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A study on physical and chemical characteristics of pumpkin (*Cucurbita* sp.) flesh

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Abstract
The research aims to study the physical and chemical characteristics of fresh pumpkin fruit. Ripe and fresh pumpkin fruits were selected for this purpose. The results obtained from the research showed that the pumpkin has good anti-oxidant property with a DPPH value of 30.01±0.79%. The fruit also contains ample amount of beta-carotene 4.09±0.12%. It also contains redusing sugar and total sugar of 23.05±0.06 g/100 g and 57.13±0.02 g/100 g respectively. Other parameters including TSS (10.47±0.02%), Moisture (91.46±1.02%), pH (6.32±0.06), Titratable acidity (0.064±0.01%), Ascorbic acid (9.84±0.83 mg/100 g), Ash (1.36±0.23%), Fat (0.62±0.001%), Phytate (0.21±0.01%), TPC (0.169±0.003 mg/100 g), TFC (0.032±0.002 mg/100 g) and Tanin (0.50±0.07 mg/100 g) were also analysed.

Keywords: *Cucurbita* sp., pasta, consumer acceptance, polyphenols

Introduction
Pumpkin is a popular fruit belonging to the family *Cucurbitaceae*, and genus *Cucurbita*. It is a fruit that is highly sought-after during the fall and winter seasons, due to its bright and vibrant colour. Pumpkins are typically round or oblong in shape, with a smooth, slightly ribbed skin that can range in colour from yellow to orange. After the pumpkins are harvested, they are usually consumed in autumn, and can be used in a variety of culinary dishes, like pumpkin pie and pumpkin soup. Salehi *et al*. (2020) [24] reported that pumpkins are becoming increasingly popular in many countries, and are widely used in traditional dishes and in modern cuisine. Pumpkins are a widely appreciated fruit found all around the world. Not only are they a beautiful and unique addition to any dish, they are also incredibly nutritious. Pumpkins are full of a variety of vitamins and minerals that are essential for good health. These include beta-carotene, vitamin C, and potassium. Beta-carotene is a powerful antioxidant that helps protect against certain diseases and can even improve eye health. Vitamin C is important for wound healing, proper immune function, and even skin health. Finally, potassium helps maintain a healthy blood pressure, supports healthy bones, and helps to regulate nerve and muscle function. In 2019, the top five producers of pumpkins were China, India, Ukraine, Russia, and the United States. This just goes to show how popular and beloved pumpkins really are. Whether it’s for their flavour or their nutritional benefits, pumpkins are enjoyed all over the world. With their rich nutrient content and plethora of health benefits, it’s no wonder why pumpkins are so popular (Sehrawat *et al*., 2018) [25].
Pumpkins are one of the most versatile fruits and have a wide variety of applications. It is used for decorations, carving, food products such as pies, soups, and breads, oils, and medicines. The global demand for pumpkins has been increasing, and the market is expected to grow significantly in the near future (Wehner *et al*., 2020) [23].
However, it is important to note that 18-21% of the pumpkin is wasted (Mala and Kurian, 2016) [26]. This includes pumpkin seeds, peels, and membranes which are often overlooked and left to rot. Fortunately, this waste can be used to make various products such as soaps, fertilizers, and even biofuels. Overall, the global growth in the pumpkin market shows the potential for this versatile fruit to be used in a variety of ways. As more initiatives are being developed to reduce pumpkin waste, it is likely that its use will continue to increase in the future (Wehner *et al*., 2020) [23].
In recent years, there have been a number of initiatives to reduce pumpkin waste and make use of all parts of the fruit. For instance, pumpkin seed oil is now being used in the cosmetics

industry and some restaurants are using the peel for garnish. In addition, the membranes are also being studied for their potential as an alternative fuel source (Mala and Kurian, 2016) [26]. Pumpkin seeds are one of the most abundant agro-industrial waste materials, and can be a great source of bioactive compounds. These compounds have been proven to bring numerous nutraceutical benefits to the body. The consumption of pumpkin seeds has been documented for thousands of years, and has been part of both traditional and modern diets. Pumpkin seeds are a nutritional powerhouse and are packed with various nutrients. They are a great source of protein, fibre, magnesium, zinc, manganese, phosphorus, copper, and iron. They are also a good source of antioxidants, which helps protect the body from free radical damage. Pumpkin seeds are also a great source of Omega 3 fatty acids and Vitamin E. These nutrients help to improve brain function, reduce inflammation, and even lower cholesterol. Pumpkin seeds are also known to support the immune system and help protect against certain types of cancer. (Salami *et al*., 2020) [27].

Overall, pumpkin seeds are an abundant and highly nutritious form of agro-industrial waste. With their many nutraceutical benefits, they are an excellent choice for those looking to improve their diet and overall health. On the other hand Pumpkin peel, also known as pumpkin skin or pumpkin peel, is the tough outer layer of a pumpkin that protects the flesh and seeds inside. It is usually discarded when pumpkins are cooked or carved, but it can actually be eaten and contains a variety of nutrients. Pumpkin peel is a good source of fiber, vitamins C and A, and antioxidants. It also contains potassium, magnesium, and other minerals (Salami *et al*., 2020) [27].

Pumpkin rind is a versatile and nutritious part of the pumpkin that should not be overlooked. It can be cooked and used in a number of recipes, such as soups, stews, and curries, or roasted as a healthy snack. Moreover, pumpkin rind extract has been shown to have anti-inflammatory and anti-cancer properties, which makes it a beneficial addition to any diet. Asif *et al*. (2017) [31] found that pumpkin rind can be used for medicinal purposes, providing additional health benefits. Overall, pumpkin rind is a nutritious part of the pumpkin that can be used in a variety of ways. From cooking to medicinal purposes, Pumpkin rind should be included in any diet for its many health benefits.

Physical parameters

Length

The length and diameter of ten randomly selected fruits were measured with the help of a centimetre scale and their average value was calculated and expressed in centimetre whereas the length of seed was measure using a Verneer Calliper.

Width

The length and diameter of ten randomly selected fruits were measured with the help of verneer calliper and their average value was calculated and expressed in centimeter.

Thickness

The thickness of 10 fruit was measured using a scale whereas the thickness of peel and seed was measured using a Verneer Calliper.

Weight

Weight of flesh, seed, peel and membrane of ten same fruits was taken on top pan electric balance and average weight of fruit was calculated and expressed in gram.

Bulk density

The method given by Rana *et al*., (2015) [30] was followed for measuring the bulk density of flours. A 50 mL graduated cylinder was filled with 10 g flour fraction followed by gentle tapping of the cylinder. The volume of flour was read directly and results were expressed as g/mL.

Chemical parameters

pH

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).

Total soluble solids (TSS)

The total soluble solids in pumpkin fruit was recorded with the help of a Hand Refractometer of 0-32 0B, 28-62 0B and 58-92 0B and expressed as degree Brix (°B) at 20 °C (Ranganna, 2014) [29].

Moisture

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) [2].

$$\text{Moisture content (\%)} = \frac{\text{Weight of fresh sample(g)} - \text{Weight of dried sample (g)}}{\text{Weight of fresh sample (g)}} \text{X100}$$

Titeratable acidity

The titratable acidity was expressed as % citric acid (AOAC 2004) [3] and estimated by using phenolphthalein as an indicator to give pink colour (end point).

$$\text{Titable acidity (\% as citric acid)} = \frac{\text{Ttitre X Normality of Alkali X Volume made up X Equivalent weight of acid}}{\text{Volume of sample taken for estimation X Weight or volume of sample taken}}$$

Ascorbic acid

Ascorbic acid content was determined as AOAC (2004) [3] method using 2, 6-dichlorophenolindophonol dye and expressed in mg/100 g of sample.

$$\text{Ascorbic acid (mg/100 g)} = \frac{\text{Titre X Dye factor X Volume made up}}{\text{Aliquote of extract taken for estimation X }\left(\frac{\text{weight}}{\text{Volumeof}}\text{ sample taken for estimation}\right)} \text{ X 100}$$

Total sugar and Redusing sugar

Total and reducing sugars and acidity was estimated according to previous established methodologies (AOAC, 1990) [5].

$$\text{a) Redusing sugar (\%)} = \frac{\text{Factor X Dilution}}{\text{Titre value X Weight or Volume of sample}} \text{ X } 100$$

$$\text{b)Total sugars percent(as invert sugars)} = \text{Calculated as in(a) making use of titre value obtained in the determination of total sugars after inversion}$$

Anti-oxidant activity

Total antioxidant activity of flesh/seed/peel/membrane/flour was determined using 2, 2- diphenyl-l-picrylhydrazyl (DPPH) radical scavenging assay Hanato *et al.* (1988) [1].

$$\text{\% Inhibition of DPPH} = 1 - \frac{\text{Absorbance of sample at 30 minutes}}{\text{Absorbance of control at 0 minutes}} \text{X}100$$

Fat

The fat was gravimetrically quantified after ether extraction in a Soxhlet. Let apparatus and crude fibre by sequential hot digestion of the sample with dilute acid and alkaline solutions (AOAC, 1990) [5]

Ash

Total ash content was determined gravimetrically by AOAC (2004) official method 942.05.

$$\text{Ash Content (\%)} = \frac{\text{Weigh of ash (g)}}{\text{Weigh of sampl taken (g)}} \text{ X } 100$$

Phenol

Total phenols of samples were determined by the Folic-Ciocalteu procedure (Ranganna, 2009) [2] and total ash content was determined gravimetrically by AOAC (2004) [3]

Flavanoid

The flavonoid content was estimated using the colorimetric assay development method of Dini *et al* (2010) [33].

Beta-carotene

Beta carotene content was determined (Ranganna, 2009) [2] by using a UV-V spectrophotometer (Model Shimadzu, Japan) and its absorbance was taken at 452 nm.

Anti-nutrients

a) Tannic acid

Tannin content was determined by volumetric method as described by Ranganna (2014) [29].

b) Phytate

This was determined using the method described by AOAC (2004) [3]

$$\text{Phytic acid (mg/s)} = \frac{\text{Total volume of extract X 100}}{\text{Volume of extract used X weight of sample used X 100}}$$

Result and Discussion

Physical characteristics of ripe pumpkin

The results obtained for the physical characteristics of flesh of pumpkin flesh are presented in Table 1. The thickness, weight, length, width and bulk density of flesh of pumpkin were recorded to be 2.9±0.19 cm, 3.9±0.94 kg, 19.44±0.94 cm, 22.5±1.9 cm and 422±11.44 kg/m3 respectively. These findings are almost in line with the results recorded by Dhiman *et al.* (2007) [20], Noelia *et al.* (2011) [11], Ramachandran *et al.*, (2022) [32] and Kumari (2013) [9] for *C. moschata*.

Table 1: Physical characteristics of ripe pumpkin

FLESH	
Thickness (cm)	2.97±0.19
Weight (kg)	3.90±0.94
Length (cm)	19.444±2.42
Width (cm)	22.50±1.96
Bulk density (kg/m3)	422±11.44

Chemical characteristics of ripe pumpkin

The Table 2 highlights the chemical properties of the pumpkin flesh. The pumpkin flesh has a moisture content of 90.26±1.02%. This is in line with the findings of Pritika (2015) [13], Kim *et al.* (2012) [14]. A range of 83.80 to 92.60% of moisture content was noticed in its flesh by various workers (Gopalan *et al.*, 1981; Wills, 1987; Teotia, 1992; Dhiman *et al.*, 2007; Kumari, 2013) [17-20, 9]. The TSS in flesh is observed to be 10.47±0.02°B. According to Noelia *et al.* (2011) [11] and Muralidhara *et al.* (2014) [10], the TSS in pumpkin ranged from 1.00 to 15.00 and 3.17 to 8.70 ˚B, respectively. The study by Kumari (2013) [9] has indicated the TSS to be 8.30 ˚B while Valenzuela *et al.* (2011) [34] have revealed comparatively lower value of 6.42 ˚B. On the other hand the pH is found to be 6.3±0.064. According to the study conducted by Armesto *et al.*, (2020) [35] similar result was observed where the pulp was found to contain a pH of 6.12. The values obtained for titratable acidity for flesh is 0.064±0.01% this is in line with the values obtained by Kumari (2013) [9]. Kumari (2013) [9] reported the titratable acidity to be 0.06 per cent. According to Noelia *et al.* (2011), the titratable acidity in ripe pumpkin ranged from 0.01 - 0.26 per cent. Sharma and Rao (2013) [21] revealed a value of 0.38%.

The flesh is found to have a fat concentration of 0.62±0.001%. Li *et al.*, (2021) [36] in a study has also reported similar observation where the fat concentration was reported to be 0.46%. The amount of ash in pumpkin flesh was found to be 1.36±0.23%. A range of 0.52 to 5.64% of total ash content was recorded by research workers (Dhiman *et al.*, 2007; Kumari, 2013) [20, 9].

The amount of redusing sugar and total sugar in pumpkin flesh was found to be 23.05±0.06 and 57.13±0.02 respectively. Sharma and Rao (2013) [21] and Kumari (2013) [9] found that flesh of pumpkin possesses 1.30 and 1.83 g/100 g reducing sugars, respectively. The ascorbic acid content was found to be 9.84±0.83 mg/100 g. Danilchenko *et al.* (2000) [22] analyzed a range of 8.93-20.63 mg/100 g for ascorbic acid in ripe pumpkin fruit while values of 14.50 and 15.00 mg/100 g were recorded by Dhiman *et al.* (2007) [20] and Sharma and

Rao (2013) [21], respectively.

The amount of total phenol and total flavonoid present in the pumpkin flesh was found to be 0.16±0.01 mg/100 g and 0.56±0.04 mg/100 g. The values of phenols for flesh of were found to be higher than that recorded by Pritika (2015) [13]. The flesh is found to have tannin concentration of 0.5±0.07 mg/100 g which is in line with the studies of ngozi and nkiru (2014). The total carotenoids of 2120 µg/100 g and β-carotene content of 1180 µg/100 g have been seen by Kandlakunta *et al*. (2008) [8] in ripe pumpkin (*C. maxima*). Another study evaluating twenty two cultivars of *C. moschata* revealed a total carotenoid content ranging from 7.02 to 138.56 µg/g (Azizah *et al*., 2009) [6]. Dhiman *et al*. (2007) [20] estimated β-carotene 13 content of 5.92-6.59 mg/100 g in pumpkin (*C. moschata*). The β-carotene content of 9.15-41.28 µg/g in samples of fresh pumpkin pulp was observed by Karanja *et al*. (2011) [7].

Table 2: Chemical characteristics of ripe pumpkin

Parameters	Flesh
TSS (%)	10.47±0.02
Moisture (%)	91.46±1.02
pH	6.32±0.06
Titratable acidity (%)	0.06±0.01
Ascorbic acid (mg/100 g)	9.84±0.83
Ash (%)	1.36±0.23
Fat (%)	0.62±0.001
Beta-carotene (%)	4.09±0.12
DPPH (%)	30.01±0.79
Phytate (%)	0.21±0.01
Redusing sugar (g/100 g)	23.05±0.06
Total sugar (g/100 g)	57.13±0.02
TPC(mg/100 g)	16.91±0.01
TFC(mg/100 g)	0.56±0.04
Tanin(mg/100 g)	0.5±0.07

Conclusion

From this study on the physico-chemical characteristics of pumpkin it was found that the pumpkin flesh is a rich source of phenols, minerals, beta-carotene, ascorbic acid and antioxidants. This makes it a potential source for the preparation, value addition as well as fortification of various products. Thus addition of pumpkin in manufacturing various food products like cake, pastries, pasta, noodles etc. can help in providing various health benefits, thus improving the nutritional status of the population without compromising with the variety of food products consumed.

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