oof soil were evaluated according to **Law No. 220/2004** - the legislative valid in the Slovak republic as well as threshold values proposed by **European Commission (EC) (2006)** and the content of heavy metals in legume seeds were evaluated according to the Food Codex of the Slovak Republic as well as according to **EU Commission No. 2021/1317** (for Pb) and **EU Commission No. 2021/1323** (for Cd).

Total polyphenols content determination

Total polyphenol content was determined according to **Lachman *et al*. (2003)**. Folin-Ciocalteau solution was used as a reagent for the colorimetric assay of polyphenolic antioxidants.The sample solutions were measured at 765 nm (instrument Shimadzu spectrophotometer 710, Kyoto, Japan). The total polyphenols contents were expressed as gallic acid equivalents in mg.kg^{-1} of dry matter.

Antioxidant activity determination

The antioxidant activity was determined using free radical DPPH (2,2-diphenyl-1-picrylhydrazyl) according to **Brand-Williams *et al*. (1995)**. The solutions of samples were measured at 515 nm specrophotometrically using a Shimadzu spectrophotometer (Japan). Results were expressed as % DPPH inhibition.

Statistical analysis

All analysis were performed in six replicates. Descriptive analysis includes mean±standard deviation. All statistical analyzes were performed by XLSTAT 2014.5.03 statistical software using Dunn's test. Mean comparisons between the total polyphenol content and the antioxidant activity were performed using the LSD or Kruskal-Wallis test (P<0.05).

RESULTS AND DISCUSSION

The heavy metals content determination

Locality Piešťany lies in the north-south valley of the Váh river in the northern extremity of the Danube lowland. The city lies 162 m above sea level. This area is characteristically lowland, dry, relatively warm and slightly windy. The soil is predominantly sandy-clay. The soil had 232 mg K.kg^{-1}(a good content), 295 mg Mg.kg^{-1} (a high content of magnesium) and 18 mg P.kg^{-1}(a low content of phosphorus), by medium level of humus and neutral soil reaction. From point of view positive nutrient content and satisfactory soil reaction a soil in Piešťany is suitable for growing legumes.
The measured contents of heavy metals in the soil (Table 1) from the Piešťany locality were compared with the limit values set by **Law No. 220/2004** about the soil protection and the use of agricultural land and the threshold values recommended by the **European Commission (2006).**The total content of heavy metals in the *Aqua regia* extract was exceeded only in the case of cadmium. The determined value of the cadmium content was 0.98 mg.kg^{-1} and exceeded the limit value established by **Law No. 220/2004** by 40%. The contents of the other analyzed elements were below the limit values determined by **Law No. 220/2004**. From the point of view of heavy element intake by plants, is important content of available and potentially available forms of heavy metals. The content of mobile forms of heavy metals in the ammonium nitrate solution in the soil from Piešťany was satisfactory, with the exception of the lead content of 0.28 mg.kg^{-1}, which exceeded the limit value by 180%.

Table 1 The contents of heavy metals in *Aqua regia* and nitrate ammonium reagent (c=1 mol.dm^{-3}) in the soil of Piešťany locality (mg.kg^{-1})

	Zn	Cu	Cr	Cd	Pb	Co	Ni
Aqua regia	82.8	25.3	35	0.98	26.8	13.8	46.6
**Limit value*	150	60	70	0.7	70	15	50
**Critical value*	200	100	100	1.5	100	-	70
Nitrate ammonium	0.08	0.11	0.04	0.04	0.28	0.16	0.17
**Treshold value*	2	1	-	0.1	0.1	-	1.5

Legend: *Limit value and *Critical value by the **Law No. 220/2004** and *Threshold value recommended by the **European Commission (2006)**

Any of the determination of heavy metals content in the soil not guarantee that the plants growing on this soil will always contain their tolerable amounts. It is therefore crucial in terms of hygiene, whether the heavy metals accumulate in parts of plant used for consumption **(Rattan *et al*., 2005)**. The subject of research was 6 chickpea varieties, 6 lentil varieties and 9 white bean varieties. We compared the content of only toxic metals - Pb and Cd - determined in selected types of legumes from the Piešťany location with the limit values evaluated by the Codex Alimentarisu of the Slovak Republic as well as by the **EU Commission No. 2021/1317** (for Pb) and **No. 2021/1323** (for Cd). Results are shown in the Tables 2-3. The contents of toxic elements Cd and Pb in lentil varieties were below the detection limit. The content of toxic elements Cd in chickpea varieties were below the detection limit, however, a low concentration of 0.02 mg.kg^{-1}was measured in the Slovák variety. The content of toxic elements Cd in white bean varieties were below the detection limit with expection Petra variety; the value of Cd was exceeded by 150% and by 1150% according to the **Codex Alimentarius (2022)** valid in the Slovakia and to the Regulation of the **EU Commission No. 2021/1323**, respectively. **Hodálová (2014)** reported that the limit values of Cd (0.1 mg.kg^{-1}) were exceeded in all observed bean varieties by an average of 31.25%. In our case of the toxic element Pb, the results reached the limit value (0.2 mg.kg^{-1}) according to the law valid in Slovakia in the 3 chickpea varieties - Bušinský, Maškovský Bagovec and Kráľová z Krajová as well as in the 3 white bean varieties - Albena, Luna, Sina. On the basis of **EU Commission Regulation No. 2021/1317**, the limit values were exceeded by 100% in the same varieties. Heavy metals such as lead and cadmium enter to the food chain by uptake by edible plants, thus our legumes samples are relatively safe, therefore we can continue to evaluate the variability of the content of bioactive substances.

Table 2 The content of toxic elements – lead and cadmium (mg.kg^{-1}) in lentil and chickpea varieties

Lentil varieties	Pb	Cd	Chickpea varieties	Pb	Cd
Slovenská zemplínska	und.	und.	*Kráľová z Krajovej*	0.2	und.
Trebišovská	und.	und.	*Maškovský Bagovec*	0.2	und.
Slovenská modrá	und.	und.	*Bušinský*	0.2	und.
Hrotovická veľkozrnná	und.	und.	*Slovák*	und.	0.02
Nelka	und.	und.	*Beta*	0.1	und.
Renka	und.	und.	*Alfa*	und.	und.
**Limit value*	0.2	0.1		0.2	0.1
***Limit value*	0.1	0.02		0.1	0.02

Legend: *Limit value by the **Codex Alimentarius valid in the Slovak Republic (2022)** and ** Limit value by the **EU Commission No. 2021/1317** (for Pb) and **No. 2021/1323** (for Cd), und. - undetected

Table 3 The content of toxic elements - lead and cadmium (mg.kg^{-1}) in white bean varieties

White bean varieties	Pb	Cd
Albena	0.2	und.
Ema	0.1	und.
Fabia	0.1	und.
Gesta	0.1	und.
Gracia	0.1	und.
Luna	0.2	und.
Petra	und.	0.25
Salva	und.	und.
Sina	0.2	und.
**Limit value*	0.2	0.1
***Limit value*	0.1	0.02

Legend: *Limit value by the **Codex Alimentarius valid in the Slovak Republic (2022)** and ** Limit value by the **EU Commission No. 2021/1317** (for Pb) a **No. 2021/1323** (for Cd), und. - undetected

The total polyphenols content and the antioxidant activity determination

The values of the total polyphenols content (mg.kg^{-1}) and the antioxidant activity (in %) in the observed varieties of lentil seeds were expressed as the average value±standard deviation of 6 measured values (Table 4). Table 4 also shows statistical significance between individual lentil varieties. There was a statistically difference between the individual varieties of lentils in the total polyphenols content and the percentage antioxidant activity. Lentils are an excellent food with antioxidant properties. We determined the values of total polyphenols in lentils in range of 1333.7-1972.9 mg.kg^{-1}. The Slovenská modrá variety had the highest average total polyphenols content (1972.9 mg.kg^{-1}) and the highest average antioxidant activity (33.57%).
Fratianni *et al.* (2014) verify the total polyphenols contents in lentils, while the results correspond with our values. In dry lentil seeds, **Alshikh *et al.* (2015)** reported the content of total polyphenols in the range of 1370–5530 mg.kg^{-1}depending on the cultivar. We determined the values of antioxidant activity in lentils in the range of 17.48-33.57%. The values are similar to those established by **Fratianni *et al.* (2014)** - an average of 23%. **Xu *et al.* (2007**) report that the total content of polyphenols in lentils harvested in the cold season is lower (486-960 mg.kg^{-1}). **Kalogeropoulos *et al.* (2010)** report amounts of polyphenols of 258-259 mg.kg^{-1}in cooked lentils. These values are lower than the values reported for

unheated legumes **Kalogeropoulos *et al.* (2010)**. **Xu and Changa (2008)** report in their study an observed decrease in total polyphenols after soaking and cooking peas, lentils and chickpeas. More pigmented varieties tend to contain higher levels of phenolic compounds (such as anthocyanins) than less pigmented varieties **(Alshikh *et al*., 2015; Balwinder *et al*., 2017)**.

Table 4 The total polyphenols content (mg.kg^{-1}) and the antioxidant activity (%) in selected lentil varieties (n=6)

Variety	*Total polyphenols*	*Antioxidant activity*
Slovenská zemplinská	1748.1± 8.0 ^{c}	22.50±0.95 ^{a,b,c}
Trebišovská	1684.1±4.7 ^{b,c}	24.41±0.73 ^{b,c}
Slovenská modrá	1972.9±22.6 ^{c}	33.57±1.31^{c}
Hrotovická veľkozrná	1432.6±10.8 ^{a,b,c}	20.01±0.85 ^{a,b,c}
Nelka	1333.7±16.1^{a}	17.48±0.77 ^{a}
Renka	1384.7±14.9 ^{a,b}	19.36±0.49 ^{a,b}

Legend: mean±standard deviation, different small letters (a,b,c) in a column show statistically significant differences (P< 0.05) between varieties, the same small letters in a column show statistically non-significant differences (P< 0.05) between varieties

Between the content of total polyphenols and the antioxidant activity, a higher medium dependence is confirmed in the case of lentils (R^2=0.8702). As the content of polyphenols increases, the antioxidant activity in lentils increases. Lentils are a legume with good antioxidant properties. This explains 87% of the variability of the model. This relationship is shown graphically in **Figure 1**.

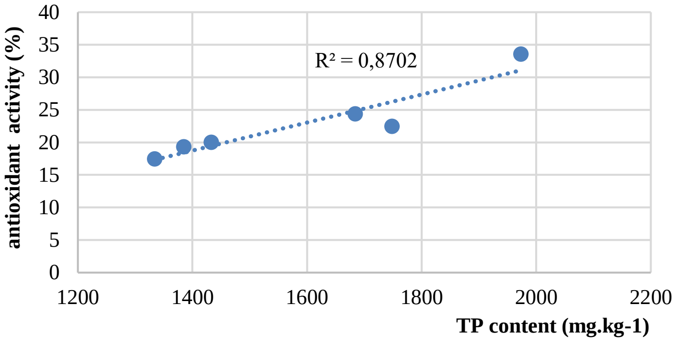

Figure 1 A relationship between the total polyphenols (TP content) and the antioxidant activity in selected lentil varieties

The values of the content of total polyphenols (mg.kg^{-1}) and antioxidant activity (%) in the selected varieties of chickpea seeds were expressed as the average value±standard deviation of 6 measured values (Table 5). Table 5 also shows statistical significance between individual lentil varieties. There was a statistically difference between the individual varieties of lentils in the content of total polyphenols and the antioxidant activity. The highest content of total polyphenols was recorded in the Alfa variety (964.7 mg.kg^{-1}), the lowest in the Slovák variety (796.6 mg.kg^{-1}). In the Alfa variety, the amount of total polyphenols was 17.4% higher than in the Slovák variety. A significantly lower content of total polyphenols (183 mg.kg^{-1}) was measured by **Fratianni *et al.* (2014)**. In chickpea varieties, **Fernandez-Orozco *et al.* (2009)** found a content of total polyphenols of 540 mg.kg^{-1}. On the contrary, **Han and Baik (2008)** reported a significantly higher content of total polyphenols in chickpea varieties (2200 mg.kg^{-1}). This inconsistency can be caused by the diverse climate and geographical area, or different chickpea cultivars. **Xu *et al.* (2007)** reported a total polyphenol content of 980 mg.kg^{-1} in chickpea harvested in the cooler season. The content of phenolics in natural matter is variable in dependence on the type of horticultural crop, also individual varieties of crops (**Drewnowski and Gomez-Carneros, 2000**). The highest antioxidant activity value was found in the Bušinský variety (5.01%) and the lowest in the Maškovský Bagovec variety (0.61%). The value of antioxidant activity in the Bušinský variety was 87.8% higher than in the Maškovský Bagovec variety. **Umar *et al.* (2022)** indicates a slightly higher value of the antioxidant activity (4.17-4.95%).
The values of the total polyphenols (mg.kg^{-1}) and the antioxidant activity (%) in the observed varieties of bean seeds were expressed as the average value±standard deviation of 6 measured values (Table 6). Table 6 also shows statistical significance between individual white bean varieties. A statistically significant difference was showed between the individual varieties of white beans in the content of total polyphenols and the antioxidant activity. The Fabia variety had the highest average content of total polyphenols (836.7 mg.kg^{-1}) and the highest average antioxidant activity (11.65%). As one variety, the Albena variety had the lowest average content of total polyphenols (501.7 mg.kg^{-1}) and the lowest average antioxidant activity (2.05%). The content of total polyphenols is 40% higher in the variety Fabia than in the variety Albena.

Luthria and Pastor-Corrales (2006) reported a total polyphenol content of 191–483 mg.kg^{-1} in bean varieties. **Xu *et al.* (2007)** reported total polyphenol content 570–699 mg.kg^{-1} for common beans harvested in a cooler season.

Table 5 The total polyphenols content (mg.kg^{-1}) and the antioxidant activity (%) in selected chickpea varieties (n=6)

Variety	*Total polyphenols*	*Antioxidant activity*
Kráľová z Krajovej	926.9±42.3 ^{b}	3.04±1.65 ^{a,b}
Maškovský Bagovec	806.6±15.4 ^{a}	0.61±0.47 ^{a}
Bušinský	850.6±7.3 ^{a,b}	5.01±0.64 ^{b}
Slovák	796.6±14.6 ^{a}	0.62±0.60 ^{a}
Beta	848.6±31.5 ^{a,b}	1.30±0.77 ^{a,b}
Alfa	964.7±25.6 ^{b}	3.06±0.90 ^{a,b}

Legend: mean±standard deviation, different small letters (a or b) in a column show statistically significant differences (P< 0.05) between varieties, the same small letters in a column show statistically non-significant differences (P< 0.05) between varieties

Figure 2 graphically shows the relationship between the content of total polyphenols and antioxidant activity in selected chickpea varieties. This relationship is statistically insignificant (R^2=0.3018). The content of total polyphenols in chickpeas does not affect its antioxidant activity. Model variability is explained at 30%. **Xu *et al.* (2007)** reported that the variable content of phenols may have a different degree of influence on the antioxidant activity in each type of legume. **Quintero-Soto *et al.* (2018)** identified twenty phenolic compounds and their levels showed a great variability among the chickpea genotypes.

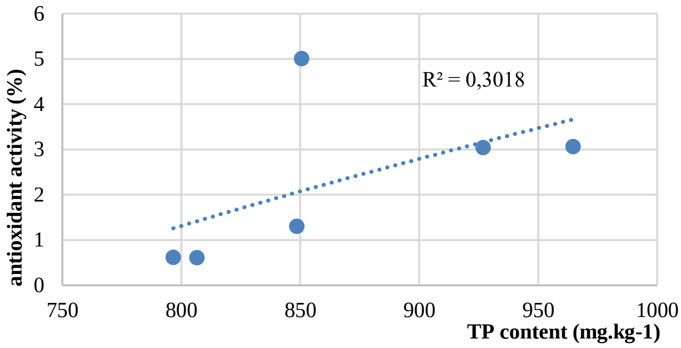

Figure 2 A relationship between the total polyphenols (TP content) and the antioxidant activity in selected chickpea varieties

Table 6 The total polyphenols content (mg.kg^{-1}) and the antioxidant activity (%) in selected white bean varieties (n=6)

Variety	*Total polyphenols*	*Antioxidant activity*
Albena	501.7±6.5 ^{a}	2.06±0.81 ^{a}
Ema	637.8±16.0 ^{a,b,c}	3.95±0.22 ^{a,b,c}
Fabia	836.7±15.1 ^{d}	11.65±1.27 ^{c}
Gesta	701.2±11.7 ^{b,c,d}	4.16±1.04 ^{a,b,c}
Gracia	526.9±9.7 ^{a,b}	2.05±1.02 ^{a}
Luna	590.5±7.2 ^{a,b,c}	3.04±0.42 ^{a,b}
Petra	586.3±3.8 ^{a,b,c}	7.21±1.44 ^{b,c}
Salva	712.1±5.8 ^{b,c,d}	6.34±0.43 ^{b,c}
Sina	731.5±3.3 ^{c,d}	4.16±0.65 ^{a,b,c}

Legend: mean±standard deviation, different small letters (a,b,c or d) in a column show statistically significant differences (P< 0.05) between varieties, the same small letters show statistically non-significant differences (P< 0.05) between varieties

There is a lower medium dependence (R^2=0.638) between the total polyphenols and the antioxidant activity in selected bean varieties. The content of total polyphenols in beans has a partial effect on the antioxidant activity of beans and **Duodu (2011)** reached the same conclusion. The variability of the model is thus explained to 63.8%. Results are shown in the **Figure 3**.

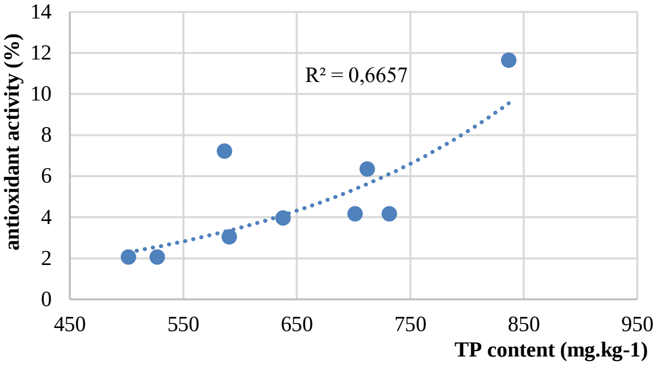

Figure 3 A relationship between the total polyphenols (TP content) and the antioxidant activity in selected white bean varieties

From point of view of the total polyphenol content and the antioxidant activity legumes between species were compared. The cross-species comparison showed a highly statistically significant influence of the type of legume on the content of total polyphenols and the antioxidant activity. The high significant correlations between the antioxidant activity and the phenolic composition were confirmed also by **Canas et al. (2008).** The highest average content of total polyphenols in the selected legume varieties was found in lentils (1592.7 $mg.kg^{-1}$), followed by chickpeas with a content of 865.7 $mg.kg^{-1}$ and the lowest amount of total polyphenols was found in beans (647.2 $mg.kg^{-1}$). In lentils, the content of polyphenols was higher by 59.36% than in beans. The antioxidant activity was again the highest in lentils at 22.9%, the lowest was in chickpeas at 2.3%, and the antioxidant activity of beans at 5%. Results are shown in the Table 7. **Xu *et al.* (2007)**, **Fratianni *et al.* (2014)**, **Alshikh *et al.* (2015)** report that of the legumes they tested, lentils had the highest concentration of phenolic components and the antioxidant activity values.

Table 7 The average of total polyphenols content ($mg.kg^{-1}$) and the antioxidant activity (%) in investigated legumes

crop	total polyphenols (mg.kg-1)	antioxidant activity (%)
lentil	1592.7 ^{c}	22.9 ^{c}
chickpea	865.7 ^{b}	2.3 ^{a}
white bean	647.2 ^{a}	5.0 ^{b}

Legend: mean±standard deviation, different letters (a,b,c) in a column show statistically significant differences (P< 0.05) between legume species, the same letters in a column show statistically non-significant differences (P< 0.05)

CONCLUSION

Soil hygiene and risky toxic metals contents in observed legumes in the current study were evaluated, then were investigatigated internal variability of total polyphenols content and antioxidant activity. The total content of cadmium and mobile forms of lead in the soil of the monitored location exceeded the limit value set by Act no. 220/2004 by 40% and 180%, respectively, but met the European Commission (EC) limit (2006). The toxic metals lead and cadmium were below the detection limit in all legume varieties. Limit values of lead were analyzed in the varieties Buinsk, Maškovský Bagovec, Kráľová z Krajová (chickpeas) and Luna, Sina, Albena (beans) (white beans). The cadmium content in the chickpea varieties was under the detection limit, except for the variety Slovák. Only the Petra variety of white beans had exceeded the limit value for cadmium. Pollutants such as Pb and Cd can enter the food chain through the uptake of plant foods, so in out legume samples are relatively suitable for human consumption, but heavy metal determination and control in plant foods is essential.
Lentil varieties had the highest total polyphenol content and the highest percentage of antioxidant activity, suggesting that lentils are foods with excellent antioxidant properties. We observed that bean varieties had the lowest levels of total polyphenols. The antioxidant activity in bean cultivars, on the other hand, was more than the percentage of antioxidant activity in chickpea varieties. Individual varieties of the selected legumes have statistically significant differences in total polyphenol content and antioxidant activity. Internal variability was confirmed in the selected legume cultivars; the variety influences total polyphenol content and antioxidant activity. In lentils, the relationship between antioxidant activity and total polyphenols was stated. The total polyphenol content of chickpeas has little or no effect on the antioxidant activity value. In beans, a partial effect of total polyphenol content on antioxidant activity was confirmed. Variability in total polyphenol content affects antioxidant activity differently in each variety and type of legume. Based on the findings, we can conclude that the type and variety of legumes affect antioxidant activity and total polyphenol content. According to our results and dietary and bioactive compound assessment, we can advise lentils as an excellent material for developing modern food products.

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