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Comparative Qualitative Analysis of Physio-Chemical Properties of Unripe and Ripe Pumpkin (*Cucurbita moschata* L.)

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ABSTRACT

The present investigation entitled "Comparative qualitative analysis of unripe and ripe pumpkin (Cucurbita moschata L.)" was carried out in department of agriculture, Bhai Gurdas Degree College, Sangrur, Punjab, India during the 2024. The experimental design selected was CRD consisting of pumpkin variety as fruit and seed are treatments which were replicated four times. A good quality fresh and healthy pumpkin variety, the Punjab Samrat was collected from the Experimental Field of Bhai Gurdas Degree College, Sangrur, The healthy disease free, unripe and ripe fruits were selected and washed with water in order to remove dust, dirt and any other foreign material. The highest pH value of peel (6.88), pulp (6.85), seeds (6.72), TSS in peel (7.20^{0}B) and pulp (7.32^{0}B), Ascorbic acid in peel (15.74mg/100gm), pulp (14.41mg/100gm), and seeds (14.71mg/100gm), total sugar content in pulp (2.20%) and seeds (1.25%), reducing sugar content in pulp (1.89%) and seeds (0.21%), crude fiber in pulp (0.82%) and seeds (7.51%), protein in pulp (1.72%) and seeds (21.68%), carbohydrates in pulp (7.51%) reported highest at ripe stage of pumpkin. Moisture content in peel (85.63%), pulp (91.72%) and seeds (7.34%), Ash content in peel (0.67%), pulp (0.58%) and seeds (9.04%), Titratable acidity in peel (0.097), pulp (0.093) and seeds (0.122), non reducing sugar in pulp (0.48%) and seeds (0.84%), starch content in pulp (4.76%) and seeds (3.32%), carbohydrates in seeds (56.52%) was recorded highest at unripe stage of pumpkin. There were distinct variations among the two different stages of pumpkin for nutritional and physico-chemical characters of fruit under study and it can concluded that the ripe stage of pumpkin was superior to unripe stage in most of characteristics.

Keywords: *pumpkin (Cucurbita moschata), physico-chemical, peel, pulp, seed, unripe, ripe.*

INTRODUCTION

Consumption of fruits and vegetables has been increased rapidly by people due to awareness regarding their health benefits. Such increased demand can only be fulfilled by either using the technology to prevent the deterioration of commodity after harvest and/or to introduce underutilized fruits or vegetables for their commercial utilization. "Underutilized species" are plants whose nutritional values are either unknown or unexplored by researchers.

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They always had an elite status among the health foods. Pumpkin is commonly known as 'Sitaphal', 'Kashiphal' or 'Lal kaddu' and belongs to the family Cucurbitaceae and the genus Cucurbita. Worldwide, there are three main types of pumpkin, namely *Cucurbita maxima, C. moschata and C. pepo* (Lee et al., 2003). The name pumpkin originated from a Greek word Pepon which means large melon. The genus Cucurbita is comprised of five domesticated species *viz Cucurbita moschata*, *Cucurbita pepo*, *Cucurbita maxima*, *Cucurbita faciola and Telfairia occidentalis* (Caili et al., 2006). Pumpkin (Cucurbita sp.) due to its unusual and extravagant characters is considered as the marvels of vegetable world. It is one of the important vegetables widely grown all over the world. Pumpkin is a vegetable coming from tropical and subtropical zones such as Mexico and South America with high consumption in the local market (Bisognin, 2002). The world production of pumpkin is estimated to be 24.62 million MT from an area of 5,10,0000 hectares (Anonymous, 2014). In India, the production of pumpkin is estimated to be 1664.0 thousand MT from an area of 74.0 thousand hectares (anonymous, 2017). The maturity of pumpkin fruit occurs in about 90-120 days and the fruits are often allowed to ripen on the vine to ensure good shelf life. The fruits are variable in size, shape (round or oval) and colour. The colour varies from green, white and blue grey or yellow, orange and red depending on species. Pumpkins are monoecious having both male and female flowers on the same plant (Kulkarni & Joshi, 2013).

Pumpkin can be profitably converted into a variety of value added products such as jam, jelly, marmalades, puree, sauces, chutney, pickle and halwa, cookies and weaning mix, pies and beverages (Bavita, 2013 & Islam et al., 2014). The pumpkins are being processed to obtain juice, pomace, dried products, cake, bread and filling material in pie (Kanu et al., 2007). Pumpkin seeds can be processed into flour which can be used for biscuit making bread and cookies (Hamed et al., 2008). Fresh seeds of *Cucurbita moschata* contain moisture, 28.5 percent; protein, 37.7 percent; and ash, 4.4 percent; whereas, dried pumpkin seeds contain moisture content of 5.6 percent, protein content of 37.4 percent and ash content of 4.4 percent (Fedha et al., 2010). Pandya and Rao (2010) studied physiological and biochemical changes in the fruit of *Cucurbita moschata* during its growth and ripening in relation to its seed development. However, a perusal of literature indicated that there is scare information regarding the influence of maturity on nutritional properties of *Cucurbita moschata*. Therefore, the present study has been undertaken to elucidate the physico-chemical characteristics during its growth and ripening, which would provide better scope to enhance its utilization through assisted selection of fruit at appropriate stage of development.

MATERIAL AND METHODS

Collection and processing

Unripe and ripe pumpkins was collected in 2017 from experimental field located at Fatehgarh sahib, Punjab. Best quality fruits was selected by sorting and grading. Dust and foreign material was removed by washing the fruits with fresh water. After washing fruits peel pulp and seeds was extracted separately by cutting into halves. Seeds was washed and dried into oven at 60^{o}c until constant weight. Seeds was grinded and packed into zip lock bag.

Harvesting of fresh fruit
↓
Sorting and Grading
↓
Washing
↓
Cutting in to pieces
↓
Remove of seeds
↓
Drying of seed in oven (60-65 ^{o}C)
↓
Grinding with mixture grinder
↓
Sieving
↓
Packing for further use in air tight bag

Fig.1: Flow chart for extraction of pumpkin seeds

Methods

Determination of physic-chemical characterization

Determination of moisture contents of *Cucurbita moschata* peel, pulp and seeds: Moisture content of pumpkin was determined according to oven method (AOAC, 1999).

Determination of ash content of *Cucurbita moschata*: Ash content of pumpkin fruit was estimated according the method described by (AOAC, 2005).

Determination of pH content of *Cucurbita moschata:* pH was estimated using pH meter (Elico) which was already calibrated at pH 4.0 with a standard buffer solution at every event of recording.

Determination of Titrable acidity content of *Cucurbita moschata:* The mixture was titrated with 0.1 N NaOH by following the method of Ranganna, S. (1995).

Determination of Ascorbic acid content of *Cucurbita moschata:* Ascorbic acid content was determined following the method of Rangana, S. (1986).

Determination of Total soluble solids (^{o}Brix) content of *Cucurbita moschata:* TSS was observed by placing 1-2 drops of extract on the prism of a hand refractometer.

Determination of total sugar content of *Cucurbita moschata:* Total sugars were estimated by the method of Dubois et al. (1956).

Determination of Reducing sugars content of *Cucurbita moschata:* Reducing sugars was estimated by the method of Miller et al. (1959).

Determination of Non reducing sugars content of *Cucurbita moschata:* Total sugars-Reducing sugars.

Determination of starch content of *Cucurbita moschata:* Starch content = Total sugars multiply 0.98.

Determination of crude fiber content of *Cucurbita moschata*: Crude fiber was estimated by the method AOAC (2005).

Determination of water-soluble protein of *Cucurbita moschata*: Water-soluble protein content of the pumpkin was determined following the method of Lowry et al. (1951).

Determination of Carbohydrate content of *Cucurbita moschata:* Carbohydrate content was calculated by differential method.

Data on physico-chemical characteristics after optimization and also during storage days were analysed with CCRD approach of RSM against a given set of responses followed with storage stability prediction through statistical means (C.D. values and SEM).

Statistical Analysis

The experimental data from 2 treatments, 4 replications pertaining to physical quality of unripe and ripe pumpkin were subjected to statistical analysis by Completely Randomized Design (CRD) to study the effects of various treatments on different parameters. Analysis of variance (ANOVA) was conducted to determine whether significant difference existed between different treatments on physical composition of pumpkin. Data has been suitably presented in the form of tables and graphs.

Table 1: Treatments for physical quality of pumpkin

Treatment no.	Treatments
T_1	Unripe pumpkin
T_2	Ripe pumpkin

RESULT AND DISCUSSION

Table 2: Physico-chemical attributes of unripe and ripe pumpkin

	Unripe pumpkin			Ripe pumpkin		
	Peel	**Pulp**	**Seeds**	**Peel**	**Pulp**	**Seeds**
Moisture (%)	85.63 ± 0.010	91.72 ± 0.226	7.34 ± 0.046	84.55 ± 0.010	90.20 ± 0.226	6.86 ± 0.046
Ash (%)	0.67 ± 0.004	0.58 ± 0.004	9.04 ± 0.005	0.61 ± 0.004	0.56 ± 0.004	8.91 ± 0.005
pH value	6.76 ± 0.044	6.70 ± 0.035	6.50 ± 0.044	6.88 ± 0.044	6.85 ± 0.035	6.72 ± 0.044
Titratable acidity	0.09 ± 0.001	0.09 ± 0.001	0.12 ± 0.001	0.06 ± 0.001	0.06 ± 0.001	0.09 ± 0.001
Ascorbic acid (mg/100gm)	10.15 ± 0.006	8.45 ± 0.006	12.56 ± 0.007	15.74 ± 0.006	14.41 ± 0.006	14.71 ± 0.007
Total soluble solids (^{0}Brix)	6.52 ± 0.053	6.00 ± 0.044	n/d	7.20 ± 0.053	7.32 ± 0.044	n/d

Values are mean ± standard deviation of three experiments. Means in the same row with different superscripts are significantly (P < 0.05) different

Table 3: Physico-chemical attributes of unripe and ripe pumpkin

	Unripe pumpkin		Ripe pumpkin	
	Pulp	**Seeds**	**Pulp**	**Seeds**
Total sugars (%)	1.80 ± 0.013	0.97 ± 0.004	2.20 ± 0.013	1.25 ± 0.004
Reducing sugars (%)	1.32 ± 0.024	0.14 ± 0.004	1.89 ± 0.024	0.21± 0.004
Non-reducing sugars (%)	0.48 ± 0.003	0.84 ± 0.004	0.31± 0.003	0.72 ± 0.004
Starch content (%)	4.76 ± 0.025	3.32 ± 0.025	3.87 ± 0.025	2.50 ± 0.025
Crude fiber (%)	0.78 ± 0.004	7.26 ± 0.004	0.82 ± 0.004	7.51 ± 0.004
Protein (%)	1.11 ± 0.055	12.86 ± 0.168	1.72 ± 0.055	21.68 ± 0.168
Carbohydrates (%)	6.58 ± 0.004	56.52 ± 0.008	7.51± 0.004	26.08 ± 0.008

Values are mean ± standard deviation of three experiments. Means in the same row with different superscripts are significantly (P < 0.05) different

Changes in Moisture content

Moisture content of pumpkin is presented in Table 2 which shows significant variation among different stages of pumpkin. The moisture content was 85.63% for the peel, 91.72% for the pulp and 7.34% for the seeds of unripe pumpkin which was higher than the peel 84.55%, pulp 90.20% and seed 6.86% value of ripe stage of pumpkin. Abdella (2008) observed similar findings in white orange variety of pumpkin. The moisture content is variable even in the same variety depending upon the locality and other environmental factors (Shafie 1981). Our results of moisture in pumpkin were similar to the reported by Fedha et al. (2010) for *C. moschata and C. maxima*. Dry matter is one of the most important properties that directly related to quality of squash fruit (Ferriol & Pico, 2008).

Changes in Ash content

Ash content of *Cucurbita moschata* is presented in Table 2, which shows significant variation. Ash content was found maximum in peel 0.67%, pulp 0.58%, and seeds 9.04% of unripe stage and minimum ash content was found in peel 0.61%, pulp 0.56% and seeds 8.91% of ripe pumpkin stage. Quintana et al. (2018) and Kaur (2017) observed similar results in ripe pumpkin. Ash content of a sample is a reflection of the minerals it contains therefore, pumpkin seeds are expected to be rich in minerals needed for good body development Hamed et al. (2008).

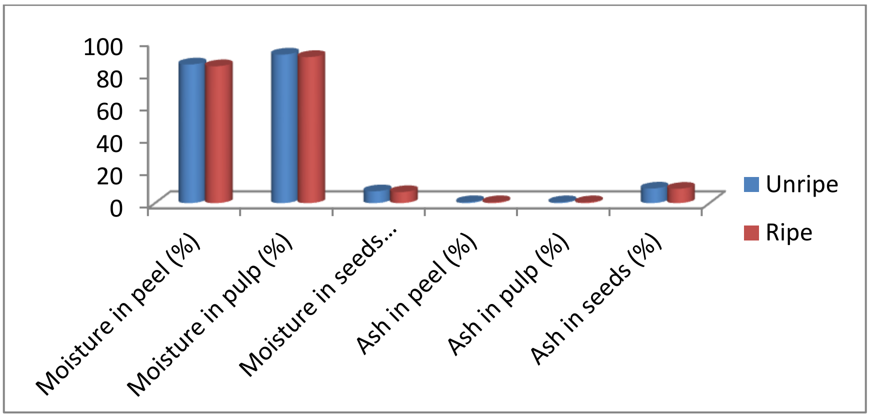

Figure 2: Variation in moisture and ash

Changes in pH and titratable acidity

It is evident from Table 2 that significant variation in pH was recorded among two stages of pumpkin. During the growth and ripening of *C. moschata* fruit, the pH of its peel, pulp and seeds fluctuated up to maturation but it attained increasing pattern from unripe stage of peel (6.76), pulp (6.70) and seeds (6.50) to ripe stage of peel (6.88), pulp (6.85), and seeds (6.72). Similar results was obtained by Bavita (2013) and Quintana et al. (2018). The changes in the pH of the fruit flesh influences the activities of ripening related enzymes and antioxidant system, ultimately affects the sensory quality (McCollum et al., 1988).

Changes in Titratable acidity

Data obtained showed (Table 2) significant variation in titratable acidity among the different stages of pumpkin. Titratable acidity declined from peel (0.097), pulp (0.093) and seeds (0.122) citric acid equivalent at unripe stage to peel (0.067%), pulp (0.064%) and seeds (0.097%) citric acid equivalent at ripened stage. Bavita (2013) observed similar results in pulp and seeds of *Cucurbita moschata*. During the ripening process, the fruits are initially acidic. During ripening, acidity decreases along with increase in free sugars including glucose, fructose and sucrose. However, the Sucrose content increases three to four fold due to the hydrolysis of starch.

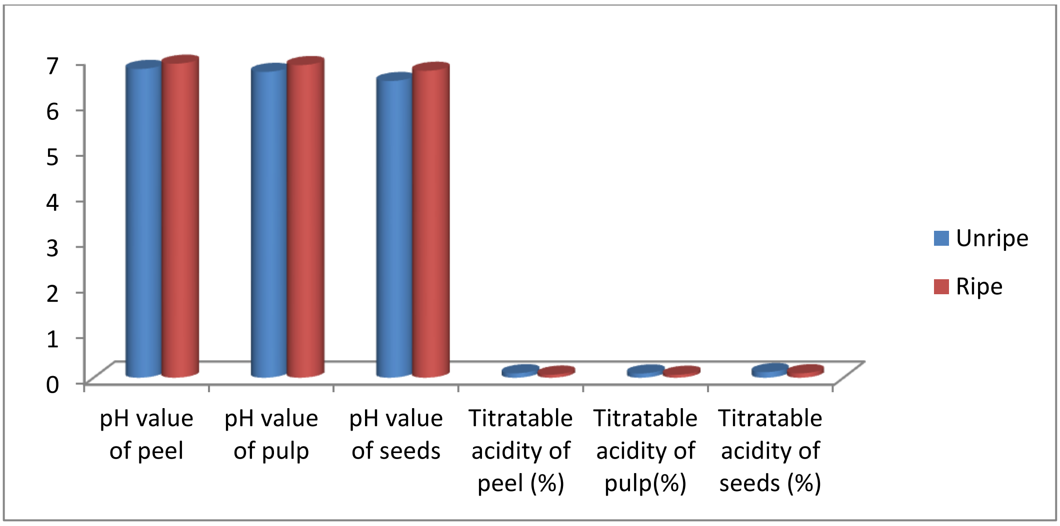

Figure 3: Variation in pH value and titratable acidity

Changes in ascorbic acid

The calculated ascorbic acid of pumpkin (peel, pulp and seeds) under study are presented in Table 2. The data revealed that ascorbic acid contents was higher at ripe stage of peel (15.74 mg/100gm), pulp (14.41 mg/100gm) and seeds (14.71 mg/100gm), whereas, lowest value of peel (10.15 mg/100gm), pulp (8.45

mg/100gm) and seeds (12.56 mg/100gm) was recorded at unripe stage of pumpkin. The findings of Bavita (2013) revealed a value of 14.49 mg/100 g in pulp and 14.60 mg/100 g in seeds for ascorbic acid of pumpkin. This may be due to the slow but continuous supply of all major and micro nutrients, which might have helped in the assimilation of carbohydrates and in turn synthesis of ascorbic acid (Jaipaul et al., 2011). The increased activity of ascorbic acid oxidase enzyme in the presence of micronutrients may be concerned to another reason for increase in ascorbic acid content (Malik et al., 2011). Lim et al. (2006) suggested that the significant ($P < 0.05$) increase in the biosynthesis of ascorbic acid are mainly due to the breakdown of starch into glucose. The higher level of ascorbic acid might be due to the perpetual synthesis of glucose 6- phosphate during the growth and development of fruits, which is considered to be the precursor of ascorbic acid.

Changes in Total soluble solids

The soluble solids were expressed in ^{o}Brix, with values of 6.52 for peel, 6.00 for the pulp of unripe stage of pumpkin, maximum value of ^{o}Brix 7.20 for peel, 7.32 for pulp was found in ripe stage of pumpkin. The possible cause depicted in the increase in TSS may be due to difference in mineralization, continuous availability of more nutrients in higher amount and better utilization by plants (Chetri et al., 2012). The increase in TSS content might be due to the growth promoting substances which could have accelerated synthesis of carbohydrate, vitamins and other quality characters (Narayan, 2011).

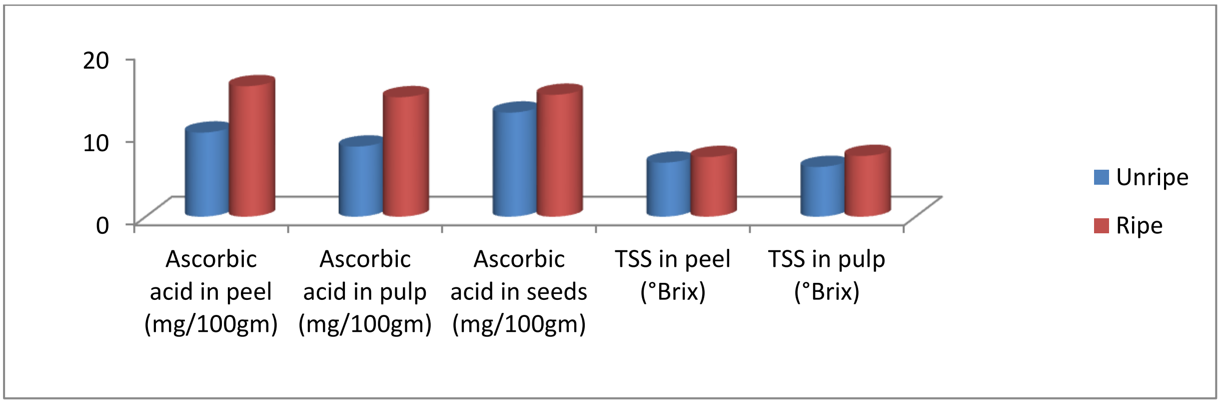

Figure 4: Variation in ascorbic acid and total soluble solids

Changes in Starch and sugar content

Starch is the main storage carbohydrate in early stages of fruit development, which degrades with the onset of ripening. In present study, highest starch content was recorded in pulp (4.76%) and seeds (3.32%) at unripe stage and lowest starch content was recorded in pulp (3.87%) and seeds (2.50%) at ripe stage. Similarly non reducing sugar degrade with the onset of ripening. Highest amount of non reducing content was recorded in pulp (0.48%) and seeds (0.84%) at unripe stage and lowest amount was recorded in pulp (0.31%) and seeds (0.72%) at ripe stage. The amount of total soluble sugars presented increasing trend from unripe stage of pulp (1.80%) and seeds (0.97%) to ripe stage of pulp (2.20%) and seeds (1.25%). An increase in the content of reducing sugars from unripe stage of pulp (1.32%) and seeds (0.14%) to ripened stage of Pulp (1.89%) and seeds (0.21%). Paliyath and Murr (2008) reviewed the pattern of sugar metabolism, and they opined that catabolic process leads to degradation of starch into glucose and fructose, which enters the metabolic pool where they are used as respiratory substrates or further converted to other metabolites. Similar interpretation in sugar metabolism has also been reported during fruit development of *Cucurbita maxima* D. 'Delica' (Harvey et al., 1997). Total solids represent the amount of dry material remaining after all the water has been evaporated and soluble solid content is used as a maturity index for some fruits. The result showed that total soluble solids changed during fruit development.

The increases in TSS, total sugar and sugar contents may be attributed to hydrolysis of starch into simple sugars (Kulkarni & Aradhya, 2005).

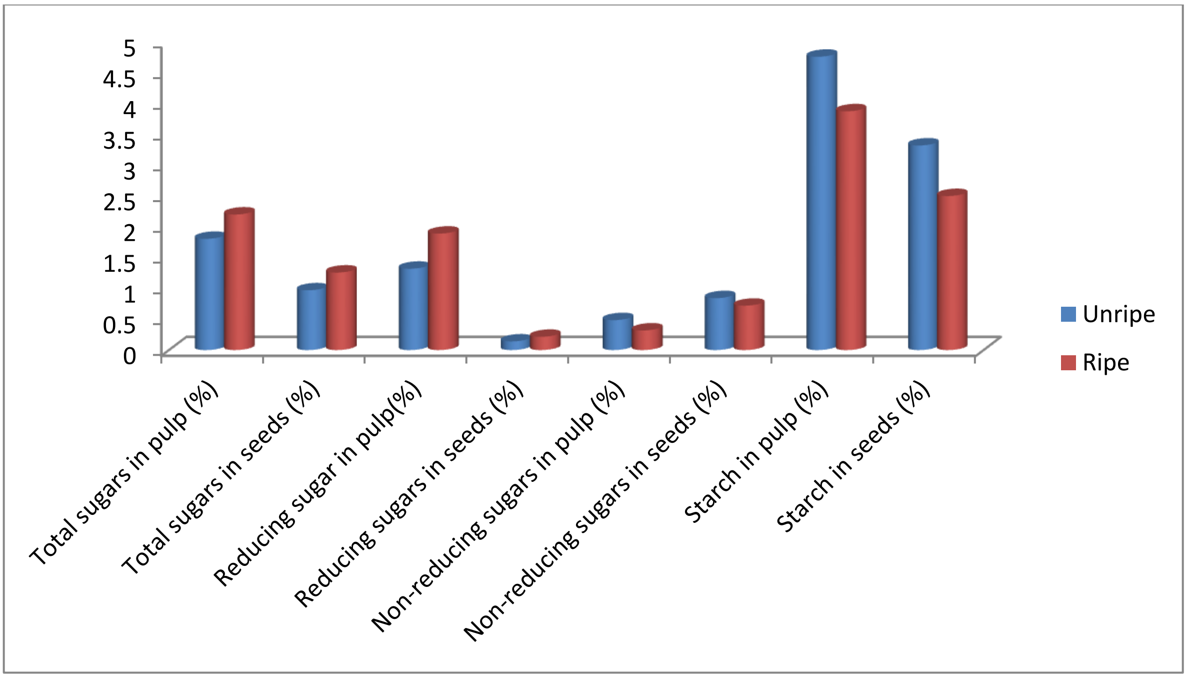

Figure 5: Variation in total sugars, reducing sugars, non-reducing sugars, and starch

Changes in crude fiber and protein

Fiber is an important component of many complex carbohydrates. It is always found only in plants particularly vegetables, fruits, nuts and legumes. Significant variation in crude fiber was recorded among two stages of pumpkin. As shown in Table 3, Crude fiber content of pulp (0.78%) and seeds (7.26%) was recorded minimum in the unripe stage of pumpkin, maximum amount of crude fiber in pulp (0.82%) and seeds (7.51%) was recorded in the ripe stage of pumpkin. Similar observation was recorded by Bavita (2013) in pulp of ripe pumpkin and kaur (2017) in seeds of punjab samrat variety of pumpkin. Alfawaz (2004) and Valenzuela et al. (2011) noticed that in Japanese pumpkin crude fiber continually increased during fruit development.

Protein content of pumpkin under study is presented in Table 3. The results show that ripe fruit contain significantly ($p<0.05$) higher protein content than unripe fruit. Protein content was found minimum in pulp (1.11%) and seeds (12.86%) at unripe stage, maximum amount of protein in pulp (1.72%) and seeds (21.68%) was recorded at ripe stage of pumpkin. The protein constituents are of primary importance not only as component of nuclear and cytoplasmic structures, but also as complement of enzyme involved in metabolism during growth, Percent of protein. A careful observation of the data indicated that there was non significant variation in protein content among the different stages of pumpkin. Similar results were reported by Nagar (2015) in Punjab samrat variety of pumpkin.

Changes in carbohydrates

Data obtained showed significant variation in carbohydrates among different stages of pumpkin. In present study Table 3, ripe stage contains 7.51% carbohydrates in pulp and 26.08% carbohydrates in seeds, while, unripe stage contains 6.58% carbohydrates in pulp and 56.52% carbohydrates in seeds.The higher the carbohydrate content the higher the degree of sweetness (kim et al., 2012). High carbohydrate is desirable; deficiency causes depletion of body tissue (Barker 1996). Carbohydrates provide the necessary calories in diets, promote the utilization of the dietary fats and reduce wastage of proteins (Balogun & Olatidoye, 2012).

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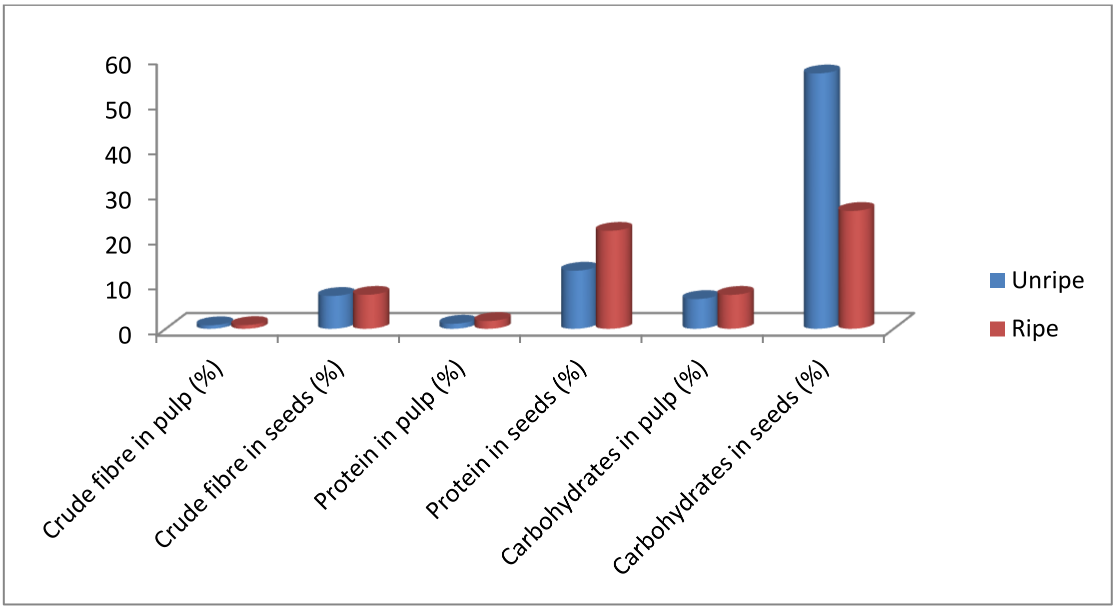

Figure 6: Variation in crude fiber, protein, and carbohydrates

CONCLUSION

From the study carried out on different stages of pumpkin peel, pulp and seeds. It can be concluded that there were distinct variations among the unripe and ripe stage of pumpkin in nutritional and physico-chemical characters of fruit. The ripe stage of pumpkin was superior to unripe stage of pumpkin in most of characteristics. Pumpkin fruit contains higher nutritional value which can be successfully incorporated in food products as it enhances the nutritional quality and shelf life.

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Conflict of Interest:

There is no such evidence of conflict of interest.

Author Contribution

All authors have participated in critically revising of the entire manuscript and approval of the final manuscript.

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