Production of some Colored Potato Genotypes in Organic Culture

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Bulletin UASVM Horticulture 75(1) / 2018

Print ISSN 1843-5262, Electronic ISSN 1843-536X

DOI:10.15835/buasvmcn-hort: 003617

Abstract

The purpose of this study was to identify the cultivars of potatoes with good production capacity and high nutritional value under ecologically culture conditions. The biological material consisted of five new potatoes cultivars: Brasovean, Carpatin, Cranberry Red, Montain Rose, Purple Majesty and Blue Congo. These new, highly pigmented varieties have yellow, pink or red peel and pulp, due to its high anthocyanin content. In order to achieve the objective, the productivity elements were determined: number of tubers and medium weight/plant, productivity as well as starches, carbohydrates, vitamin C content and antioxidant capacity. The obtained results were statistically interpreted by the analysis of variance, and the differences between genotypes were estimated by the threshold of significance at $p \leq 0.05\%$. Cultivar Carpatin recorded the best production (32.7 t/ha) and Cranberry red and Montain Rose cultivars recorded the highest content in vitamin C (17.6 respectively 18.64 mg/100g f.m) and Blue Congo with highest antioxidant capacity (162.65 DPPH μ MTE/100g).

Keywords: antioxidant capacity, ecological, quantitative

Introduction

Potato culture occupies an important place among crop plants because it is a source of human food, a good animal feed and raw material for industrial processing.

Coloured potatoes (*Solanum tuberosum* L.) are an important source of foods rich in antioxidant phenols. These antioxidants have effects against free radicals and lower the risk of coronary heart disease, by reducing cholesterol in the blood serum and by increasing the resistance of vascular walls (Chellaram *et al.*, 2014).

Through breeding, new varieties have been created, with high production capacity, disease and pest resistance, and high quality attributes to meet market requirements. In recent years, new potato genotypes have emerged, which differ especially in the color of the peel and pulp.

Due to its pleasant taste, digestibility and high nutritional value, potatoes are increasingly used in human food, which are consumed in various forms (cooked, baked, fried, in the form of soups, salads, purees). Also, the potato has high energy value due to the high content of starch, proteins, fats, minerals and vitamins (Hoza *et al.*, 2015). Consumption requires special attention because the tubers accumulate alkaloids that form solanine and at concentrations higher than 20 mg/100 g s.p. is toxic, carcinogenic (Soare and Duță, 2011).

From an agrofitotechnical point of view, potato is a plant that harnesses mild, sandy-clay soil (even sandy at potatoes for early consumption) in more humid and cool areas, where cereals fail in culture.

Potatoes with colorful pulp are grown on all continents, but on small surfaces. For a long time, they have not shown interest to consumers

because of the less attractive pulp color (Pazderu *et al.*, 2015). *Solanum tuberosum* L. var. *Vitelotte* is a widely used potato variety for human consumption. Pigments responsible for attractive color belong to the anthocyanin class (Bontempo *et al.*, 2013). At present, has grown the interest in these varieties, as healthy foods (Lange *et al.*, 2007, Hecht, *et al.*, 2015). In this respect, it was studied the behavior of a new potato assortment, which is distinguished by the color of the shells and pulp: yellow, cream, pink, purple, regarding the quantity and quality of the production.

Material and methods

The study was conducted in 2016 on an early potato organic crop in south-west Romania on a soil with clay-sandy texture (44°19'N and 23°48'E), favorable area for growing potato. The experiment was placed in a completely randomized design with 3 repetitions. The planting was carried out in the second decade of March, after the following 70X30 cm technological scheme. The biological material consisted of two autochthonous cultivars: Carpatian and Brasovean and four foreign cultivars: Cranberry Red, Montain Rose, Purple Majesty and Blue Congo.

At the preparation of the land, was applied 10 t/ha of compost consisting of 50% of swine dumplings, 25% of ground mass and 25% of dry mass (dried leaves, straw and corn stalks). At planting, wood ash was sprinkled on the gutters at a dose of 500 kg/ha. Ash is both a natural repellent and an insecticide. Also at plantation, organic fertilizers, Guanito and Itallpolina (500 kg/ha) were added. Guanito (6N-15P2O5+3K2O) is a result of lilac excrements compost and Itallpollina (4N-4P2O5-4K2O) is obtained by composting avian manure.

Prior to planting, the tubers were treated with Shore, 500ml/100 l water, ecologically produced for viruses, and after emergence 3 treatments were applied. Against pests were planted species with repellent effect: basil and marigolds and crop protection with agro-textil.

Chemical analysis:

The dry matter content was determined in the oven at 105 °C for 3 hours.

Reducing sugars (%) were extracted in distilled water (1:50w/v) and assayed colorimetric with 3.5 dinitrosalicylic.

The vitamin C was determined by iodometric method, and reducing sugars (%) by colorimetric method using 3.5 dinitrosalicylic acid (DNS).

Starch was determined from the potatoes as described by Vasanthan (2001).

DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging assay: The capacity of sample extracts to reduce the radical 2,2-diphenyl-1-picrylhydrazyl was assessed using the method of [13] with some modification. A 0.075 mM (final concentration) DPPH solution in methanol was mixed with sample extracts and vortexed thoroughly. The absorbance of the mixtures at ambient temperature was recorded for 20 min at 2 min intervals. The absorbance of the remaining DPPH radicals was measured at 519 nm. The normal color of DPPH will turn into yellow when its singlet electron is paired with a hydrogen atom coming from a potential antioxidant. A blank reagent was used to study stability of DPPH over the test time.

The scavenging activity of extracts was evaluated as a percentage of DPPH discoloration using the formula:

$$\% \text{ scavenging} = 100 * \frac{A_0 - (A_1 - A_S)}{A_0}$$

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where A0 is the absorbance of DPPH alone, A1 is the absorbance of DPPH + extract and AS is the absorbance of the extract only.

The Trolox calibration curve was plotted as a function of the percentage of DPPH radical scavenging activity. The final results were expressed as micromoles of Trolox equivalents, TE/100g (μmol TE/100g fw). All determinations were performed in triplicate, and all results were calculated as mean.

Statistics: The analysis of variance was performed on data for differences between and within the varieties using the ANOVA. Mean separations were determined by least significant difference (LSD) at p ≤ 0.05%.

Results and discussions

The data presented in Table 1 indicate that the varieties studied differ in phenotypic aspects: they have yellow peel and pulp, blue peel and pulp, pink peel and pulp, red peel and pulp or partially

Table 1. Morphological characterization of potato cultivars

Cultivar	The shape of the tuber	Color		Maturity	The depth of the eyes
		Peel	Pulp		
Brasovean	long oval	red	yellow	early	superficial – medium
Carpatin	long oval	red	yellow	early	superficial - medium
Blue Congo	oval elongated	pink	violet	early	superficial
Purple Majesty	oval	blue	blue violet	early	medium
Montain Rose	long oval	dark-purple	red	mid-early	superficial
Crambery Red	oval	red	red	mid-early	superficial

Table 2. Morphological and production characteristics of studied potato cultivars

Cultivar	Number of stems/plant	No. of tubers/plant	Weight of tubers/plant (g)	Production (t/ha)
Brasovean	5.0±0.5	5.38±0.12b	510±70a	30.6±1.9a
Carpatin	4.5±1.7	5.81±0.06b	545±45a	32.7±1.8a
Blue Congo	4.7±0.2	5.50±0.8b	300±25b	18.0±1.5bc
Purple Majesty	3.5±1.1	4.22±0.53c	250±20bc	15.0±0.8c
Montain Rose	3.7±0.3	4.72±0.12bc	320±10b	19.2±1.3b
Crambery Red	4.9±0.3	7.54±0.11a	226±34c	13.56±0.4c
LSD 0.05%	2.45	1.12	76.19	3.92

Note: Values represent the mean and SE,

Values in the same column followed by different superscript letters are significantly different at $p < 0.05$

violet peel and pulp due to the high content of anthocyanins.

The harvest of potatoes took place on 24.06.2016, determining some morphological characteristics and average weight/nest in each variety and variants. Regarding the medium no. of stems/plant, this was according to the data in the literature, from 3.5 to 5.5, and results reported by Masarirambi *et al.*, 2012. Referring to the number of tubers this ranged from 4.22 to 5.81. The average weight of tubers/plant recorded the highest values in Romanian cultivars, Carpatin with 545 g/plant, respectively Brasovean with 510 g/plant. Foreign cultivars ranged between 250-320 g/plant (Tab. 2). Similar results were obtained on unpolluted soil (320g/plant) (Draghici *et al.*, 2016).

The potato production of the studied cultivars showed high variability, from 13.56 t/ha to 32.7

t/ha, evidencing the Carpatin autochthonous cultivar.

The biochemical composition of tubers depends mainly on the genetic structure, the environmental factors during the growing of the tubers, the variety, the storage conditions, etc.

The dry substance content of potato tubers is an important quality index in determining the processing capacity (Jariene *et al.*, 2015). Potato cultivars with over 20% dried substance are suitable for industrial processing, chips and other dehydrated products (Rahman *et al.*, 2016). Freshly harvested potatoes contain about 75% water and 25% dry matter (Addisu *et al.*, 2014).

In the present study, the highest content in dry matter was obtained for Montain Rose 23.82% and Purple Majesty, with 23.81%, and the lowest values was at Crambery Red cultivar, with 16.29% (Tab. 3). Other authors reported that the

Table 3. Biochemical content and antioxidant activity in potato cultivars studied

Cultivar	Dry substance (%)	Starch (%)	Reducing sugars (%)	C Vitamin (mg/100g)	Antioxidant activity DPPH (μ MTE/100g)
Braşovean	19.47 $\pm$ 0.07c	13.71 $\pm$ 0.71c	0.419 $\pm$ 0.03b	13.97 $\pm$ 0.14d	85.39 $\pm$ 0.72d
Carpatin	21.92 $\pm$ 0.36b	12.81 $\pm$ 0.51c	0.339 $\pm$ 0.06c	11.91 $\pm$ 0.26e	64.31 $\pm$ 0.71e
Blue Congo	22.05 $\pm$ 0.22b	16.94 $\pm$ 0.86b	0.521 $\pm$ 0.023a	14.32 $\pm$ 0.18d	162.65 $\pm$ 1.48a
Purple Majesty	23.81 $\pm$ 0.10a	19.66 $\pm$ 1.34a	0.309 $\pm$ 0.006c	15.9 $\pm$ 0.18c	147.71 $\pm$ 2.79b
Montain Rose	23.82 $\pm$ 0.18a	16.99 $\pm$ 0.51b	0.174 $\pm$ 0.006d	18.64 $\pm$ 0.39a	149.66 $\pm$ 1.54b
Crambery Red	16.29 $\pm$ 0.73d	14.25 $\pm$ 0.25c	0.338 $\pm$ 0.01c	17.6 $\pm$ 0.48b	97.07 $\pm$ 0.93c
LSD 0.05%	0.98	2.18	0.061	0.83	4.33

Note: Values represent the mean and SE.

Values in the same column followed by different superscript letters are significantly different at $p < 0.05$

content in dry matter ranged from 13.56 to 24.60 % (Rahman *et al.*, 2016; Jariene *et al.*, 2015), in a study regarding the biochemical composition at colored potatoes reported values from 20.63 at Blue Congo and 26.71 % at Viollete.

Concerning the starch content at the cultivars studied, it ranged from 12.81% to 19.66%. Regarding reductive carbohydrates, there was a variation amplitude between 0.174% for Montain Rose and 0.521% for Blue Congo.

Considerable differences were found in Vitamin C in the cultivars studied. Thus, the potatoes with colored pulp had higher than values in yellow pulp potatoes. The highest content was recorded in the Montain Rose 18.64 mg/100g, with red pulp. The results obtained in this study are consistent with those presented by Silveira *et al.* (2011).

Pigments present in colored potatoes are powerful antioxidants in human diet (Brown, 2005). Anthocyanins content and potato antioxidant activity depending on the maturity, variety, environmental conditions. pulp color. High temperature preparation destroys anthocyanin compounds and significantly lowers potato color (Chellaram *et al.*, 2014).

Regarding the antioxidant activity (DPPH) of potato cultivars. in the present study the highest values were recorded in three of the colored cultivars from 147.71 μ MTE/100g to 162.65 μ MTE/100g. while the indigenous cultivars recorded values much lower than foreign ones, from 64.31 μ MTE/100g at Carpatin to 85.39

μ MTE/100g at Brasovean. So, it's obvious that in the case of colored pulp genotypes. the values significantly outnumber those with yellow or white pulp. Similar results have been reported in a study of six genotypes of colored pulp (red or purple), white or yellow, the antioxidant activity was significantly higher in varieties with purple colored than in white and yellow pulp (Sang *et al.*, 2016). They found that the highest activity to capture ABTS radicals in violet varieties was 121.39 mg/100 g AAE dried samples, while the yellow and white genotypes had the smallest ABTS activities to capture radical of 80.64 and 71.88 mg AAE/100 g, respectively.

Also, in another study of 13 potato cultivars with different pulp color, the high levels of anthocyanic pigments that print high antioxidant activity in colored cultivars were recorded (Pazderu *et al.*, 2015). Chellaram *et al.* (2014), in a study to measure the antioxidant capacity of three violet potato cultivars processed differently, suggests that for the efficient use of purple potato dye they must be kept away from light and heat treatment.

Conclusion

The evaluated potato cultivars are of great interest. given their high content of bioactive compounds and antioxidant activity. Comparing the cultivars studied with regard to the obtained production, it is found that the Brasovean and Carpatin Romanian cultivars recorded the best yields compared to the varieties with colored pulp.

From the nutritional point of view, Cranberry red and Montain Rose cultivars with colored pulp, recorded the highest content in vitamin C (17.6 and respectively 18.64 mg/100g fm) and the highest antioxidant capacity was at Blue Congo (162.65 DPPH μ MTE/100g). These cultivars are recommended in the ecological farming system.

References

1. Addisu S, Chemed, Bultosa G, Dechassa N (2014). Effect of Variety and Storage on the Tuber Quality of Potatoes Cultivated in the Eastern Highlands of Ethiopia. Science. Technology and Arts Research Journal Sci. Technol. Arts Res. J., 3(1): 84-89.
2. Albert IO (2010). Research on organic potato cultivation. Agricultura. IXX. 1. 2: 73-74.
3. Bontempo P, Carafaa V, Grassib R, Basilec A, Tenored GC, Formisanoe C, Riganoe D, Altucci L (2013). Antioxidant, antimicrobial and anti-proliferative activities of *Solanum tuberosum* L. var. Vitelotte. Food Chem Toxicol., 55: 304-12.
4. Brown CR (2005). Antioxidants in Potato. American Journal of Potato Research 82: 163-172.
5. Chellarama C, Parthasarathy V, Praveena MM, Johna AA, Ananda TP, Priyac DK (2014). Analysis of Phenolic Content and Antioxidant Capacity of Potato. *Solanum tuberosum* L from Tamilnadu Region. India. APCBEE Procedia 8: 105-108.
6. Draghici EM, Scarlat V, Pele M, Postamentel M, Somacescu C (2016). Usage of Perlite in Polluted Sandy Soils for Potato Crop. Revista de chimie. vol. 67(11): 2281-2286.
7. Hecht K (2015). Editorial healthy snacks: Recent trends and innovative developments to meet current needs. LWT – Food Science and Technology, 62: 373–375.
8. Hejtmánková K, Piv V, Trnková E, Hamouz K, Lachman J (2009). Quality of Coloured Varieties of Potatoes. Czech J. Food Sci. Vol. 27: 310-313.
9. Hoza G, Enescu BG, Becherescu A (2015). Research regarding the effect of applying herbicides to combat weeds in quickly-potato cultures. Scientific Papers. Series B. Horticulture. Vol. LIX: 219-224.
10. Lange MC, Lemay DG, German JB (2007): A multi-ontology framework to guide agriculture and food towards diet and health. Journal of the Science of Food and Agriculture. 87: 1427-1434.
11. Masarirambi MT, Mandisodza FC, Mashingaidze AB, Bhebhe E (2012). Influence of plant population and seed tuber size on growth and yield components of potato (*Solanum tuberosum*). Int. J. Agric. Biol. 14: 545-549.
12. Rahman MA, Tuhin SR, Chowdhury IF, Haque N, Afroj M, Ahmed S (2016). Biochemical composition of different potato varieties for processing industry in Bangladesh. Agriculture-Science and Practice, 1-2: 81-89.
13. Pazderů K, Hamouz K, Lachman J, Kasal P (2015). Yield potential and antioxidant activity of potatoes with coloured flesh. Plant Soil Environ, 61(9): 417-421.
14. Sang HL, Seung HO, Hwang IG, Hyun YK, Woo KS, Woo KH, Hong SK, Lee J, Heon SJ (2016). Antioxidant Contents and Antioxidant Activities of White and Colored Potatoes (*Solanum tuberosum* L.). Prev. Nutr. Food Sci., 21(2):110-116.
15. Silveira LR, Chiesa VB, Tavares IB, Souza RC, De Silveira MA, Da Alves DC, Junior WP (2011). Physical-chemical characterization and clones of sweet potato of orange pulp in the conditions of PalmasTO. Estudos. 38(2): 365-380.
16. Soare R, Duță A (2011). Tehologii legumicole alternative. Ed. Universitaria, Craiova.
17. Vasanthan T (2001). Overview of laboratory isolation of starch from plant materials. Food Anal Chem. Unit E2.1.1-E2.1.6.