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THE ANTIOXIDANT ACTIVITY OF SEVERAL POTATO CULTIVARS (BRAŞOV 2015-2016)

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Abstract: *Despite the fact that some vegetable sources have higher antioxidants content than potatoes, in many countries the potatoes are consumed in higher quantities and so, potatoes make a valuable contribution to the daily intake of these valuable compounds. The objective of this study was to evaluate the antioxidant activity (AA) of thirty potato cultivars. The antioxidant activity was estimated by measuring the capacity to quench the stable radical DPPH in ethanol extracts. Higher values of AA were found in samples (flesh and skin extracts) from the cultivars 'Salad Blue' and 'Blue Purple of Galanesti': 4.88 and 11.80 mg/g Trolox equivalents, respectively 4.3 and 10.11 mg/g Trolox equivalents (values reported on dry weight).*

Key words: *potato, antioxidant activity, cultivars.*

1. Introduction

Antioxidants play an important role in the prevention of atherosclerosis and heart disease [10], [11], [14]. These compounds function by scavenging radicals, donating electrons and hydrogen, reducing peroxides and quenching singlet oxygen [10]. Antioxidant activity describes the ability of redox molecules in foods and biological systems to scavenge free radicals, considering the additive and synergistic effects for all antioxidant compounds [10]. The marketing of so-called superfoods is commonly based on their antioxidant potential. A high antioxidant activity with health benefits has been claimed for a large number of foods based on *in vitro* antioxidant assay.

Potatoes with a dark colour of the flesh and skin can also be a food with a high level of antioxidant activity because of their rich content of phenolic compounds. In addition, potatoes are one of the most consumed vegetables in many countries [18]. Many studies investigated the antioxidant effects of potato polyphenols [2]. Most of them searched the effect on different oils [12], [15], [16]. Koduvayur et al. [16] used potato peel extracts for fish oil and oil in water emulsions and their results point out that some of these extracts are highly efficient at reducing lipid peroxidation. Some researchers used potato peels to limit oxidation in meat [3], [7], [12], [13]. There are some studies that compare the antioxidant activity of potato peels extracts with the commercial

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synthetic antioxidants butylated hydroxyl toluen (BHT) and butylated hydroxyl anisol (BHA) [1], [13], [15].

The main objective of this study was to evaluate the amount of antioxidant activity of ethanol extracts of thirty potato varieties cultivated in Brasov over two years with different climatic conditions.

2. Material and Methods

2.1. Biological Material

The following potato cultivars were chosen for this study:

- BV 1791/1, BV 1871/4, BV 1876/1 - Romanian breeding lines from NIRDPSB Brasov with lower resistance to Potato Virus Y (data not shown);
- '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).

The seed tubers of selected varieties were obtained from the Breeding Department of the National Institute of Research and Development for Potato and Sugar Beet Brasov (and were cultivated in 2015 and 2016, with some exceptions cultivated only in 2016).

Seed tubers were planted in May in Brasov (coordinates lat. 45.6744234, long. 25.539622) in 2016 and 2015, with three replicates, following an alpha block design. 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 being planted in Brasov in 2016 and 148 days in Brasov in 2015. After harvest, marketable tubers (medium sized undamaged and unflaweddefects) were selected, washed, stored at 4^{o}C until the sample preparation.

Table 1

The climatic conditions of the 2 years

Month	Year	Mean temperature (^{o}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

2.2. Sample Preparation

Composite samples (4 to 10 tubers from each cultivars) were prepared by peeling 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.

2.3. Extraction

The extraction was carried out following the method described by Valcarcel et al. [19]. Thus, 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 ethanol solution 80% (v/v) in water were added.

The tubes were shaken 5 min at room temperature and centrifuged 15 min at 4137g. A part of the supernatant was transferred to 1.5 ml tubes and stored at -20°C until analysis.

2.4. Antioxidant Activity (AA) Analysis

The antioxidant activity was determined following the method presented by Goupy et al. [8] and Valcarcel et al. [19]. Trolox solutions with different concentrations (ranging from 0.01 to 0.04mM) were prepared in ethanol. A solution of DPPH (1,1-diphenyl-2-picrylhydrazyl) 0.238 g l^{-1} in ethanol was prepared 2 h before the experiment and stored at 4°C. This solution diluted 1:5 was made and 0.5 ml of it was pipetted in tubes containing blank, standard or sample extract solutions. The tubes were vortex mixed and placed in the dark for 30 minutes. The absorbance of each solution was determined against air at 515 nm using a UV VIS spectrophotometer Spectronic Genesys 5 (Milton Roy). Antioxidant activity was expressed as milligrams Trolox per 100 g DW of the sample and was calculated by dividing the IC_{50} of the Trolox by that of each sample. Higher values of these results corresponded to samples with good antioxidant activity.

2.5. 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.

3. Results and Discussions

Results regarding the antioxidant activity of potato extracts (estimated by measuring the capacity to quench the stable radical DPPH) are presented in Table 2. Varieties had a significant effect on this parameter. The cultivars 'Salad Blue', 'Blue Purple of Galanesti' and 'Vittelote' had the highest detectable antioxidant potential of the material studied in both years. Antioxidant activity levels were very different ranging from 17 to 488 mg Trolox per 100g DW and from 225 to 1150 mg Trolox per 100g DW for the flesh tissue and skin, respectively. The average of AA in flesh was nine to eleven lower than in the skin. The correlation between the AA in both tissues was weak positive, with a Pearson's coefficient of 0.259 ($p<0.001$).

Results regarding the influence of skin and flesh colour on AA are presented in Figure 1. The tubers with blue skin had the highest values. These values were significantly different from other colours, except red-skinned varieties (Fig. 1). In the flesh tissue, blue potatoes had the highest AA values, significantly different from all the other colour variants. Blue and red colours are due to the presence of anthocyanins [4] and the higher AA values obtained for this kind of tubers colour can be attributed to these pigments with high antioxidant potential.

Figure 2 presents the positive correlations between AA and TPC (total polyphenol content, data not shown) for the tubers flesh (Pearson's coefficient 0.904 at $p<0.001$) and for the tubers skin (Pearson's coefficient 0.623 at $p<0.001$). These strong correlations between AA and TPC were reported in previous studies [4], [9], [17], [19] which specified that both phenolic and flavonoid compounds are the main contributors to the antioxidant potential. This contribution depends on the extraction, quantity of each phenolic compounds and interactions between them, which could be additive, synergistic or antagonistic [7], [9].

Despite the fact that some vegetable sources have higher AA than potatoes, in many countries potatoes are consumed in higher quantities and so, potatoes make a valuable contribution to the daily intake of

compounds with antioxidant potential. 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 AA level became popular for the people.

Antioxidant activity (mg Trolox/100g DW) of potato (2015-2016) Table 2

Cultivar / Breeding line	Flesh / Skin colour	Brasov 2015		Brasov 2016	
		Flesh	Skin	Flesh	Skin
BV 1791/1	W / LY	17 *(n)**	225 *(r)*	18 (*l*)	263 *(j)*
'Arizona'	Y / Y	51 *(i-m)*	603 (*k)*	60 (*ghi*)	644 *(fgh)*
'AVG'	B/B	382 (*b*)	973 (c)	433 (*b*)	1011 (*ab)*
'Baltic Rose	LY / R	-	-	57 (*hi)*	238 (j)
'Bellarosa'	Y / R	58 *(i-l)*	592 (*k)*	54 (*hij*)	635 (*fgh*)
'Blue Congo'	PB / B	181 *(d)*	846 (*ef*)	238 (*d)*	876 (*a-e)*
'Brasovia'	WY / Y	61 *(h-l)*	734 (*hi*)	72 (*fgh*)	760 (*c-f)*
'Carrera'	Y / Y	72 *(ghi*)	246 (*r*)	84 *(f)*	270 *(ij)*
'Castrum'	LY / Y	42 *(klm)*	327 (*pq*)	55 (*hij*)	371 *(j)*
'Christian'	Y / R	63 *(g-j)*	771 (*g)*	56 (*hij*)	815 (*b-f)*
'Cosiana'	WY / R	18 (*n*)	373 (*no*)	18 (*l*)	402 *(ij)*
'Ferrari'	Y / R	-	-	81 (*f*)	637 *(f-h)*
BV 1871/4	C / R	83 (*fgh*)	752 (*gh*)	109 *(e*)	806 *(b-f)*
'Hermes'	LY / C	111 (*e*)	290 *(r)*	120 (*e*)	338 *(ij)*
'Jelly'	Y / Y	45 (*klm*)	742 *(ghi)*	78 (*fg*)	782 *(c-f)*
'La Bella'	WY/PR	-	-	54 (*hij*)	774 *(c-f)*
'Marvis'	WY / Y	43 (*klm*)	395 *(n)*	46 (*ijk*)	437 (*h-j)*
'Orlena'	DY/DY	-	-	84 *(f)*	765 (*c-f)*
BV 1876/1	LY / Y	50 (*i-m*)	354 *(op)*	47 (*ijk*)	417 *(ij)*
'RedFantasy'	Y / R	86 (*fg*)	681 *(j)*	71 (*fgh*)	720 (*d-g)*
'Red Lady'	Y / R	103 (*ef*)	910 (*d*)	113 *(e)*	955 *(a-c)*
'Red Scarlet'	LY / R	-	-	29 (*kl*)	884 *(a-e)*
'Riviera'	Y / Y	60 (*h-l)*	600 (*k*)	74 (*fgh*)	660 (*e-g)*
'Roclas'	Y / Y	40 *(k-n)*	462 (*m)*	48 (*ij*)	507 *(g-i)*
'Rudolph'	WY/R	-	--	56 (*hij*)	879 *(a-e)*
'Salad Blue'	B / B	462 *(a)*	1180 (*a*)	488 (*a*)	1051 *(a)*
'Sevastia'	DY / Y	96 (*ef)*	876 *(e)*	120 *(e)*	911 *(a-d)*
'Torino'	LY / R	-	-	60 (*ghi)*	328 *(ij)*
'Tornado'	W / R	-	-	37 *(i-l)*	772 *(e-a)*
'Vittelot'	B/B	298 *(c)*	1112 (b)	353 *(c)*	838 *(a-f)*

*Means with different letters are significantly different at p<0.05 in each column. Values reported are the mean of three 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; DY=dark yellow; Y=yellow; R=red; B=blue; PB=part blue; C=cream; "- " no sample available.

Unfortunately, the cv. 'Blue Purple of Galanesti', 'Salad Blue' (reported in this study with higher AA level in the flesh) is not favoured by the consumers because the tubers are small, elongated and with deep eyes.

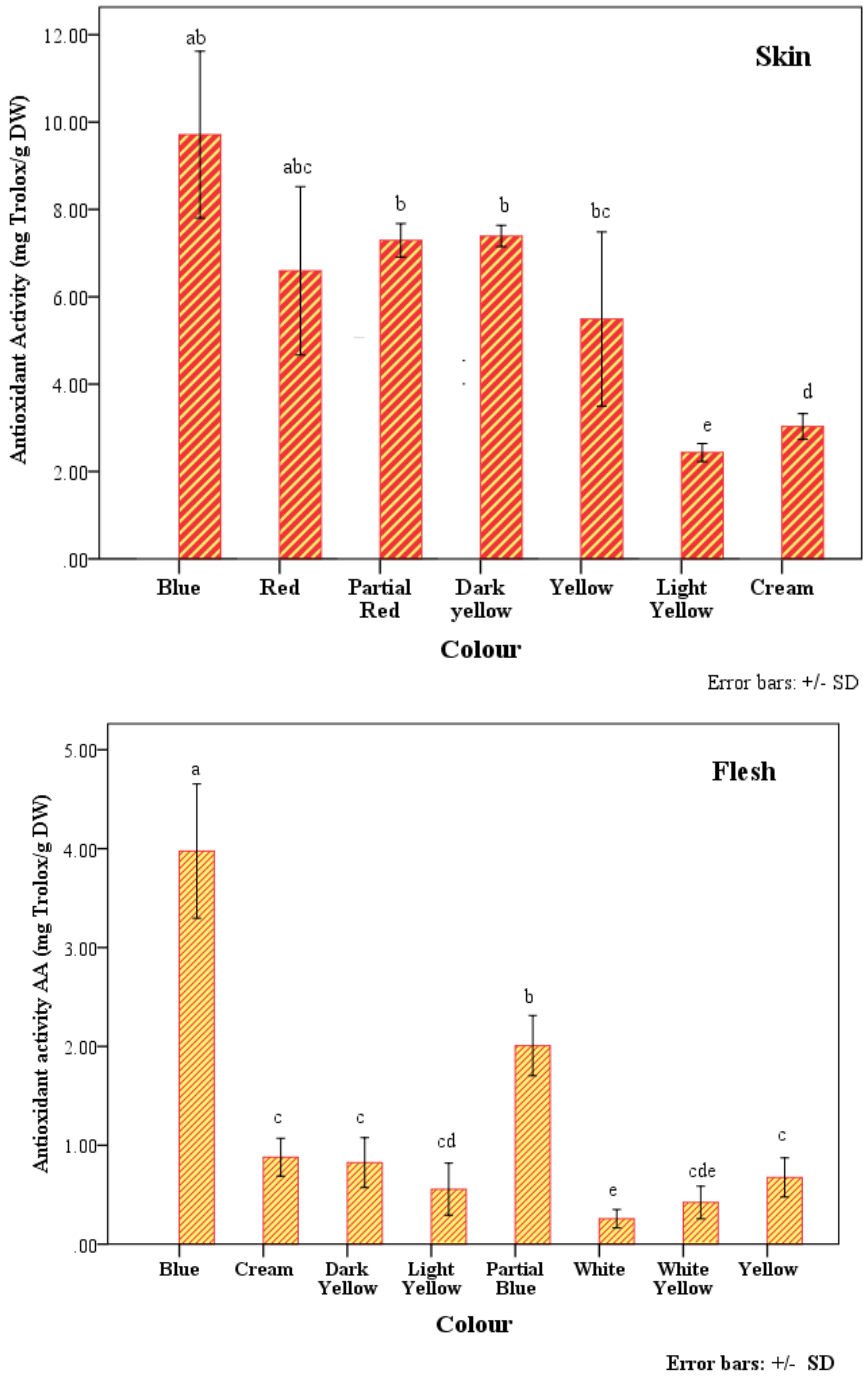

Fig. 1. *Mean total phenolic content (TPC) and antioxidant activity (AA) according to the colour of the tuber's skin and flesh. Bars represent mean values of samples collected in 2015 and 2016 with different skin and flesh colour. Error bars represent standard deviations. The letters differing in the upper part of the bars indicate significant difference at $p<0.05$*

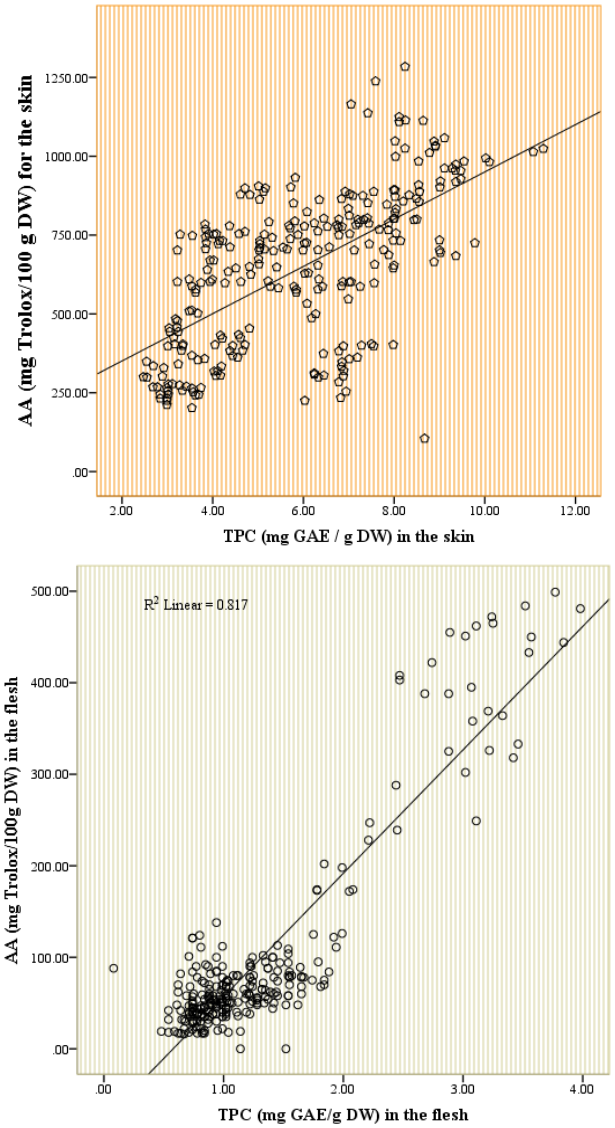

Fig. 2. *Correlations between total polyphenol content (TPC) and antioxidant activity (AA) in skin and flesh of the potato tubers. Pearson correlation coefficients are respectively 0.623 for the skin (B) and 0.904 for the flesh (A) at p<0.001*

Also, their appearance, size and shape could affect the consumer's acceptability. Maybe in the future, the potato breeders will correct this parameters by developing new valuable cultivars, with functional food characteristics.

As reported by other researchers, potato peels are a great source of compounds with high antioxidant potential because almost 50% of phenolic compounds are located in the peel and adjoining tissues [1], [3]. There is much information in the literature about antioxidant activity in potato varieties grown in different controlled conditions. In this study, there was analysed some cultivars were analyzed

including new Romanian varieties, other highly another lovely - appreciated cultivars and some cultivars with strong colour in the flesh and skin tissue.

4. Conclusions

Thirty potato cultivars with different colours of the skin and flesh tissue (grown in Brasov two years) were analysed for the estimation of AA values. The most popular Romanian cultivars were chosen for this study. In addition, new Romanian cultivars and several potatoes 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 tested cultivars were found. The cultivars with blue skin and flesh tissues had the highst values of AA. More studies are needed to support the utilisation of potato extracts in foods as antioxidants.

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