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Comparative evaluation of physico-chemical attributes of different portions of *C. moschata* and *C. maxima* species of pumpkin

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Abstract

Present study was conducted to evaluate the various physico-chemical attributes of different portion of ripe pumpkin. Ripe pumpkin comes under the category of underutilized fruits and is cultivated all over the World. Ripe pumpkin also called as *lal kaddu* in India is considered as good source of phytochemicals such as carotenoids, vitamins and minerals. For analysis of quality attributes of different portions (flesh, brains/fluffy portion and peel) of ripe fruits, two species of pumpkin viz. *C. moschata* Duchesne ex Poiret and *C. maxima* Duchesne were selected. Among different species of pumpkin, highest ascorbic acid and titratable acidity were found in flesh portion of *C. maxima* and minimum titratable acidity, ascorbic acid and beta carotene were obtained in peel portion of *C. moschata*. Brains/fluffy portion of *C. maxima* species was found with highest amount of beta carotene and total fiber among all portions of both the species. However, peel portion of *C. maxima* showed highest values for total soluble solids, total phenols and fiber among all portions of both species of ripe pumpkin. Thus, ripe pumpkin of *C. maxima* species was found with better quality attributes in comparison of *C. moschata*.

Keywords: Ripe pumpkin, *C. moschata*, *C. maxima*, quality attributes, different portions

Introduction

Pumpkin belongs to the family Cucurbitaceae and genus Cucurbita. Pumpkin plants are hardy creepers or soil surface runners, but also able to climb and can be grown under wide climatic conditions. Pumpkins are cultivated for their ripe fruits as well as the seeds in the central cavity and the yellow or orange flesh. The genus Cucurbita, indigenous to the western hemisphere, is comprised of five domesticated species viz., *Cucurbita moschata*, *C. maxima*, *C. pepo*, *C. ficifolia*, and *C. turbaniformis*. Among these, *Cucurbita moschata* Duchesne ex Poiret, *C. maxima* Duchesne ('winter squash') and *C. pepo* L. (squash) are the worldwide commonly grown species of pumpkin (Lee *et al.*, 2003) [21]. *C. moschata* and *C. maxima* are the most frequently consumed species of pumpkin in countries like India, Pakistan, Bangladesh etc., whereas, *C. pepo* is consumed up to lesser content in comparison to the other two species in these countries. Quality of ripe pumpkin's species depends on several factors such as type of genotype and growing conditions. Pumpkin is an annual crop originating from Mexico and South America and its cultivation was started around five thousand years ago (Bates *et al.*, 1990 [7] and Bisognin, 2002) [10]. In India, the main season of growing cucurbits is summer and rainy in most parts of the country (Seshadri, 1989) [30]. The world production of pumpkin is estimated to be 15.6 million metric tonnes (Anonymous, 2013a). While India produces 49,00,000 tonnes of pumpkin, squash and gourd from an area of 5,10,000 hectares (Anonymous, 2013b).

The fruits of pumpkin are large, variable in shape (round or oblong), covered with small raised spots weighing 2-10 kg, sometimes even upto 20 kg (Seshadri, 1989) [30]. The edible portion in pumpkin has been recorded to be 77.5% (Pawar *et al.*, 1985) [26] and 76.66% (Dhiman *et al.*, 2007) [13]. Thus, almost 22.50-23.45% of pumpkin comes under waste portion. Pumpkin fruit is considered as good source of proteins, sugars, beta carotene, polyunsaturated fatty acids, phytosterols and vitamins such as vitamin C and E (Jun *et al.*, 2006 [18] and Kumari, 2013) [20]. The colour of flesh of pumpkin varied from pale yellow to crimson which is due to the presence of carotenoids mainly beta carotene (Murkovic *et al.*, 2002 [23]; Bhaskarachary *et al.*, 2008 [8] and Norshazila *et al.*, 2014) [25].

Pumpkin is also considered as medicinal plant as it has various nutraceutical properties such as antibacterial and antihypertensive (Fu *et al.*, 2006), ^[16] antioxidant activity (Dutta *et al.*, 2006 ^[15] and Attarde *et al.*, 2010) ^[3], anticarcinogenic and antidiabetic (Saha *et al.*, 2011) ^[29]. Phyto-chemicals found in pumpkin also have a potential role in human health by protecting cells and tissues from the damaging effects of free radicals and singlet oxygen (Azizah *et al.*, 2009) ^[4]. Beta carotene found in pumpkin is one of the major plant carotenoids which converted into vitamin A in the body and perform many functions in overall health (Albuquerque *et al.*, 2003) ^[1]. Thus, ripe pumpkin can play an important role to improve nutritional status of weaker sections of developing countries in respect of vitamin A. Traditionally; flesh of pumpkin is utilized to cure intestinal infections and stomach disorders. Now a days, scientists have collaborated with nutrition researchers to develop plant based functional foods. Underutilized crop as well as food waste utilization is an another important approach in nutraceutical and food industries. Thus, it is important to know quality attributes of mostly consumed species of ripe pumpkin i.e. *C. moschata* and *C. maxima* for efficient utilization of this fruit. The quality of these species of pumpkin can be evaluated by using physical and chemical methods. Thus, present studies were conducted to study physico-chemical characteristics of various portions (flesh, brains/fluffy portion & peel) of two different species (*C. moschata* & *C. maxima*) of ripe pumpkin.

Materials and Methods

The present investigation was carried out to study the physico-chemical attributes of different portions of ripe pumpkin species viz. *C. moschata* Duchesne ex Poiret and *C. maxima* Duchesne. Ripe pumpkin fruits of *C. moschata* and *C. maxima* were procured from local market of district Solan of HP India and brought to the laboratory of FPR in the department of Food Science and Technology, Dr YS Parmar UHF, Nauni, Solan for conducting the studies. Fruits after thorough washing in water were used for separation of different portions such as flesh, brains/fluffy portion and peel. Flesh, brains/fluffy portion and peel were marked as P₁, P₂ and P₃, respectively. *C. moschata* was represented as SP₁ and *C. maxima* was denoted by SP₂. For the estimation of various physico-chemical characteristics of flesh, brains/fluffy portion and peel of *C. moschata* and *C. maxima*, standardized methods and instruments were used. All samples of ripe pumpkin, in the studies were analyzed in triplicate replication to avoid experimental error.

Physical Attributes

The weight of fruits was taken on a top pan balance. The average weight of the fruits was calculated and expressed as gram (g). Thread and scale were used for the measurement of length and width of the randomly selected fruits and expressed as cm. Fruit firmness was measured with an Effigi penetrometer (model FT 327), which recorded the pressure required to force a plunger of 11 mm diameter into pared flesh of fruit samples. The results were expressed in lbs/inch². The color of different portions of *C. moschata* and *C. maxima* were observed visually by comparing with color cards of Royal Horticulture Society, London. In order to obtain recovery of different portions, fruits were peeled and cut into slices. Flesh, brains/fibrous strands and peel of *C. moschata* and *C. maxima* were weighed separately on a top pan balance. Recovery was calculated by subtracting the weight of

respective portion from whole fruit and % recovery was calculated accordingly.

Chemical Attributes

The moisture and total solids of different portions were determined by drying the weighed samples to a constant weight in a hot air oven at 70±1 °C and expressed in per cent (%) as described in Ranganna (2009) ^[28]. Total soluble solids (TSS) of different portions were measured with hand refractometer. For this sample was crushed in pestle mortar to extract juice. TSS was recorded by placing 1-2 drops of the extract on prism of hand refractometer and expressed in degree brix (°B). Ascorbic acid content was determined as AOAC (2004) ^[2] method using 2, 6-dichlorophenol-indophenol dye and expressed in mg/100g of sample. The titratable acidity was expressed as % citric acid (AOAC 2004) ^[2] and estimated by using phenolphthalein as an indicator to give pink colour (end point). The pH was determined by using a digital pH meter (CRISON Instrument, Ltd, Spain). Before estimation of pH of sample, pH meter was calibrated with standard buffers of 4, 7 and 9. Beta carotene content was determined (Ranganna, 2009) ^[28] by using a UV-V spectrophotometer (Model Shimadzu, Japan) and its absorbance was taken at 452 nm. Total fiber content was estimated by method given by Gould (1978) ^[17]. Total phenols of samples were determined by the Folic-Ciocalteu procedure (Ranganna, 2009) ^[28] and total ash content was determined gravimetrically by AOAC (2004) ^[2] official method 942.05.

Result and Discussion

Physical Characteristics

The results obtained for physical characteristics of two different species of ripe pumpkin viz. *C. moschata* and *C. maxima* are presented in Table 1. An appraisal of data revealed that an average weight of 3460±130 g was recorded for the fruits of *C. moschata* while 3250±110 g for *C. maxima*. The mean length and diameter of 35.50±0.55 and 23.00 0.05 cm was observed for *C. moschata*, respectively, whereas, the corresponding values for *C. maxima* were 32.36±0.45 and 21.05±0.05 cm. It is clear from the results that comparatively higher values for weight, length and diameter were noticed in *C. moschata* than *C. maxima*. These findings are almost in line with the results recorded by Dhiman *et al.* (2007) ^[13], Noelia *et al.* (2011) and Kumari (2013) ^[20] for *C. moschata*. The average firmness reading recorded in *C. moschata* was 20.80±0.25 lbs/inch² while that of *C. maxima* was 18.50±0.20 lbs/inch² which is near to the values noticed by Dhiman *et al.* (2007) ^[13] and Kumari (2013) ^[20] for *C. moschata*. The different portions of *C. moschata* and *C. maxima* were examined for visual colour by using Royal Horticulture Cards, London. The flesh of *C. moschata* matched yellow orange group 23 (A) while that of *C. maxima* orange group 24 (A). The brains of *C. moschata* and *C. maxima* came under orange group 28 (B) and 28 (A), respectively. The peel of the fruits matched grayed orange group 166 (C) and 167 (B), respectively for *C. moschata* and *C. maxima*. The data indicated higher colour intensity for brains followed by flesh and peel irrespective of the species. Badesha (2017) ^[6] has recorded visual colour of pale yellow for peel and yellow to orange for flesh of *C. moschata*. The recovery of flesh, brains/fluffy portion and peel was found to be 79.00±3.60, 10.00±2.00, 7.00±1.90 per cent for *C. moschata* and 83.00±4.10%, 11.50±1.72, 6.00±2.00 per cent for *C. maxima*, respectively (Table 1). Almost similar results

have been given by Pritika (2015) [27] for *C. moschata*. The data clearly reflected that fruits of *C. maxima* gave higher

recovery of flesh and brains, whereas, the peel recovery was more in *C. moschata*.

Table 1: Physical characteristics of ripe pumpkin

Characteristics	Species	
	<i>C. moschata</i> (Mean ± SE)	<i>C. maxima</i> (Mean ± SE)
Weight (g)	3460±130	3250±110
Length (cm)	35.50±0.55	32.36±0.45
Diameter (cm)	23.00±0.05	21.05±0.05
Firmness (lbs/inch ²)	20.80±0.25	18.50±0.20
Colour (card number of Royal Horticulture Society, London)		
Flesh (P ₁)	Yellow orange group 23 (A)	Orange group 24 (A)
Brains (P ₂)	Orange group 28 (B)	Orange group 28 (A)
Peel (P ₃)	Grayed orange group 166 (C)	Grayed orange group 167 (B)
Per cent recovery (%)		
Flesh (P ₁)	79.00±3.60	83.00±4.10
Brains (P ₂)	10.00±2.00	11.50±1.72
Peel (P ₃)	7.00±1.90	6.00±2.00

Chemical Characteristics

Table 2 highlights the chemical attributes of different portions viz. flesh (P₁), brains (P₂) and peel (P₃) of *C. moschata* and *C. maxima* species of ripe pumpkin. On an average, the moisture content in flesh, brains and peel of *C. moschata* was found to be 87.17±1.62, 89.70±1.70, 83.30±1.55 while the respective values in *C. maxima* were 84.00±1.59, 86.50±1.60 and 80.40±1.20 per cent. All the portions of *C. moschata* had higher moisture content in comparison to *C. maxima*. Among different portions, maximum moisture content was seen in brains followed by flesh and peel irrespective of the specie. Total solids of 12.83±0.50 and 16.00±0.67 in flesh, 10.30±0.39 and 13.50±0.63 in brains, 16.70±0.71 and 19.60±0.73 in peel were seen in *C. moschata* and *C. maxima*, respectively. Results regarding moisture and total solids in flesh were near to the values recorded by Pritika (2015) [27] for *C. moschata*, Kim *et al.* (2012) for *C. moschata* and *C. maxima* but higher than the results of Usha *et al.* (2010) [30], Bhat and Bhat (2013) [9] and Kumari (2013) [20] in *C. moschata*. The present findings of moisture and total solids in peel of *C. moschata* and *C. maxima* are supported by the results recorded by Kim *et al.* (2012) [19]. The TSS in flesh, brains and peel of *C. moschata* was reported to be 10.50±0.40, 11.00±0.45 and 13.00±0.53 °B, respectively while the corresponding value in *C. maxima* was 12.70±0.51, 12.00±0.30 and 14.80±0.67 °B. Titratable acidity of 0.061±0.002, 0.064±0.003, 0.020±0.001 per cent and 0.067±0.004, 0.068±0.003, 0.025±0.001 per cent was recorded in flesh, brains and peel of *C. moschata* and *C. maxima*, respectively. The present findings are in accordance with the values reported by Dhiman *et al.* (2009) [14], Pritika (2015) [27], Badesha (2017) [6] but higher than the values observed by Kumari (2013) [20] in flesh of *C. moschata*. The data (Table 2) showed that the pH of flesh, brains and peel was 7.16±0.21, 6.89±0.18, 7.27±0.16 respectively, for *C. moschata*, whereas, *C. maxima* showed the corresponding values to be 6.95±0.15, 6.70±0.15 and 7.11±0.12. Flesh, brains and peel of *C. moschata* and *C. maxima* were found to possess ascorbic acid of 10.50±0.14, 8.35±0.10, 5.00±0.07 mg/100 g and 14.20±0.16, 11.40±0.12, 7.05±0.08 mg/100 g, respectively. Ascorbic acid found in flesh is in compliance with the values observed by Danilchenko *et al.* (2000), Pritika (2015) and Badesha (2017) [6]; lower than the reports of Kumari (2013) while higher than the findings of Muralidhara *et al.* (2014) [22] for flesh of *C. moschata*. The analysis of ripe pumpkin showed that flesh, brains and peel of *C. moschata* had 12.10±0.16, 16.75±0.20 and 4.95±0.05 mg/100g of β-

carotene, whereas, 15.97±0.18, 21.10±0.21 and 5.75±0.06 mg/100g, respectively were recorded in *C. maxima*. The highest β-content was seen in brains followed by flesh and peel in both the species. While comparing the β-carotene and ascorbic acid content in *C. moschata* and *C. maxima*, it was noticed that *C. maxima* contained higher amount for these parameters. Almost similar values were observed by Kim *et al.* (2012) [19] for β-carotene of flesh in *C. moschata* and *C. maxima*. Further, the values for β-carotene content in peel of both the species found to be quite lower than the results of Kim *et al.* (2012) [19]. The ascorbic acid in flesh was in accordance with the observations of Babu (2015) [5] and Pritika (2015) [27] for *C. moschata*. A perusal of data showed that flesh, brains and peel of *C. moschata* and *C. maxima* had total phenols of 0.50±0.02, 0.52±0.03, 0.88±0.04 mg/g and 0.51±0.01, 0.54±0.04, 0.90±0.05 mg/g, respectively. Maximum amount of phenols was recorded to be in peel followed by brains and flesh of both the species. The data observed very less difference is noticed in respect of total phenols of flesh and brains of both the species of pumpkin. But the peel of *C. moschata* recorded significantly higher phenolics in comparison of *C. maxima*. The values of phenols for flesh of *C. moschata* were found to be higher than that recorded by Pritika (2015) [27]. The flesh, brains and peel of *C. moschata* possessed fiber content of 0.75±0.04, 0.80±0.05 and 1.34±0.12 per cent, whereas, in *C. maxima* the values analyzed were 0.90±0.07, 0.94±0.07 and 1.08±0.10 per cent, respectively. The present data reflected the higher content of fiber in peel as compared to the brains and flesh of both the species. The peel of *C. moschata* recorded higher value for fiber in comparison to *C. maxima*. On the other hand, the flesh and brains of *C. maxima* showed slightly higher value for the same parameter. The results are in conformity with the values for fiber recorded by Kim *et al.* (2012) [19] in flesh and peel of *C. moschata* and *C. maxima*. The ash content in flesh, brains and peel of *C. moschata* and *C. maxima* was reported to be 1.05±0.10, 1.03±0.12, 1.37±0.17 per cent and 1.07±0.13, 1.05±0.12 and 1.20±0.14 per cent, respectively. Maximum ash content was noticed in peel followed by flesh and brains of *C. moschata* as well as *C. maxima*. Among both species, flesh and brains of *C. moschata* had slightly more ash content than *C. maxima* while peel of *C. moschata* had significantly higher ash content than *C. maxima*. However, no literature is available regarding quality attributes of brains of ripe pumpkin, but the results noticed by Kim *et al.* (2012) [19] for flesh and peel of *C. moschata* and *C. maxima* support the findings of present investigation.

Table 2: Chemical characteristics of ripe pumpkin

Characteristics	<i>C. moschata</i> (SP ₁) Mean ± SE			<i>C. maxima</i> (SP ₂) Mean ± SE		
	Flesh (P ₁)	Brains (P ₂)	Peel (P ₃)	Flesh (P ₁)	Brains (P ₂)	Peel (P ₃)
Moisture (%)	87.17±1.62	89.70±1.70	83.30±1.55	84.00±1.59	86.50±1.60	80.40±1.20
Total Solids (%)	12.83±0.50	10.30±0.39	16.70±0.71	16.00±0.67	13.50±0.63	19.60±0.73
TSS (°B)	10.50±0.40	11.00±0.45	13.00±0.53	12.70±0.51	12.00±0.30	14.80±0.67
Titrateable acidity (%)	0.061±0.002	0.064±0.003	0.020±0.001	0.067±0.004	0.068±0.003	0.025±0.001
pH	7.16±0.21	6.89±0.18	7.27±0.16	6.95±0.15	6.70±0.15	7.11±0.12
Ascorbic acid (mg/100g)	10.50±0.14	8.35±0.10	5.00±0.07	14.20±0.16	11.40±0.12	7.05±0.08
β-carotene (mg/100g)	12.10±0.16	16.75±0.20	4.95±0.05	15.97±0.18	21.10±0.21	5.75±0.06
Total phenols (mg/g)	0.50±0.02	0.52±0.03	0.88±0.04	0.51±0.01	0.54±0.04	0.90±0.05
Fiber (%)	0.75±0.04	0.80±0.05	1.34±0.12	0.90±0.07	0.94±0.07	1.08±0.10
Ash (%)	1.05±0.10	1.03±0.12	1.37±0.17	1.07±0.13	1.05±0.12	1.20±0.14

Conclusion

It was concluded from the results that the ripe pumpkin fruit (*lal kaddu*) is a rich source of beta carotene, vitamin C and other total soluble solids. Among two different species of ripe pumpkin, *C. maxima* species contained better quality (ascorbic acid, TSS, beta carotene, titrateable acidity, & total phenols) attributes in comparison to *C. moschata*. Among different portions of ripe pumpkin fruits, brains/fluffy portion were found with highest amount of beta carotene and whereas, flesh/pulp was found with more ascorbic acid (vitamin C) and titrateable acidity. However, maximum Total Soluble Solids (TSS), total phenols and fiber were obtained in peel portion irrespective of the species used.

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