TOTAL PHENOLIC CONTENT IN SEVERAL POTATO CULTIVARS (BRASOV, 2015-2016)

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ABSTRACT

Potato tubers are a valuable source of bioactive nutrients such starch, amino-acids, dietary fibers, vitamins, minerals and phenolic compounds. Some of these phenolics could have beneficial effects on humans health. The present study evaluated the total phenolic compounds (TPC) in skin and flesh of thirty potato genotypes grown in Brasov trials, over two years. Lower levels of TPC were found in the flesh than in the skin of the tubers. Blue varieties Salad Blue had the highest values for all parameters excepting the TPC in flesh which was higher in the genotype Blue Purple of Galanesti. For TPC, maximum values find in flesh and skin tissue were 3.76 and 10.79 mg / gallic acid equivalents (values reported on dry weight).

INTRODUCTION

Blue and purple potato with flesh strongly pigmented represents a rich source of polyphenols (chlorogenic acid) anthocyanin pigments unexploited enough in the world and almost at all, until now, in Romania. Even though many species produce polyphenols and anthocyanins, availability and the cost of certain materials vegetal origin limited commercial exploitation of these natural sources of anthocyanin pigments only for a few species [6].

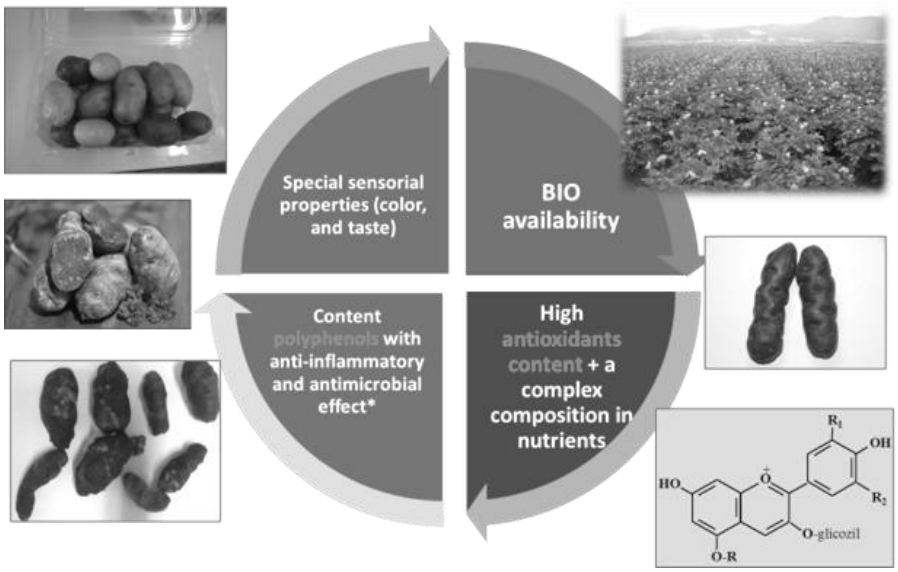


Figure 1. Potatoes with strong colour in flesh and skin – valuable vegetable.

Some of the reasons that led the choice of this subject (study poliphenolic content of potato tubers because of their valuable advantages presented in figure 1) were: the special bioavailability of this plant, economic considerations (lower price compared to other sources of polyphenols), relatively high content of anthocyanin and the presence of

valuable polyphenols (chlorogenic acid, quercetin and kaempferol glycosylated with rutinose significant amounts of catechin, usually acylated glycosides of rutinose and glucose) as described by Andre et al. (2006) and Ezekiel et al. (2013) [1,10]. Recent studies on potato composition revealed however that there is much more in potatoes than starch. Indeed, the potato tubers contain important phytochemicals (as phenolic compounds) that may prevent the development of diabetes, cardiovascular diseases and certain types of cancers. In particular, potato components have been shown to have favourable impacts on several measures of cardio-metabolic health, including lowering blood pressure, improving lipid profiles and decreasing markers of inflammation [19, 20]. Tubers with increased level of poliphenols could have an impact on human health, because these compounds posses antioxidant, antiglycemic, antiviral and anti-inflammatory activities [16, 20]. This impact could be strong especially for people where potato is the most important food crop and therefore would be of interest to consumers, producers and policymarkers [19]. The main objective of this work was to evaluated the amount of total poliphenols content and antioxidant activity of ethanolic extracts of thirty potato varieties grown in Brasov over two years with different climatic conditions.

MATERIAL AND METHOD

Biological material. The following potato genotypes were chosen for this study:

- BV 1791/1, BV 1871/4, BV 1876/1 - Romanian breeding lines from NIRDPSB Brasov with lower resitance to Potato Virus Y (data not show)
-‘Christian’, ‘Roclas’, ‘Sevastia’, ‘Marvis’, ‘Castrum’, ‘Brasovia’, ‘Cosiana’ (new and very new Romanian varieties)
-‘Albastru Violet Galanesti ‘(‘Blue Purple of Galanesti’), ‘Blue Congo’, ‘Vittelote’, ‘Salad Blue’ (cultivars with strong pigmentation in the flesh)
-‘Bellarosa’, ‘Riviera’, ‘Carrera’, ‘Jelly’, ‘Red Lady’, ‘Red Fantasy’, ‘Hermes’, ‘Arizona’ (cultivars very appreciated by the producers, being the top 20 varieties cultivated in the Romanian area with different resistance to Potato Virus Y) [5]
-‘La Bella’, ‘Tornado’, ‘Ferrari’, ‘Baltic Rose’, ‘Rudolph’, ‘Red Scarlet’, ‘Torino’, ‘Orlena’ (cultivars with a very interesting red colour skin).

Seed tubers were planted in May in Brasov (coordinates lat. 45.6744234, long. 25.539622) in 2016 and 2015, with three replicates. Similar fertilizer chemical inputs were applied in both years. The climatic conditions of the experimental years are presented in table 1. Mature tubers were harvested 160 days after planting in Brasov in 2016 and 148 days in Brasov in 2015. After harvest, marketable tubers (medium size and free of damage and defects) were selected, washed, stored at 4^{o}C until the sample preparation.

Sample preparation. Composite samples (4 to 10 tubers from each cultivars, in fonction of their size) were prepared by pooling tubers with a potato peeler. The tuber flesh was quartered from stem to bud and one of the quarters sliced. The tissues were freeze-dried (ScanVac CoolSafe 55-9 Pro Freeze Dryer, Denmark), ground to a fine powder (using a coffee grinder) and stored to -20^{o}C until analysis.

Extraction. The extraction was carried following the method described by Valcarcel et al. (2015) [19]. So, 0.2 g of freeze-dried potato skin or 0.6 g of flesh were weight into a 50 ml centrifuge tubes and 5 ml of etanolic solution 80% (v/v) in distilate water were added. The tubes were shaken 5 min at room temperature and centrifuged 15 min at 4137g. A part of supernatant was transferred to 1.5 ml eppendorf tubes and stored at -20^{o}C until analysis.

Total Phenolic Content (TPC) Analysis. The TPC was determined spectrophotometrically by Folin Ciocâlteu method [18] with several modifications [8]. 20 μl of skin extracts and 50 μl of flesh extracts were mixed with 50μl, respectively 100μl distilated water in a 96 well flat bottom assay plate (NUNC, Denmark). 50ml Folin

Ciocalteu reagent were added and mixed for 1 min in the plate reader (TecanSun Rise, softwere Magellan). After 5 min., 80 μl of a 20% solution (w/v) of Na_2CO_3 were added and mixed with a pipette; the microplates were shaken for 5 min. in the plate reader. After that, the plates were incubated at room temperature in the dark, agitating at 150 rpm on a MicroPlate Shaker (Biosan PST-60HL-4, Latvia) for 90 min. The absorbance of the samples was determined at 725 nm (TecanSun Rise, softwere Magellan). Gallic acid was used as standard and total phenolic content was expressed as milligrams GAE (Gallic acid equivalents) per gram of dry weight (DW) materials.

Table 1

The climatic conditions in the 2 experimental years

Month	Year	Mean temperature (°C)	Rainfall (mm)
May	2015	13.2	82.6
	2016	12.4	100.4
June	2015	16.3	107.7
	2016	19.0	121.2
July	2015	17.9	95.9
	2016	19.7	28.8
August	2015	17.3	78.5
	2016	18.4	85.8
September	2015	13.5	54.7
	2016	15.0	38.0
October	2015	8.2	42.7
	2016	6.9	96.0
Average / Sum	**2015**	**14.4**	**462.1**
	2016	**15.2**	**470.2**

Statistical interpretation. Each set of comparable assay was conducted with the same bulk sample. Analysis of variance (ANOVA) and Duncan's multiple range test were used to analyze the data.

RESULTS AND DISCUSSIONS

The trials conducted in Brasov in 2015 and 2016 show that cv. 'Salad Blue' had the highest mean TPC value in skin. In the flesh tissue, cv. 'Blue Purple of Galanesti' show the highest TPC value in both years. The genotype with the lowest quantified TPC values was breeding line BV 1791/1 in 2015 and 2016 for both tissues flesh and skin, respectively (table 2).

The levels of TPC ranged from 0.59 to 3.35 and 2.68 to 10.79 mg GAE g^{-1} DW in the flesh and skin, respectively, with flesh and skin contents showing a significant difference between the cultivars (table 2). The skin of the potatoes studied contained on average 4.04 and 4.22 times more phenolic compounds (TPC) than the flesh, in 2015 respectively in 2016 (table 2). TPC in both tissue (skin and flesh) was positively correlated with the colour of the tissue, with a Pearson coefficient 0.731 ($p<0.01$) and 0.489 ($p<0.01$) for skin and flesh respectively.

The results obtained in our experiments are comparable with those reported by another researchers, with values ranging from 1.56 to 12.9 and 0.54 to 3.59 mg GAE g^{-1} DW in the skin, respectively in the flesh [19], from 1.4 to 2.4 mg GAE g^{-1} DW in the flesh

[7],from 0.92 to 12.37mg GAE g^{-1} DW for whole tubers [1,21] from 1.00 to 4.3 mg GAE g^{-1} DW in the skin [14,15].

Table 2

Total polyphenol content (mg GAE/g DW) of potato samples analysed (Brasov, 2015-2016)

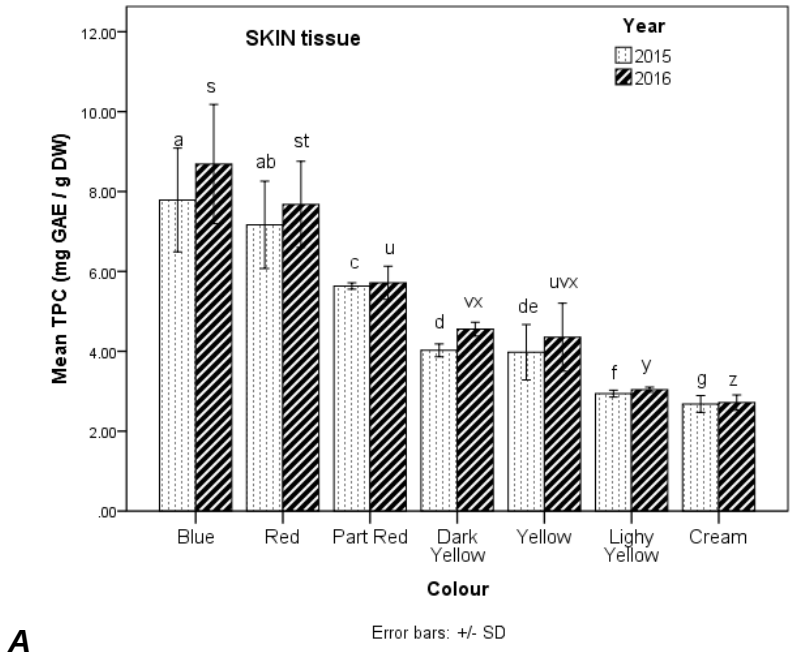
Cultivars / genotypes	Flesh / Skin colour	Brasov 2015		Brasov 2016	
		Flesh	Skin	Flesh	Skin
BV 1791/1	W / LY	0.59 *(l)**	2. 68 (*p*)	0.82 (*n*)	2.72 (*m*)
Arizona	Y / Y	1.22 (*fg*)	4.07 *(l)*	1.30 *(ghij)*	4.89 *(j)*
AVG	**B/B**	**3.03 (*b*)**	**9.39 *(a)***	**3.*38 (b)***	**10.79 (a)**
Baltic Rose	LY / R	-	-	0.98 *(jklmn)*	6.60 (*fg*)
Bellarosa	Y / R	1.18 (*fg*)	6.36 *(fgh)*	1.20 *(ghijkl)*	7.47 *(e)*
Blue Congo	PB / B	1.94 (*c*)	6.07 *(h)*	2.29 (c)	6.95 (*f*)
Brasovia	WY / Y	0.92 (*i*)	3.35 *(mn*)	1.04 *(ijklmn)*	3.90 (*k*)
Carrera	Y / Y	0.96 (*hi*)	3.63 *(m)*	1.34 *(fghi)*	3.48 (*kl*)
Castrum	LY / Y	1.15 (*gh*)	4.01 *(l)*	1.43 (*efgh*)	4.55 *(j)*
Christian	Y / R	1.15 (*gh*)	6.54 *(f)*	1.53 (*efg*)	6.93 (*f*)
Cosiana	WY / R	0.73 (*ijkl*)	7.16 *(e)*	1.03 (*jklmn*)	7.68 (e)
Ferrari	Y / R	-	-	1.41 (*efgh*)	6.15 (*gh*)
BV 1871/4	C / R	0.78 (*ijkl*)	7.96 *(d)*	0.88 (*lmn*)	8.32 *(cd*)
Hermes	LY / C	0.75 (*ijkl*)	2.94*(op)*	0.87 (*lmn*)	3.04(lm)
Jelly	Y / Y	1.66 (*d*)	5.16 *(j)*	1.65 (*def*)	5.73 *(hi)*
La Bella	WY/PR	-	-	0.90 (*lmn*)	5.71 *(hi)*
Marvis	WY / Y	0.75(*ijkl)*	4.51 *(k)*	0.91 (lmn)	4.66 *(j)*
Orlena	DY/DY	-	-	1.73 (*de*)	4.55 (j)
BV 1876/1	LY / Y	0.90(*ij)*	3.48 *(mn)*	1.06 (*ijklmn*)	3.25 *(l)*
RedFantasy	Y / R	1.23 (*fg*)	7.35 *(e)*	1.20 (*hijklm*)	8.38 *(cd)*
Red Lady	Y / R	1.40 (*ef*)	8.97 *(b)*	1.51 (*efgh*)	9.68 (*b*)
Red Scarlet	LY / R			0.99 (*jklmn*)	7.85 (*de*)
Riviera	Y / Y	1.34 (*efg*)	3.41 *(mn)*	1.65 (*def*)	3.95 (*k*)
Roclas	Y / Y	0.88(*ijkl)*	3.15 *(no)*	1.27 (*ghijk*)	3.56 (*kl*)
Rudolph	WY/R			0.95 (*klmn*)	34 (*cd*)
Salad Blue	**B / B**	**3.35 (*a)***	**9.09 *(ab)***	**3.76 (a)**	**9.26 (*b*)**
Sevastia	DY / Y	1.66 (*d*)	4.99 (*j*)	1.95 (*d*)	5.57 (*i*)
Torino	LY / R	-	-	0.86 *(mn*)	6.86 *(f)*
Tornado	W / R	-	-	0.96 (*klmn*)	6.95 *(f)*
Vittelot	**B/B**	**3.05 (b)**	**8.33 (c)**	**3.25 (*b)***	**8.67 (*c)***
Mean		**1.38**	**5.57**	**1.47**	**6.21**

*Means with different letters are significantly different at $p<0.05$ in each column. Values reported for the two Romanian trials are the mean of three filed replicates. Abbreviations: AVG Albastru Violet de Galanesti (Blue Purple of Galanesti); BV 1791/1, BV 1871/4, BV 1876/1 breeding lines. DW dry weight; GAE gallic acid equivalents. W white; C cream; LY light yellow; Y yellow; R red; B blue; PR part red; PB part blue. cream; - no sample available

Despite the fact that some vegetable sources have higher TPC than potatoes, in many countries the potatoes are consumed in higher quantities and so, potatoes make a valuable contribution to the daily intake of phenolic compounds. A recent study in USA estimated that potatoes were the third highest contributor to the daily intake of phenolic compounds, after oranges and apples, with a daily intake consumption of 171 g day^{-1} [6].

These valuable properties of potatoes could be greater if the cultivars with high TPC level become popular for the people. Unfortunately, the cv. 'Blue Purple of Galanesti', (reported in this study with the higher TPC level in the flesh) is not accepted with pleasure by the consumers because the tubers are small, elongated and with deep eyes. Maybe in

the future, the potato breeders correct these quality parameters by developing new valuable cultivars, with functional food characteristics.



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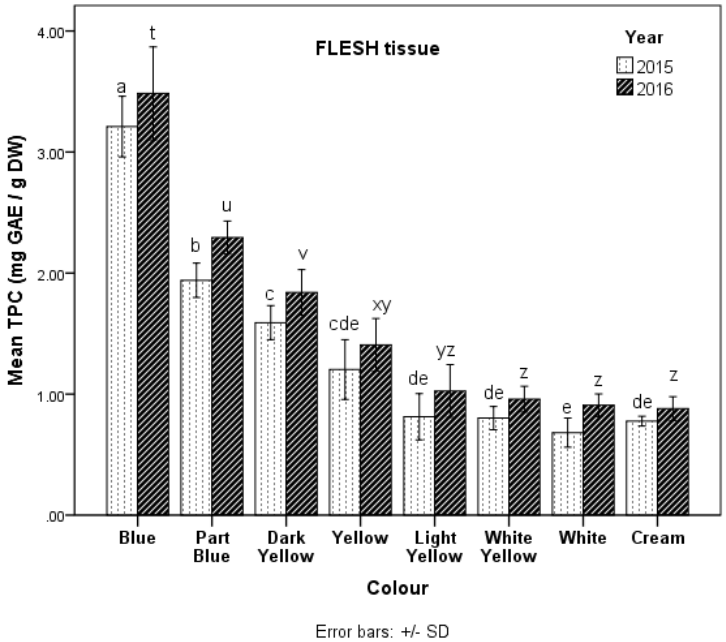

B

Figure 2. Mean total phenolics content (TPC) according to the colour of the skin (A) and flesh (B) colour of the tubers. Bars represents mean values of samples collected in 2015 and 2016 with different skin and flesh colour. Error bars represent standard deviations. The letters different upper the bars indicate significant difference at p<0.05.

As reported and another researchers, potato peels are a great source of phenolic compounds because almost 50% of phenolic are located in the peel and adjoining tissues [3, 4. The results presented in this study revealed higher TPC in skin compared with the flesh tissue. There are many information in the literature about TPC in potato varieties grown in different controlled conditions. In this study, there were analysed several cultivars, including new Romanian varieties, another lovely - appreciated cultivars and some cultivars with strong colour in the flesh and skin tissue.

Results regarding the influence of skin and flesh colour on TPC are presented in figure 2. The tubers with blue skin had the highest TPC values. These values were significantly different from other colours, except red-skinned varieties (figure 2). In the flesh tissue, blue potatoes had the highest TPC values, significant different from all the other colour variants. Blue and red colours are due to the presence of anthocyanins [2] and the higher TPC values obtained for this kind of tubers colour can be attributed to these pigments with high antioxidant potential. Strong correlations between TPC and antioxidant activity were reported in previous studies [1,12,17,19] which specified that both phenolic and flavonoid compounds are the main contributors to the antioxidant potential. This contribution depend on the extraction, quantity of each phenolic compounds and interactions between them, which could be additive, synergistic or antagonistic [9,11,13,19].

CONCLUSIONS

Thirty potato genotypes with different colour of the skin and flesh tissue (grown in Brasov trials two years) were analysed for estimation their total polyphenols content. The most popular Romanian cultivars were used for this study. In addition, some breeding lines, several new Romanian varieties and different potato cultivars with interesting skin and flesh colour were studied. The results obtained were in the range of values reported in the literature.

Significant differences between the different cultivars tested were found. The cultivar with blue skin and flesh had the higher values of total polyphenols content.

Because of the great importance of potato in population's food, this study offer information to potato researchers, producers and public on the level of these phytochemicals with functional properties.

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