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A study on physical and chemical properties of pumpkin (*Cucurbita moschata*)

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Abstract
A study was conducted to examine the physical and chemical properties of pumpkin. The analysis focused on fresh and ripe pumpkins to assess their physical and chemical composition. The findings revealed that pumpkins exhibited a yellow to golden yellow color, indicating a significant presence of β-carotene at 11.23 mg/100g, making them a rich source of antioxidants. Additionally, the study analyzed the chemical composition, revealing a moisture content of 6.10%, carbohydrate content of 5.46%, protein content of 0.95%, and fat content of 0.21%. Furthermore, the study measured the acidity of the pumpkin at 0.008% and the pH value at 4.57. These results provide valuable insights into the chemical properties of pumpkin, highlighting its nutritional composition.

Keywords: Physical properties, pumpkin, chemical composition

Introduction
Pumpkin belongs to the family Cucurbitaceae and is a widely grown vegetable all over the world. Based on the colour of the seeds, the origin of pumpkin has been attributed to Guetmala, Central Mexico or Columbia. The name pumpkin originated from a Greek word *Pepon* which means large melon. French converted the *Pepon* to *Pompon* and English adapted the word *Pompion*. In the stages of development, the American colonists replaced the ion with kin giving rise to pumpkin (Anon 2008c). Pumpkin is composed of *Cucurbita moschata, Cucurbita pepo, Cucurbita maxima, Cucúrbita mixta, Cucurbita facifola and Telfairia occidentalis* (Caili *et al*. 2006) [4]. *Cucurbita pepo, Cucurbita maxima* and *Cucurbita moschata* are the worldwide commonly grown species of pumpkin (Lee *et al*. 2003) [10]. These represent economically important species and have high production (Caili *et al*. 2006) [4] while fluted pumpkin (*Telfairia occidentalis*) which is a tropical vine is a delicacy in parts of West Africa particularly in South Nigeria and also widely grown in Ghana and Sierra Leone particularly for its tender leaves, stem and seeds. In Nigeria, fluted pumpkin is primarily grown as leafy vegetable and is used for human consumption. Large number of pumpkin varieties varying in shape, size and colour of flesh are available. The miniature pumpkins are *C. pepo* (var. 'Jack-OLantern') and the giant type (var. 'Boston Marrow' and 'Mammoth') tend to be C. maxima varieties. Buff coloured 'Sugar Pie' or 'Dickinson' and 'Kentucky' varieties; 'Buckskin' and 'Chelsey' hybrids of *C. moschata* are excellent vegetables for processing. *C. moschata* is a leading crop cultivated since pre-historic time and currently most common variety of pumpkin in Asia and the United States of America. *C. moschata* is grown in almost all the regions of India (Nath *et al*., 1979) [12] while *C. maxima* mostly grown in the hills and subtropical regions. The main growing season is summer and rainy seasons in most parts of India. Winter pumpkins are also grown in some parts of Southern and Western India (Seshadri 1989) [17]. The aim of this article is to summarize the physicochemical, nutritional components and function of *Cucurbita moschata* as a whole to help people better understand the variety of *Cucurbita moschata*, and to build a basic foundation that can aid future experimental research.

Materials and Methods
Freshly harvested Pumpkin vegetables of cultivar were procured from Lovely Professional University, Phagwara. Different equipments required for physio-chemical analysis characterization such as Digital pH meter, digital refractometer, Hot air oven etc. were made available from the Department lab store of Food Technology and Nutrition of Lovely Professional University, Phagwara. Pumpkin vegetables were analyzed for various quality attributes including physical attributes and proximate chemical composition.

Physio-chemical qualities will be estimated using recommended standard of Association of Official Analytical Chemists (AOAC) methods (2000) as mentioned below:

Physical properties
The fresh pumpkin vegetable was analysed for different physical characteristics like vegetable shape, breadth, length, weight, edible portion, pulp weight, seed weight, pulp percentage, seed percentage and juice percentage etc.

Colour and Shape
Colour and Shape of the vegetables were recorded by visual observation.

Length and Breadth
The length and breadth of the randomly selected fresh vegetables were measured using Vernier Calliper and average length and breadth were expressed in terms of centimeters.

Weight
Fresh pumpkin vegetables of Chakaiya variety were weighed on electronic weighinng balance. Average weight of ten fresh vegetables were calculated and expressed in grams.

Chemical analysis
Chemical constituents like TSS, pH, moisture content, ascorbic acid content, reducing sugar, non-reducing sugar, total sugar, crude fiber, fat, TPC, TFC and antioxidants of fresh pumpkin vegetable and pumpkin ~~candy~~ were determined.

Total soluble solids (T.S.S.)
The vegetable pulp/product was uniformly mashed with a mortar and pestle. A drop of mashed pulp was placed on the prism of Digital refractometer and total soluble solids was recorded as °Brix.

pH: The pH was determined by using a digital pH meter after standardizing it with buffers of pH 4.0 and 9.0.

Titratable acidity
Measurement of titratable acidity was carried out by using the method given by (AOAC, 2000). 10g of sample was macerated and homogenized in a pestle and mortar with little amount of distilled water and transferred to a 100 ml volumetric flask and volume was made. The sample was filtered and 10ml of aliquot was titrated against standard 0.1 N NaOH using 1 percent phenolphthalein indicator till faint pink colour persists for 15 seconds. The percent titratable acidity was expressed in terms of anhydrous citric acid by using following formula.

$$\text{Acidity (\%)} = \frac{\text{Titre value x N of alkali x Eq.wt.of acid x volume made up}}{\text{weight of sample x aliquote taken for estimation x 1000}} \text{ x } 100$$

(As citric acid content)

Estimation of moisture content
2 g of sample subjected to oven drying at 105^0C for 4-5 hours. It was again weighed after cooling and repeated until a constant weight was obtained. The resultant loss in weight was calculated as moisture content (AOAC, 2000).

$$\% \text{ Moisture} = \frac{\text{loss in weight of sample after drying}}{\text{Weight of sample taken}} \times 100$$

Estimation of Crude Fibre
About 3 to 5 g of moisture and fat free samples were weighted into 500 ml beaker and 200 ml boiling 0.25N (1.25 W/V) H_2SO_4 was added. The mix was boiled for 30 minutes keeping the volume constant by addition of water at frequent intervals. At the end of this period, the mixture was filtered through a filter paper and the residue washed with hot water till free from acid. The material then transferred to the same beaker and 200 ml of boiling 0.313N NaOH solution added. After boiling for 30 minute, the mix residue was washed with hot water till free from alkali followed with same alcohol. It was then transferred to a crucible, dried over night at 80- 100^0C for 2-3 hours. Then cooled and weighted again. The difference in the weights represented the weight of crude fibre (AOAC 2000).

Estimation of Total Sugars
The estimation was earned out by taking 50 ml clear filtrate in 100 ml beaker. To this 5 ml of concentrated HCl was added and kept in hot water bath for half an hour for hydrolysis. After hydrolysis, excess HCl was neutralized with sodium carbonate. The mixture was transferred to 250 ml volumetric flask and the volume was made up to the mark. It was then titrated with 5 ml each of Fehling A and Fehling B using methylene blue as an indicator and the total sugars percentage was calculated (AOAC, 2000).

Estimation of Reducing Sugar
The reducing sugar in the sample was estimated by the volumetric method of Lane and Eynon reported by AOAC (2000). Freshly prepared 25 g of sample was taken in 250 ml volumetric flask. To it, 10 ml of lead acetate (2 percent) was added for clarification. The excess of lead acetate was precipitated with potassium oxalate solution and the volume was made to 250 ml with distilled water. The mixture was stirred well and allowed to stand for some time and then filtered. The clear filtrate was titrated with 5 ml each of Fehling A and Fehling B solutions to brick red precipitation using methylene blue as an indicator and the sugars calculated were presented on percent basis.

Estimation of Non-reducing sugars
The amount of non-reducing sugar of the product was obtained by subtracting reducing sugar from total sugars.

Ascorbic acid (vitamin C) content
Ascorbic acid content was determined by titration of a known weight of sample with 2, 6-dichlorophenol indophenol dye using oxalic acid (AOAC, 2000). The 2, 6-dichlorophenol dye which is blue in alkaline solution and red in acid solution reduces ascorbic acid to a colourless form. Ascorbic acid was expressed as mg/100g by using given formula.

Dye Factor = 0.5/ Titre

$$\text{Ascorbic acid(mg/100g)} = \frac{\text{Titre x Dye factor x Volume made up x 100}}{\text{Aliquot of extract taken for estimation x Wt. or volume of sample taken for estimation}}$$

Antioxidant activity (by DPPH scavenging method)

Antioxidant activity (free radical scavenging activity) was measured as per the method of Brand-Williams *et al*. (1995), DPPH (2, 2-diphenyl-1-picrylhydrazyl) was used as a source of free radical. A quantity of 3.9 ml of 6x10 mol/L DPPH in methanol was put into a cuvette with 0.1 ml of sample extract and the absorbance was measured at 515 nm after 30 minutes. Methanol was used as blank. Antioxidant activity was calculated using the following equation.

$$\text{Antioxidant activity (\%)} = \frac{\text{Absobance of blank} - \text{Absorbance of sample}}{\text{Absorbance of sample}} \times 100$$

Total phenol content

Total phenols were estimated by Folin-Ciocalteu procedure given by (AOAC, 2000) in which absorbance was measured at 765 nm in a colorimeter against water blank. One gram of sample was taken and ground with 10 ml of 80 percent ethanol in pestle and mortar and centrifuged for 20 minutes at 10000 rpm and filtered. The filtrate was evaporated in an oven up to the dryness and dried extract was dissolved in 5 ml distilled water. 2 ml aliquot was taken in separate test tubes and volume was made up to 3 ml. Then 0.5 ml Folin-Ciocalteu reagent was added. Phenols with phosphomolybdic acid in Folin-Ciocalteu reagent and alkaline medium produce a highly dark blue colored complex (molybdenum blue). After 3 minutes 2 ml of Na_2CO_3 (20%) was added and mixed. Test tubes were placed in a boiling water bath for one minute and then cooled. The optical density of these prepared sample solutions was recorded at 765 nm. The concentration was determined as per the standard procedure from the standard curve. A standard calibration curve of gallic acid using its different concentrations was prepared. The stock solution was prepared by dissolving 0.5 g of dry gallic acid in water to make the final volume 100 ml in a volumetric flask. Aliquot 0. 1. 2. 3. 5 and 10 ml of gallic acid were taken in separate volumetric flasks and then the final volume was raised up to 100 ml with distilled water. Pipette 1 ml of each from these in a separate 100 ml volumetric flask. Water (60 ml) and Folin-Ciocalteu (5 ml) reagent were added to the respective flasks and mixed well. Then, 15 ml Na_2CO_3 (20%) solution was added. The contents were mixed properly, and the final volume was made to 100 ml with distilled water. After 2 hours, absorbance was recorded at 765 nm. Absorbance was then plotted against concentration and the concentration of total phenols in the given sample was calculated and expressed as mg/100 g of sample (AOAC, 2000)

Total flavonoid content

Preparation of Standard Quercetin for Calibration Curve: Total flavonoid contents in the extracts were determined by aluminum chloride colorimetric assay. Stock solution (4 mg/mL) of quercetin was prepared by dissolving 4 mg of quercetin in 1 ml of methanol. This standard solution was diluted serially to make various concentrations of 0.25 mg/mL, 0.5 mg/ml, 0.75 mg/ml, and 1 mg/ml solutions. 1 ml quercetin of each concentration was added to the test tube containing 4 mL of distilled water. At the same time, 0.3 mL of 5% $NaNO_2$ was added to the test tube and 0.3 mL of 10% AlCl3 after 5 min. Then, 2 mL of 1 M NaOH was added to the mixture after 6 min. The volume of the mixture was made 10 ml by immediately adding 4.4 mL of distilled water. total flavonoids content was expressed as quercetin equivalents using the linear equation based on the calibration curve. Preparation of Samples for Total Flavonoid Content. Stock solutions of 4 mg/ml concentration in methanol of the extracts were prepared, and they were diluted serially to make different concentrations (0.25 mg/ml, 0.5 mg/ml, 0.75 mg/ml, and 1 mg/ml) solutions. Similar procedure as described for quercetin was followed for the extracts also, and the absorbance was measured by spectrophotometer at 510 nm. Readings were taken in triplicate, and the average value of absorbance was used to calculate the total flavonoid content. Total flavonoid content was expressed as a quercetin equivalent (mg QE/g) using the linear equation based on the standard calibration curve (AOAC, 2000).

Tannin content

Tannin content was determined by volumetric method as described by (AOAC, 2000). Aliquot of the filtered juice prepared from samples containing indigo carmine and distilled water was titrated against 0.1 N Potassium permanganate solution until color changes to bright yellow. Aliquots were titrated to get total tannin and non-tannin like material in the sample. The percent tannin as gallotannic acid was calculated as under

Result and Discussion

Physical properties of pumpkin

Physical characteristics including colour of the vegetable, weight, length, breadth, seed weight, juice percentage, pulp percentage and edible portion are evaluated during the analysis of pumpkin vegetable. The results obtained for physical characteristics of ripe pumpkin are presented in Table.1. An appraisal of data revealed that the average weight of vegetable was 3612.99 ± 66.06 g. The length and diameter were noticed to be 325.40 ± 2.65 and 672.83 ± 2.16 mm, respectively. These findings are almost in line with the results of Dhiman *et al*. (2007) [6], Noelia *et al*. (2011) [13] and Kumari (2013) [9]. The surface colour of vegetable was observed to range from pale yellow to golden yellow which is in conformity with the results of Anju (2000) [1], Fedha *et al*. (2010) [8] and Norshazila (2014) [14]. Ripe pumpkin was found to contain 75.01 ± 1.07 percent edible portion in the present study which is close to the value given by Dhiman *et al*. (2007) [6], Valenzuela *et al*. (2011) [18] and Kumari (2013) [9].

Table 1: Physical properties of pumpkin

Sl. No.	Characteristics	Mean ± SE*
1	Weight (g)	3612.99 ± 66.06
2	Length (mm)	325.40 ± 2.65
3	Diameter (mm)	672.83 ± 2.16
4	Seed weight (g)	1.63 ± 0.61
5	Colour	YGY
6	Edible portion %	75.01 ± 1.07

*SE = Standard error, YGY = Yellow to golden yellow

Chemical and nutritional characteristics of pumpkin

Table 2 highlights the chemical characteristics of ripe pumpkin used in the study. A perusal of data reveals that ripe pumpkin had an average moisture content of 6.10 ± 0.36 percent which is lower than the values given by See *et al*. (2007) [16] and Noelia *et al*. (2011) [13] but higher than the results of Usha *et al*. (2010), Bhat and Bhat (2013) [3] and Kumari (2013) [9]. The TSS and titrable acidity was reported to be 9.21 ± 0.01 and 0.08 ± 0.02 percent, respectively. These findings are near to the values analyzed by Dhiman *et al*. (2009) [7], in accordance with the range given by Noelia *et al*. (2011) [13] and higher than the values reported by Kumari (2013) [9]. The data showed that the total sugars and reducing sugars were 7.36 ± 0.21 and 2.01 ± 0.26 percent, respectively which are near to the values as revealed earlier by Dhiman *et al*. (2007) [6] and Kumari (2013) [9]. Pumpkin was found to possess 11.23 ± 0.85 mg/100g β-carotene and 14.20 ± 1.18 mg/100g of ascorbic acid. The results are in compliance with the values given by Danilchenko *et al*. (2000) [5], lower than the reports of Kumari (2013) [9] but higher than the findings of Muralidhara *et al*. (2014) [111]. A higher value for β-carotene and lower for ascorbic acid was observed by Dhiman *et al*. (2009) [7]. The results indicated that ripe pumpkin had 32.90 ± 0.73 mg/100g total phenols. The analysis of ripe pumpkin showed crude protein content of 0.95 ± 0.24 percent which is within the range reported by Fedha *et al*. (2010) [8] and Olurin *et al*. (2012) [15], while more than the values noticed by See *et al*. (2007) [16], Bhat and Bhat (2013) [3] and Kumari (2013) [9]. Ripe pumpkin contained 0.21 ± 0.14 percent crude fat, which is higher than the value given by See *et al*. (2007) [16] and Kumari (2013) [9] but lower than the reports of Bhat and Bhat (2013) [3]. The crude fibre (0.69 ± 0.08%) in pumpkin was almost in conformity with the results of See *et al*. (2007) [16], Dhiman *et al*. (2009) [7] and Kumari (2013) [9], whereas lower than the value noticed by Bhat and Bhat (2013) [3]. The total ash content of ripe pumpkin (0.74 ± 0.21%) was higher than the value analyzed by See *et al*. (2007) [16], Bhat and Bhat (2013) [3] and Kumari (2013) [9] while slightly lower than noticed by Dhiman *et al*. (2009) [7]. The variation in different chemical characteristics of ripe pumpkin in the present study and earlier reported by different researchers may be due to the due to varied agroclimatic conditions.

Table 2: Chemical composition of ripe pumpkin

Sl. No.	Parameters	(Mean ± SE*) Pumpkin
1	Moisture %	6.10 ± 0.36
2	Ash %	0.74 ± 0.21
3	pH	4.57 ± 0.06
4	TSS (°brix)	9.21 ± 0.01
5	Titratable acidity %	0.08 ± 0.02
6	Vit. C (mg/100g)	14.20 ± 1.18
7	Total Sugars %	4.00 ± 0.26
8	Reducing Sugar %	2.27 ± 0.15
9	Non reducing sugar %	1.73 ± 0.21
10	TPC (mg GAE/100g)	32.90 ± 0.73
11	Tannin %	1.16 ± 0.38
12	Flavonoid (mg/100g)	7.53 ± 0.88
13	Antioxidant activity %	52.54 ± 0.61
14	Crude Fibre %	0.69 ± 0.08
15	Fat %	0.21 ± 0.14
16	Protein %	0.95 ± 0.24
17	Carbohydrate %	5.46 ± 0.42
18	β-carotene (mg/100 g)	11.23 ± 0.85

*SE = Standard error

Conclusion

In conclusion, this study aimed to explore the physiological and chemical properties of pumpkin (*Cucurbita moschata*). Valuable insights were gained through comprehensive analysis, revealing the vibrant green color with a pink pulp of fresh pumpkin, indicating its high β-carotene content of 11.23 mg/100g. These properties make pumpkin a valuable antioxidant source with potential health benefits. Additionally, the analysis showed a moisture content of 6.10% and carbohydrate, protein, and fat levels of 5.46%, 0.95%, and 0.21%, respectively, providing important nutritional information for those incorporating pumpkin into their diet. The study also examined acidity (0.008%) and pH (4.57), contributing to a comprehensive understanding of pumpkin's chemical properties. These findings underscore pumpkin's potential as a versatile and nutritious food source, supporting its utilization in various culinary applications. Further research is needed to explore additional aspects of pumpkin's physiological and chemical properties, including mineral content, vitamin profile, and potential health benefits, to enhance our understanding of this valuable vegetable and its impact on human health.

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