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Analysis of some chemical characteristics of pumpkins of the genus Cucurbita moschata and Cucurbita maxima and their dependence on soil indicators

S. I. Papanov[1*], E. G. Petkova[2], I. G. Ivanov[3]

[1]*Medical University Plovdiv, Department of Pharmacognosy and Pharmaceutical Chemistry, Faculty of Pharmacy, 15A, V. Aprilov Blvd., 4000 Plovdiv, Bulgaria*

[2]*Medical University Plovdiv, Medical College, 120, Br. Bakston Str., 4004 Plovdiv, Bulgaria*

[3]*University of Food Technologies, Technological Faculty, 26, Maritza Blvd., 4002 Plovdiv, Bulgaria*

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The homeland of the pumpkin is Central and South America. There are over 300 species of pumpkins in Bulgaria. The high nutritional and biological qualities combined with the valuable dietary, medicinal and taste properties of pumpkin fruits determine their importance in the nutritional balance. The fruits are rich in mineral salts and vitamins. The highest content is of provitamin A (carotene) - from 6 to 20 mg%. The dietary qualities of the fruit are related to the content of peptonizing enzymes which break down insoluble proteins into soluble peptones. The orange color of the pumpkin is due to the antioxidant beta-carotene. This study presents the relationships between some characteristics of pumpkins and the qualities of the soils on which they were grown. The mineral composition and pH of the soil determine the pH of the studied fruits. There is a directly proportional relationship between the total phenols and the antioxidant activity. A directly proportional relationship between pH and total phenols and antioxidant activity was also found.

Keywords: pumpkins, antioxidant ability, total polyphenols content

INTRODUCTION

The homeland of the pumpkin is Central and South America. As a cultivated plant, pumpkins were grown as early as 1000 BC in Mexico and Peru and successfully in all parts of the world with a warmer climate. They were brought to Europe in the 16th century. Pumpkins are used because their fruits can be stored for a longer time due to their hard skin and can be consumed in winter too. Their fruits and seeds are used for consumption, medicinal purposes, for fodder and decoration [1-4]. There are over 300 species of pumpkins in Bulgaria. In our geographical region, pumpkins have found favorable conditions and are grown today in all areas around the country. The most widely-spread species and those with the biggest economic importance are: Cucurbita maxima Duch. - white pumpkin, large-fruited, chestnut; Cucurbita moschata Duch. - nutmeg pumpkin, violin; Cucurbita pepo L. - plain pumpkin, pork pumpkin [2-5].

The high nutritional and biological qualities combined with the valuable dietary, medicinal and taste properties of pumpkin fruits determine their importance in the nutritional balance. The usable part of the pumpkin comprises up to 85% of the weight. The starch content is high - 2 to 7% of the raw mass. The fruits are rich in mineral salts and vitamins. The highest content is of provitamin A (carotene) - from 6 to 20 mg%.

The dietary qualities of the fruit are related to the content of peptonizing enzymes, which break down insoluble proteins into soluble peptones. The orange color of the pumpkin is due to the antioxidant beta-carotene. It is one of the most important ingredients in pumpkins. In the human body it becomes the vital vitamin A - reduces the risk of developing certain types of cancer, offers protection against heart disease, and improves eyesight [5-7]. In 100 grams of pumpkin there are more than 3 mg of this provitamin, which is approximately one third of the recommended daily amount. Also 100 grams contain 9 mg of vitamin C or about 11% of the recommended daily intake [8]. Pumpkin also contains some of the very rare vitamins found in plant foods - such as vitamin K which is responsible for proper blood clotting. Vitamin D is also found in pumpkins. The most unique one, however, is the little-known vitamin T which helps treat anemia and hemophilia [9].

The vitamins with the highest content in pumpkins are vitamin C, vitamin E and several representatives of the vitamin B group - riboflavin (B2), niacin (B3), pyridoxine (B6) and folic acid (B9). Moreover, an extraordinary trait of pumpkin is its low caloric value, since its flesh, depending on variety, contains merely 15-25 kcal in 100 g, and thanks to the presence of numerous easily digestible

*To whom all correspondence should be sent:
E-mail: stoyan.papanov@abv.bg

nutrients it has become an advantageous component of slimming diets. It regulates metabolism, lowers glucose level in blood, possesses detoxicating, as well as slightly dehydrating properties. Another attributed function of pumpkin species is defense against cancer [23].

The micro elements that are contained in highest doses in pumpkins are potassium, copper, manganese, iron, magnesium and phosphorus. Alongside with their other roles, some of these elements are also cofactors in enzyme complexes with potent antioxidant activity [10].

Due to its low sodium and high potassium content, pumpkin is a good natural diuretic. Pumpkin contains 90 % water and has a diuretic effect. Phosphorus and magnesium improve memory and the nervous system's activity [9].

Pumpkins have significant soil requirements. They grow well on rich, structural, well-aerated soils with high humus content. They do not tolerate compacted cold soils with insufficient water permeability. Doikova *et al*. (1997) have found that soil types and fertilizers influence the yield of different pumpkin types [7]. Pumpkin brings joy to people and it is no coincidence that it has found a place in folk tales and legends. This study presents the relationships between some characteristics of pumpkins and the qualities of the soils on which they were grown.

Material and methods

For the period of time from 09.2019 to 01.2020, pumpkins of the varieties Muscat pearl pumpkin and Tahitian melon squash of the Cucurbita moschata family and Argentina and Danka Polka varieties from the Cucurbita maxima family were examined.

The antioxidant characteristics of pumpkin from different varieties cultivated in Bulgaria were the object of the study. The varieties from Bulgaria were grown in the following order - in the area of the village of Kavrakirovo, (97 m above sea level), Petrich municipality, Blagoevgrad region. All studied pumpkins were raised on alluvial meadow soils. According to the research of Shaban *et al*., the optimal pH for pumpkins cultivation is from 6.5 to 6.8 [11].

The studies were conducted in the Laboratory of the University of Food Technology Plovdiv and the Laboratory of Pharmaceutical Analysis of the Medical University of Plovdiv.

The following research methods were used in the study:

• Systematic approach and critical analysis of the accessible scientific periodicals;

• DPPH method for determination of antioxidant activity (radical detecting activity);

• Spectrophotometric method for determination of absorption and calibration curve in gallic acid.

Determination of pH, titratable acidity and juice extraction. Using a Philips food processor, the pumpkin fruits were liquefied to juice. The latter was then pre-filtered and centrifuged at 3000 rpm for 15 min. With the WTWinoLab pH 7110, Germany pH meter the pH was potentiometrically measured. The titratable acidity was expressed as a percentage of malic acid. It was determined by titrating 10 mL of pumpkin juice with 0.1 M NaOH to a pH value of 8.1. The resultant findings were expressed in g citric acid per 100 g juice.

Total polyphenolics content (TPC). Using a Folin-Ciocalteu assay the measurements of the total phenolic contents were done correctly. Folin-Ciocalteu reagent (Sigma) (1 mL) was mixed with 0.2 mL of sample and 0.8 mL of 7.5% Na_2CO_3. At room temperature for about 20 minutes in darkness the reaction was performed. The absorbance of the sample was measured at 765 nm against a blank sample obtained in the same way without extract. The results were expressed in mg equivalent of gallic acid (GAE) per 100 g juice, according to the calibration curve built in the range of 0.02 - 0.10 mg gallic acid (Sigma) used as a standard.

Antioxidant activity (DPPH assay). A mixture of each analyzed extract (0.15 mL) with 2.85 mL of freshly prepared 0.1 mmol solution of 1,1-diphenyl-2-picrylhydrazyl radical (DPPH, Sigma) in methanol (Merck) was prepared. This was done at 37° C in darkness and the absorption at 517 nm was recorded after 15 min against methanol. The antioxidant activity was expressed as mmol Trolox equivalents (TE) per 100 g juice by using a calibration curve built with 0.05, 0.1, 0.2, 0.3, 0.4 and 0.5 mmol 6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid (Trolox®, Fluka) dissolved in methanol (Sigma).

RESULTS AND DISCUSSION

In the present study, we considered pumpkins of the Muscat pearl pumpkin and Tahitian melon squash varieties of the Cucurbita moschata family and pumpkins of the Argentina and Danka Polka varieties of the Cucurbita maxima family. The pumpkins have been grown in the area of the village of Kavrakirovo, Petrich municipality, Blagoevgrad region. All varieties of the pumpkins have been grown on alluvial-meadow soils. The altitude at which the pumpkins were grown is about 97 meters.

The pH is an important variable indicator of soils, as it affects many chemical processes. It particularly affects the plant's nutrition by controlling the chemical forms of various nutrients and influences the ongoing chemical reactions. The pH of the typical alluvial-meadow soils in the region is in the range from 6.5 to 6.8. With the help of a pH meter (WTWinoLab pH 7110, Germany) we found that the pH of the soils is within the above range. Alluvial-meadow soils are fertile soils that are formed in different climates along large rivers on loose sandy gravel with alluvial deposits. They are spread on I and II floodplain terraces of the country's rivers. They have only one thin surface horizon - darker, up to 10 cm, after which there are only layers that differ in the type of grouping. The optimal soil reaction of the respective soil type is slightly acidic to neutral (pH 6.5 to 6.8) [12-15].

Antioxidants are a group of biochemicals, low-molecular compounds that enter the body through various foods. The main property of these substances is the destruction of free radicals in the body. They connect to the free radicals and stop their harmful effects. It is believed that there are hundreds and probably thousands of substances that can act as antioxidants [12, 14, 16].

Phenols are hydroxyl derivatives of benzene in which the hydroxyl group is directly attached to the aromatic nucleus. Depending on the number of hydroxyl groups, the phenols are monovalent, divalent, trivalent and polyvalent. The more complex phenols may contain more than one phenolic residue in their molecule and are therefore divided into monophenols, diphenols, triphenols and polyphenols [12, 17-19].

An idea of the relationship between the general phenols and the antioxidant activity of the considered pumpkins is given in Table 1. As it can be seen from the table, with the increase in total phenols the antioxidant activity also increases. Total phenols range from 54.00 ± 0.50 mg GAE / 100 g to 117.70 ± 1.40 mg GAE / 100 g. Antioxidant activity ranges from 98.60 ± 5.30 mmol TE / 100 g to 138.20 ± 1.80 mmol TE / 100 g. It is highest in the Danka Polka variety and lowest in the Pearl variety. The established rectilinear relationship between the antioxidant activity and total phenols in this case gives us a reason to determine only one indicator and have information about the other. According to the content of total phenols and antioxidant activity, the considered varieties can be arranged as follows: Danka Polka (highest), Tahitian melon, Argentina and Pearl [20, 21].

Titratable acidity, expressed as a percentage of malic acid, was determined by titrating 10 mL of pumpkin juice with 0.1 M NaOH to a pH value of 8.2. The results were expressed in g malic acid per 100 g juice. The results for the obtained values of the total phenols and the titratable acidity are presented in Figure 1.

Table 1. Relationship between total phenols and antioxidant activity.

Cultivar	Total phenols	Antioxidant activity (DPPH)
Muscat pearl pumpkin	54.00 ± 0.50 mg GAE/ 100 g	98.60 ± 5.30 m mol TE/ 100 g
Tahitian melon squash	60.28 ± 1.60 mg GAE/ 100 g	110.50 ± 3.60 m mol TE/ 100 g
Argentina	55.85 ± 1.20 mg GAE/ 100 g	99.23 ± 1.21 m mol TE/ 100 g
Danka Polka	17.70 ± 1.40 mg GAE/ 100 g	138.20 ± 1.80 m mol TE/ 100 g

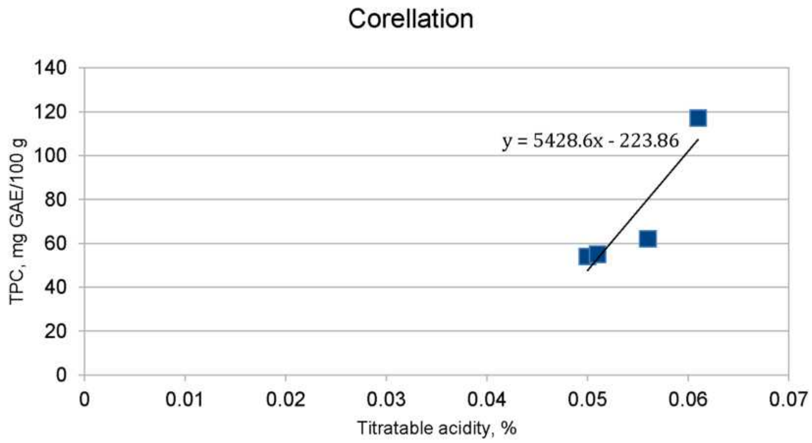

Figure 1. Correlation relationship between total polyphenols content (TPC) and titratable acidity in the investigated pumpkin fruits

The correlation between total polyphenols and titratable acidity is 0.9103. The examined pumpkin cultivars are characterized with the highest quantity of malic acid as compared to other organic acids, especially citric acid. Its content ranged from 2.27 g/kg FW to 4.54 g/kg FW. Changeable dominance of either malic or citric acid in pumpkin fruit was observed, depending on cultivar [22]. The obtained results regarding the indicators pH and titratable acidity are presented in Table 2.

Table 2. Relationship between pH and titratable acidity.

Cultivar	pH	Titratable acidity, %
Muscat pearl pumpkin	6.32	0.056
Tahitian melon squash	6.70	0.061
Argentina	6.48	0.050
Danka Polka	7.20	0.051

The obtained pH values are from 6.32 to 7.20. The highest pH value is in the Danka Polka variety, and the lowest in the Pearl variety. The titratable acidity has approximately the same value for the considered varieties - from 0.05% to 0.06%. The changes in the pH and titratable acidity are in a small range.

We determined the correlation between pH and titratable acidity for the considered fruits. Its value is 0.038677. The correlation between the total phenols and pH is 0.984078.

CONCLUSIONS

The mineral composition and the pH of the soil determine the pH of the studied fruits. There is a directly proportional relationship between the total phenols and the antioxidant activity. A directly proportional relationship between pH and total phenols and antioxidant activity was also found. No proportional relationship was found between total phenols and titratable acidity. The titratable acidity has approximately the same values for the different varieties of the same family.

REFERENCES

1. S. Genchev, Application of growth regulators in vegetable production, Plovdiv, Hr. G. Danov, 1981.
2. P. Gorbanov, *Fertilization of agricultural crops*, 351 (2010).
3. Hr. Daskalov, N. Kolev, T. Murtazov, G. Genkov, Vegetable Production, State Publishing House for Agricultural Literature, 1965.
4. MAFF. Quality control of fresh fruits and vegetables. Plant Growing and Quality Control Directorate for Fresh Fruits and Vegetables, 2002.
5. D. Cholakov, Vegetable production in the tropics and subtropics, Academic Publishing House Plovdiv, 2001.
6. http://www.adf.org.yu/Projects/KI/2-12-08-02.html
7. N. Shaban, S. Bistrichanov, Ts. Moskova, E. Kadum, I. Mitova, M. Tityanov, P. Bumov, Vegetable production, Sofia, 2014.
8. https://www.2befit.bg/bg/
9. https://www.hera.bg/s.php?n=280
10. https://www.puls.bg/khranene-c-21/
11. S. Papanov, Ek. Petkova, I. Ivanov, *Bulg. Chem. Commun.*, **51**(1), 113 (2019).
12. https://sites.google.com/site/laboratoriacentral/za-nas/obsi-fizikohimicni- pokazateli/fenoli
13. M. Xanthopoulou, T. Nomikos, E. Fragopoulou, S. Antonopoulou, *Food Research International*, **42**(5-6), 641 (2009).
14. F. Que, L. Mao, X. Fang, T. Wu, *Food Science and Technology*, **43**, 1195 (2008).
15. H. Wu, J. Zhu, W. Diao, Ch. Wang, *Carbohydrate Polymer.,* **113**, 314 (2014).
16. I. Dini, G. C. Tenore, I. Dini, *LWT - Food Science and Technology*, **53**(1), 382 (2013).
17. Z. Vastag, L. Popovic, S. Popovic, V. Krimer, D. Pericin, *Food Chemistry*, **124**(4), 1316 (2011).
18. E. Nwanna, G. Oboh, *Pak. J. Biol. Sci.*, **10**(16), 2682 (2007).
19. F. Oloyede, G. Agbaje, E. Obuotor, I. Obisesan, Food Chemistry, **135**(2), 460 (2012).
20. M. Kim, Ch. Hong, M. Nam, K. Lee, *Korean Journal of Food Science and Technology*, **43**(2), 195 (2011).
21. L. Chen, G. Huang, *International Journal of Biological Macromolecules*, **118**, Part A, 770 (2018).
22. A. Nawirska, 0. Iszanska, A. Biesiada, A. Sokottepwska, Z. Kucharska, *Food Chemistry*, **148**, 415 (2014).
23. P. Astorg, *Trends in Food Science and Technology*, **8**, 406 (1999).