Scientific Papers. Series B, Horticulture. Vol. LXIV, No. 1, 2020
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

NUTRITIONAL QUALITY CHARACTERISTICS OF TWO PUMPKINS TYPE CULTIVATED IN BULGARIA

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Abstract

Among the plant species of the diverse genus Cucurbita L., C. maxima Duchesne and C. moschata Duchesne have the greatest agro-economic importance. Both species are cultivated for food, feed and ornamentation, widely distributed in the world and known for their high biological and nutritional value. The main aim of this study was to assess two types of pumpkins (C. maxima and C. moschata) in terms of the traits of agronomic importance with the emphasis on basic fruit flesh quality parameters. The following traits of agronomic importance were analyzed: total yield (kg/da), fruit weight (kg), an thesis day and length of main stem; whereas the chemical analyses of fruit flesh included the content of dry weight (%), ash content (%), sugars (mg/g fresh weight), and carotenoids (mg/kg fresh weight) and pH.

Key words*: yield, productivity, nutrition value, carotenoids, pumpkins.*

INTRODUCTION

In recent years, consumer's interest in the health enhancement role of specific foods or physically active food components, so-called nutraceuticals or functional foods, has exploded (Hasler, 1998; Javaherashti et al., 2012).

Pumpkins are gourd squashes of the genus *Cucurbita* and the family *Cucurbitaceae*. The pumpkin species available include *C. pepo*, *C. moschata*, and *C. maxima*. These three species are cultivated worldwide and have high production yields (Kim et al., 2012). They are an increasingly popular vegetable used as a component in various dishes with dietary properties (caloric value 17 g/100 g; sugars 10%, high content of carotenoids and vitamin C).

Pumpkin is one of the vegetables that meet the requirements of healthy nutrition. They are widespread, because they can grow under different climate conditions.

Pumpkin fruit is a rich source of valuable nutrient components, such as carotenoids, potassium, vitamins C, B2, and E, characterizes low energetic content and high amount of fiber (Kunachowicz et al., 1997; USDA, 2006; Biesiada et al., 2011), which allows to produce different foods for adults and infants (as a component of purees, jellies, jams, juices). Moreover, the high percentage of pectin in the pumpkin helps to cleanse the intestine and helps the body to release from the accumulated radionuclides (Slavin, 2013).

Because the nutrient composition of pumpkins will differ depending on their origins and cultivation environments it may be important to know the nutritional profiles of the various pumpkin species (Park et al., 1997; Kim et al., 2012).

For the effective utilization of pumpkin fruit and its parts as a functional food component or medicinal herb, qualitative and quantitative information on the nutritional is essential.

The Bulgarian food composition include several types of pumpkins -mature pumpkin, zucchini squash, summer squash, mainly *C. moschata* and *C. maxima*.

Despite its importance, pumpkin has not gained adequate research attention in Bulgaria to harness its potential.

In Bulgaria, there are separate publications on the use, yield and development of pumpkins. They are dating back to the 70's and 80's of the last century. There is limited current research on the nutritional quality of the varieties grown in Bulgaria.

This study was initiated to generate information on fresh quality of the crop. The main aim of this study was to assess two types of pumpkins (*C. maxima* and *C. moschata)* in terms of the traits of agronomic importance with the emphasis on basic fruit flesh quality parameters.

MATERIALS AND METHODS

The experiment was conducted in the period 2015-2017 years. The selected varieties were representative of two main types of pumpkins: *Cucurbita maxima* - cultivar Plovdivska 48/5 and *Cucurbita moschata* - cultivar Muschatna 51/17. The plants were grown in the Experimental field at the Agricultural University - Plovdiv on technology for field production of pumpkins (Cholakov, 2009). The feeding area for each plant was 2 x 2 m. The sowing of the seeds was performed in May. Each cultivar was grown in 4 replicates x 5 wells. For the optimal development of the plants, during the growing season, the necessary agro technical measures were carried out, according to the applied technology. The harvesting of the fruits was carried out in the botanical maturity, at the end of September.

The following traits of agronomic importance were analyzed: total yield (kg/da), fruit weight (kg), number of fruits per plant, an thesis day and length of main stem; whereas the chemical analyses of fruit flesh included the content of dry weight (%), ash content (%), sugars (mg/g fresh weight), and carotenoids (mg/kg fresh weight) and pH.

The moisture (dry matter) was determined by gravimeter by BSS 7133-81 and refractometer by BSS 17257-91, respectively. pH values was determined by BSS 11688-93. Ash content was determined according to the standard AOAC procedures (AOAC, 2007). The total soluble sugars content was evaluated by the phenol-sulfuric acid method (Dubois et al., 1956). The amount of present carbohydrates was determined from a calibration curve constructed with glucose. The reducing sugars were evaluated by the PAHBAH method (Lever, 1972).

For the carotenoid extraction, 25 mL of acetone was successively added until a paste was obtained. The paste was transferred to a sintered funnel (5 μm) coupled to a 250 mL Buchner flask and filtered under vacuum. This procedure was repeated at least three times until the sample was colorless. The obtained extract was transferred to a 500 mL separatory funnel containing 40 mL of petroleum ether. The acetone was removed through the slow addition of ultrapure water (Milli - Q - Millipore) to prevent the formation of emulsion. The aqueous phase was discarded, and this procedure was repeated four times until no residual solvent remained. The extract was then transferred with a funnel to a 50 mL volumetric flask containing 15 g of anhydrous sodium sulfate. The final volume was adjusted with petroleum ether, and the samples were analyzed at 450 nm (de Carvalho et al., 2012).

RESULTS AND DISCUSSIONS

The two species differ in terms of growth and growing season. Environmental conditions, soil type, nutrient availability and their absorption of plants at different stages of relativity determine their vegetative manifestations and productivity (Table 1).

Table 1. Agronomic traits of two types of pumpkins

Type	Thesis day	Length of main stem, cm	Fruit weight, kg	Yield kg/da
C.maxima	163	542.00	5.152	2546.250
C. moschata	156	355.00	3.732	1865.938

Two species of pumpkins differ in terms of the length of main stem, thesis day, length of main stem, fruit weight and yield. *C. maxima* is distinguished by a longer growing season, larger fruits and higher yield. *C. moschata* ripens 7 days earlier than *C. maxima*. Considering the traits of agronomic importance, the variation among the pumpkin species was observed for thesis day, length of main stem, fruit weight, yield, which is common for complex traits and in accordance to the results of Sultana et al., 2015, Chaudhary et al., 2017a, and Brdar-Jokanović et al., 2019.

The variability of *C. maxima* and *C. moschata* genotypes and their specific responses to different environmental conditions and constraints are well-documented by other authors, e.g. Mladenović et al. (2014), Conti et al. (2015), Bakhtouri et al. (2017), Mishra (2017), Martínez et al. (2018), Brdar-Jokanović et al. (2019). Our results are in line with established trends in previous studies.

The main factors that determine the culinary use of pumpkin fruits is the content and balance of sugars and the content of carotene. By defining these indicators, fruits can be standardized in nutritional and biological value, which are directly related to consumer preferences and expand the range of available fruits on the market.

The presented data showed that soluble dry matter was the highest in *Cucurbita moschata* - cv. Muschatna 51/17 (10.50%) in the comparison with *Cucurbita maxima* - cv. Plovdivska 48/5 (9.25%). The values were statistically significate ($p<0.05$) due to the different variety. The moisture content in the analyzed pumpkin was in the range of 88-89% (on the fresh basis), ash content 0.9% and pH 6.3-7.5 (Table 2).

According to the specificity of the selected variety of pumpkins, technological measurements showed that after weighing, peel and seed separation, the fruit mass for processing for both varieties was over 70%, the seeds were from 6.27% for *Cucurbita maxima* to 9.50% at butternut squash *Cucurbita moschata* (Figure 1). Unusable for culinary purposes part of the fruits of both types of pumpkins (peel) is less than 20%.

Table 2. Physicochemical characterization of pumpkin

Type	Dry matter, %	Moisture content, %	pH	Ash content, %
Cucurbita maxima	9.25	89.08±0.26	7.57	0.93±0.05
Cucurbita moschata	10.50	88.85±0.15	6.73	0.98±0.07

Variation in DM content of pumpkin fruit has also been reported by Paulauskiene et al. (2006) and Zinash et al. (2013), who studied the quality of pumpkin cultivar in relation to their electrochemical and antioxidant properties. The difference could be due to variation in starch content of the genotype of the pumpkin fruit; with high DM content there is high content of starch (Hazzard, 2006).

These results to be close to the pH values of pumpkin reported by Paulauskiene et al. (2006) and Zinash et al. (2013) varying between 5.87 to 6.99. In addition, Zinash et al. (2013) noted that there is a tremendous variation among pumpkin genotypes for pH and titratable acids.

Pumpkin fruit is composed of pulp and seeds. Pumpkin pulp contains polysaccharides, pigments, amino acids, active proteins, and minerals. Pumpkin seeds are high in lipids and proteins, and they are a good source of many elements such as potassium, phosphorus and magnesium (Zhou et al., 2007)

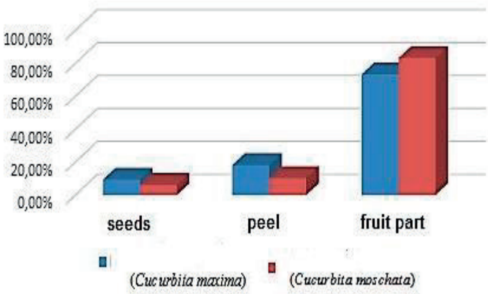

Figure 1. Technological characterization for *Cucurbita maxima* and *Cucurbita moschata*

The results for total soluble sugars in pumpkins varied from 5,8 to 4,9 % on fresh matter basis. *Cucurbita maxima* cultivar Plovdivska 48/5 as evaluated as the rich source of sugars (5.8%), especially sucrose (5.12%). The result of this study agrees with the findings of Sudhakar et al. (2003) who reported that sugar content of pumpkin fruit varied from cultivar to cultivar. Cantwell and Suslow (1998) also reported variations in total sugar contents among 36 varieties of pumpkin and indicated that sugar is the major component of total soluble solids and it determines the flavor and sensory quality of pumpkin fruit.

Terazawa et al. (2001) reported that, oligosaccharides, monosaccharides and sucrose were the principal soluble sugars accumulated by the fruit. The content of total sugars in C.maxima is higher than C. moschata by approximately 1%. The same variety is with a higher content of sucrose and fructose. The data for the carbohydrate composition in the raw pumpkin (Figures 2 and 3) showed that all these samples were source of sucrose

(Seroczynska et al. 2014). Fructooligosacchides were not detected in all investigated pumpkins, which was in accordance to Malinovska et al. (2014).

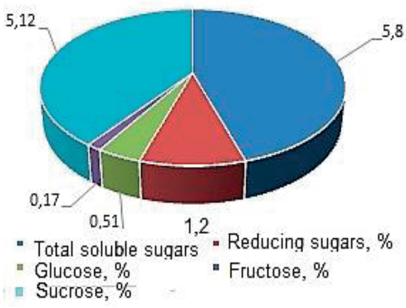

Figure 2. Sugars content in *Cucurbita maxima*

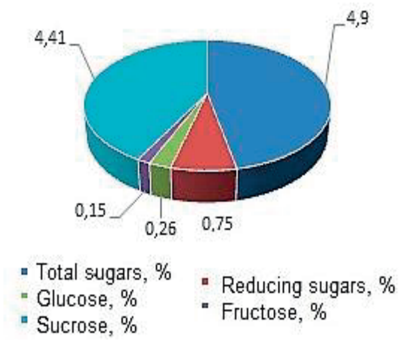

Figure 3. Sugars content in *Cucurbita moschata*

C. moschata demonstrated higher levels of carotenoids (254 µg/g fresh weight), compared with *C. maxima* - 135 µg/g fresh weight (Figure 4).

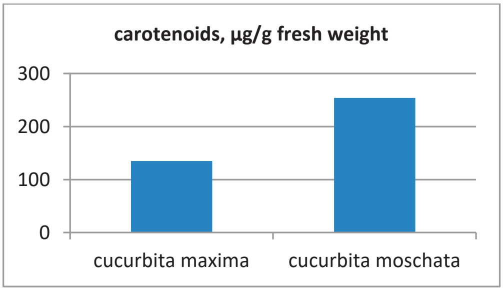

Figure 4. Carotenoids content in *C. maxima* and *C. moschata*

The high carotenoid content is one of the reasons why pumpkin is such a nutritionally valuable fruit (Dinu et al., 2016; El Khatib and Muhieddine, 2019). Carotenoids are considered a major source of vitamin A which is necessary for embryonic development, growth, and normal eyesight. Pumpkin is an excellent source of pro-vitamin A carotenoids (Zhou et al., 2007; El Khatib and Muhieddine, 2019).
Major qualitative and quantitative differences in carotenoids can be noted in relation to cultivar, environmental conditions (temperature, nutrient availability, intensity of sunlight, ripening stage, harvest time), and genetic factors. Different factors may be responsible for the different concentrations detected. It is well known that the climate has a significant influence on the content of carotenoids in vegetables. Fruits of the same cultivars produced in different regions exhibit higher or lower carotenoid concentrations in relation to warmer or more temperate climates. Bergantin et al. (2018) suggest that it is probably associated with an increase in carotenogenesis, when fruits are more exposed to sunlight, even if it may cause photodegradation. Based on the results of our study, we suppose that the difference in carotene content is a species and variety characteristic. The reason for this hypothesis is that both varieties are grown under the same climatic conditions and soils.

CONCLUSIONS

Vegetative manifestations and productivity of two species differ in terms of growth and growing season. Environmental conditions, soil type, nutrient availability and their absorption of plants at different stages of relativity determine their differences.
Cucurbita maxima is rich source of sugars, especially sucrose, compared with *Cucurbita moschata*, but contains less carotenoids.
The results of the economic productivity of the plants give us reason to believe that they may be recommended for cultivation in order to enrich the assortment of pumpkins. In addition, further research on the optimization of agro-technical procedures for the production of this type of pumpkins is required in order to maximize their potential for yield and quality.
The complex characteristics of fruits make them suitable not only for the fresh market but also for processing.

ACKNOWLEDGEMENTS

This research work was carried out with the support of Agricultural University - Plovdiv, Bulgaria and also was financed from Research centre of Agricultural University - Plovdiv, Project 15/15: "Enriching the variety of vegetable crops through agro biological and ecological evaluation of new genotypes and samples".

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