Middle East Journal of Applied Sciences
ISSN 2077-4613

Volume : 08 | Issue :02 |April-June| 2018
Pages: 295-306

Evaluation of Physical and Sensory Characteristics of Jam and Cake Processed Using Pumpkin (*Cucurbita moschata*)

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Received: 14 Jan. 2018 / Accepted: 15 Mar. 2018/ Publication date: 05 April 2018

ABSTRACT

This investigation was carried out to evaluate jam and cake made from pumpkin, where four treatment of pumpkin jam were applied. Also, pumpkin cake produced by substituting the wheat flour with 5, 10 and 15% of pumpkin powder to give three blends of cake as comparing with control treatment (100% wheat flour). The pumpkin jam samples exhibit excellent nutritional properties. Amongst the prepared treatments, pumpkin jam prepared with adding orange juice was rich in vitamin C, having good color properties and perfect sensory properties. Concerning the pumpkin blended cake, it was observed that pumpkin powder showed significant effect on the nutritional value of cake, where the moisture, ash and fiber contents were found to be increased, whereas fat, protein and total carbohydrates did not affect by addition of pumpkin powder in comparison with the control treatment. However, substitute the wheat flour with pumpkin powder resulted in sensory acceptable cake wealthy in vitamin C content. Finally, pumpkin could be preserved in the form of jam or powder as well as minimizing the postharvest loss and providing value add product with benefit physical and sensory Characteristics.

Key words: Pumpkin, Pumpkin powder, Pumpkin jam, Cake, Nutritional value, Vitamin C, Sensory properties.

Introduction

Pumpkin (*Cucurbita moschata*) is a gourd-like squash of the genus Cucurbita belongs to the family of Cucubitaceae. *Cucurbita moschata* are the worldwide commonly grown species of pumpkin (Lee *et al.,* 2003), it represents economically important species because of its high production (Caili *et al.,* 2006). Pumpkins are extensively grown in tropical and subtropical countries (Das and Banerjee, 2015). Pumpkin has received considerable attention in recent years for the sake of providing the human body his nutrional needs because of its healthy nutritional benefit where it is rich in vitamins, minerals and pectin, contains beneficial fatty acids and amino acids (Djutin, 1991, Bombardelli and Morazzoni, 1997 and Krokida *et al.,* 2003), it is considered to be a good source of carotenoids, and a very rich source of carotene (Azevedo-Meleiro and Rodriguez Amaya, 2007) mainly β-carotene which gives its yellow or orange color (Bhaskarachary *et al.,* 2008). Consumption of foods containing carotene helps in prevention of eye disorders, cancer and skin diseases (Bendich, 1989). It is considered to be a major source of vitamin A and so incorporation of β-carotene rich foods in diets is the best measure to improve vitamin A nutrition of individuals to overcome the problems and diseases caused by vitamin A deficiency (VAD) (Chandrashekhar and Kowsalya, 2002, Siems *et al.,* 2005). Also, Pumpkin species reported to have pharmacological characteristics including anti-oxidant, lipid-lowering, hepatoprotective (Makni *et al.,* 2008), anti-microbial (Park *et al.,* 2010), anti-diabetic properties (Caili *et al.,* 2006 and Xia and Wang, 2006) and anti-obesity properties (Lee *et al*., 2012).

Pumpkin flesh is a tasteful additive in a many variety of food products for both children and adults, it has been traditionally consumed as freshly boiled and steamed or in preparing soup and salad (Das and Banerjee, 2015). Also, Pumpkin fruits mainly are being processed to obtain juice, pomade, pickles. (Nawirska *et al.,* 2009). Ptitchkina *et al.,* (1998) had been reported that pumpkin could also be processed into flour for the diversification in the production of bakery products. The chemical

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composition as well as the antioxidants content of pumpkin fruit make it become an important food product for human consumption (Guiné and Barroca, 2012), in the same time, pumpkin, like most vegetables, is a perishable food, thus, it becomes necessary to use methods that allow preserving its properties, as well as, prevent its postharvest loss and try to process it into a value added product. Therefore, the objective of our study is to evaluate the physical and sensory characteristics of processed jam and cake using pumpkin.

Materials and Methods:

Pumpkins fruits (var. *Cucurbita moschata*) were purchased from the local market, peeled, halved and the seeds were removed and subjected to cleaning, the flesh pumpkin was then grated. Orange juice, sugar, Flour (72% extraction), whole fresh egg, shortening, fresh milk, baking powder, vanilla and salt (sodium chloride) were purchased from local market.

Preparation of pumpkin jam:

The pumpkin jam was prepared according to Sindumathi and Amutha (2014) where the grated pumpkin was taken in an open stainless steel pan and a required amount of sugar was added and heated continuously under low flame. When the total soluble solids reached 60°brix, orange juice was added as a source of citric acid, the mixture was mixed thoroughly and stirred continuously using a steel ladle. Heating was stopped when the total soluble solids reached 67- 68°brix, and the mixture was hot filled into sterilized glass jars and cooled under ambient temperature. The jam prepared was stored at room temperature until analyzed. Pumpkin jam formulation where as follows:

(PC): 1Kg grated pumpkin + 750 gm sugar + juice of one lemon (control treatment).
(PO20): 1Kg grated pumpkin + 750 gm sugar + juice of one lemon + 200 ml orange juice.
(PO40): 1Kg grated pumpkin + 750 gm sugar + juice of one lemon + 400 ml orange juice.
(PO60): 1Kg grated pumpkin + 750 gm sugar + juice of one lemon + 600 ml orange juice.

Preparation of pumpkin blended cake:

The grated pumpkin was dried at 50°C using Solar Power Plant, Solar Energy Department, Engineering Research Division, National Research Centre. The samples were then grinded using kitchen miller to obtain the pumpkin powder which were then kept chilled in an air-tight container at 4°C temperature, until laboratory analysis and cake processing. The samples were evaluated in triplicate for each analysis.

Cake was prepared according to Bennion and Bamford (1997). The control cake blend (TC) was formulated from 100 g flour, 85 g whole fresh egg, 85 g sucrose, 55 g shortening, 3 g dry milk, 3.8 g baking powder and 0.6 g vanilla. Pumpkin powder was substituted wheat flour at levels 5, 10 and 15% to give three blends (PC5, PC10 and PC15), respectively. Shortening and sugar powder were creamed together using a kitchen machine (National, Japan) for 5-10 min. Flour, dry milk and baking powder were mixed together, then the mixture was added gradually to shortening, sugar, egg, vanilla and beaten for 3 min using the mixing machine at low speed. The blend was scaled at 30 g into baking pans and baked at 180°C for 35 min. Baked cakes were left to cool for 1 hr. at room temperature and stored after packaging with poly ethylene bags at refrigerator until analysis.

Analytical methods:

Moisture, total ash, crude fat, crude fiber, crude protein and ether extract contents of pumpkin jam and pumpkin cake were determined according to the methods described in the A.O.A.C. (2000), The carbohydrates content was calculated by difference.

For pumpkin jam samples, the pH was measured using digital pH meter, reducing sugars content was determined according to Holme and Peck (1983), vitamin C was estimated according to Brubacher *et al*. (1985), consistency was measured using viscometer, V60002, FFUNGILAB, Spain (Spindle R7) 100 rpm, torque was maintained at 100% and Color was measured by Chroma meter (Konica Minolta, model CR 410, Japan) calibrated with a white plate and light trap supplied by the manufacturer at Cairo

University Research Park (CURP), Faculty of Agriculture, Cairo university. Color was expressed using the CIE L, a, and b color system (CIE, 1976). A total of three spectral readings were taken for each sample. Lightness (L*) (dark to light), the redness (a*) values (reddish to greenish). The yellowness (b*) value (yellowish to bluish) was estimated.

Physical Characteristics of pumpkin blended cake:

The normal weight and volume of pumpkin cake treatments were determined within 1 h after baking by method according to A.A.C.C. (2000), where specific volume were calculated for these formulas [volume (cm^3)/weight (g)].

Sensory evaluation:

In order to evaluate the characteristics of the product and to access what variations of the product would gather better, sensory evaluation for different blends of cake was estimated. Color, taste, odor, texture and overall acceptability of pumpkin jam and appearance, crust color, crumb color, taste, texture and overall acceptability of pumpkin cake were estimated by ten experienced panelists according to A.A.C.C. (2000).

Statistical analysis:

All analyses were performed in triplicate and data reported as mean ± standard deviation (SD). Data were subjected to analysis of variance (ANOVA). All tests were conducted at the 5% significant level.

Results and Discussion:

Processes that expose foods to high levels of heat may cause some nutrient loss. Therefore, it was important to evaluate the nutritional value of pumpkin jam.

Nutritional value of pumpkin jam:

Data presented in Table (1) showed that the moisture content of pumpkin jam treatments was 29.605, 28.662, 34.429 and 31.763 for PC, PO20, PO40 and PO60, respectively. Increasing the moisture content in PO40 and PO60 treatments may be attributed to the adding of orange juice where Momin and Thakre (2015) illustrated that mixing orange juice with sugar in jam manufacturing will decrease the time need for jam processing and so the rate of moisture loss will decrease. Moisture content in any food commodity plays a key role in deciding its shelf life (Fellows, 2000). Usually, high sugar content makes the moisture unavailable for the growth of microorganisms, thus improving the shelf life of food (Afoakwa *et al.,* 2006).

Table 1: Nutritional value of pumpkin jam treatments.

Proximate analysis	PC	PO20	PO40	PO60
Moisture	29.605^{c}±0.01	28.662^{d}±0.007	34.429^{a} ±0.014	31.763^{b} ±0.014
Ash	0.755^{b}±0.009	0.443^{c}±0.008	0.871^{a} ±0.006	0.637^{b}±0.012
Crude Fibre	0.914^{a}±0.011	1.008^{a}±0.007	0.894^{a}±0.009	0.97^{a}±0.080
Crude Protein	3.098^{b}±0.016	2.441^{d}±0.012	3.019^{c}±0.009	3.491^{a}±0.011
Ether extract	0.024^{a}±0.012	0.062^{a}±0.011	0.049^{a}±0.009	0.059^{a}±0.012
Total Carbohydrates	65.604^{b}±0.604	67.384^{a}±0.384	63.757^{c}±0.757	63.08^{d}±0.080

(PC) is control pumpkin jam, (PO20) is the pumpkin jam treatment with 20% orange juice, (PO40) is the pumpkin jam treatment with 40% orange juice, (PO60) is the pumpkin jam treatment with 60% orange juice.
Mean value ± Standard deviation of three replicates, means sharing the same letter in a raw are not significantly different at $p \geq 0.05$.

Ash content represents minerals like calcium, phosphorus and iron. Maximum ash content was obtained with PO40 treatment followed by PC, PO60 where the PO20 treatment was the lower in ash

content. The standard value for ash content is 0.5% according to nutritional value based on USDA Nutrient Database.

Crude protein of pumpkin jam recorded for PO40 and PO60 (3.019% and 3.491%) were close to the value of PC (3.098%) where the PO20 treatment recorded the lowest value of crude protein (2.441%). These protein values regarded to be higher than value of protein content in jam reported by USDA National Nutrient Database which was 0.37g/100g.

There is no significant difference in crude fiber values among jam treatments, the higher crude fiber content found with the PO20 treatments (1.008%) where the lowest value was observed with the PO40 treatment (0.894%). the crude fiber content was in accordance with the value recommended with the USDA National Nutrient Database for Standard Reference which refer that the fiber content for jams is 1.1g/100g. The highest carbohydrates content was significantly noticed for the PO20 treatment, followed by PC, then, PO40 and PO60.

pH value of pumpkin jam:

Fruit products are being effectively preserved at low pH. The pH value is most important factor that should be monitored and controlled in jam processing. Figure (1) shows that the pH values of the PO20, PO40 and PO60 treatments was found to be significantly lower than the PC treatment. Also, data in figure (1) display the reducing sugars content of the pumpkin jam which significantly varying from (23.02%) in PO20 sample treatment to (15.912%) in PO60 sample treatment. The decrement trend in the reducing sugars content increased as the orange juice percentage increased, this may be due to adding orange juice where Momin and Thakre (2015) mention that, as the orange juice increased the time needed for gel jam formation is decreased, so decreasing the period of jam exposure to heat and thus the rate of convert non-reducing sugars like sucrose to reducing sugars decrease. Pearson (1970) reported that the reducing sugars in jams were to be in the range of 22.0%-40.0%, where Khalid (2009) found that the reducing sugars of mango jams ranged from 21.94-33.63%. On the other hand, Sindumathi and Amutha (2014) stated that the reducing sugars content of coconut based jam was 15 %.

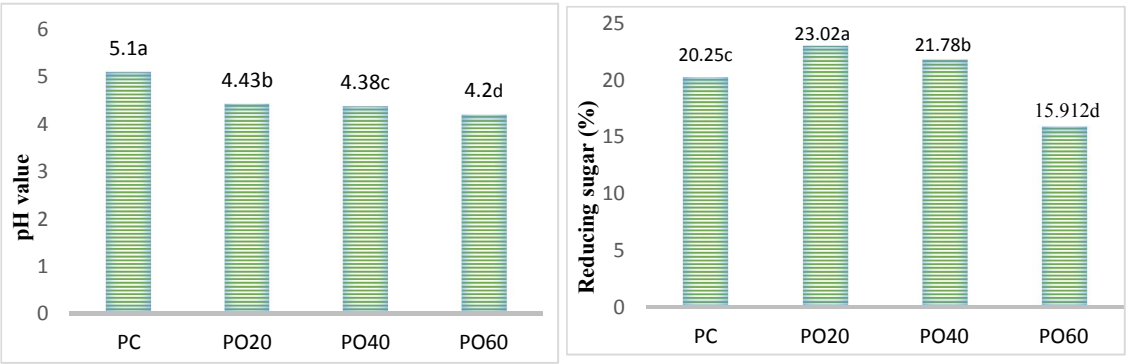

Fig. 1: The pH value and reducing sugar content of pumpkin jam.

Consistency of pumpkin jam:

Consistency of jam is a parameter that affected by pectin concentration, processing temperature and sugar added to jam during processing (Yoo *et al.,* 2009), and so, measurement of consistency considered to be a useful predictive information to take guidelines about formulation, processing and product development. Figure (2) demonstrates the consistency of pumpkin jam in centipoises (cP) and it was 49.901 (cP), 48.177 (cP), 47.991 (cP) and 46.249 (cP) for PC, PO60, PO40 and PO20 treatments, respectively. It was found that the addition of orange juice affected the jam consistency and minimize the effect of pumpkin pectin on jam consistency and this was in accordance with Momin and Thakre (2015) who illustrate that mixing orange juice which have a high viscosity with sugar, which has the property of forming a viscous semi solid, in jam manufacture will cause a fast formation of jam and increase the stability of solid in liquid colloids and decrease the time need for jam process. Likewise,

Raphaelides *et al.,* (1996) observed that sucrose formed the most rigid gels that give better viscosity to the product.

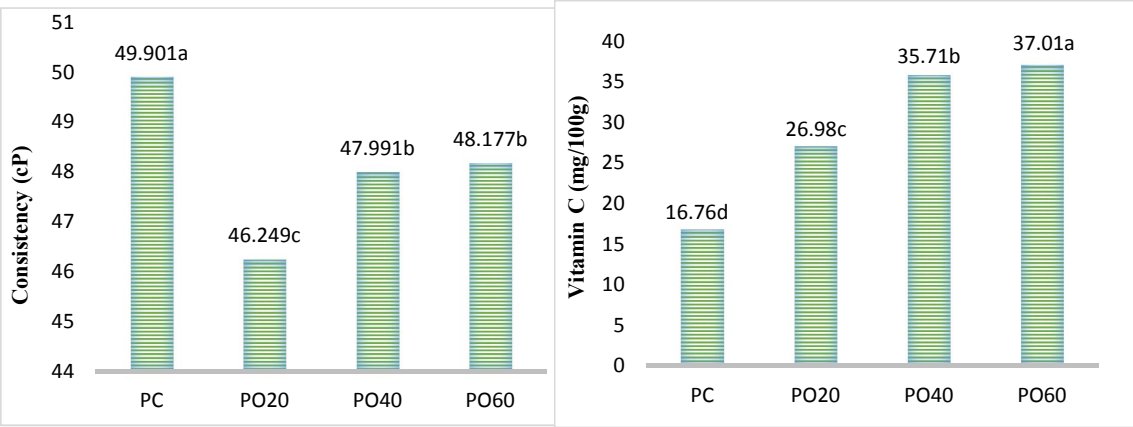

Fig. 2: The consistency and vitamin C content of pumpkin jam.

Vitamin C of pumpkin jam:

There was a fact that heating used during food processing decline the natural antioxidant compounds occurring in processed food (Anese *et al.,* 2002), also, Sood *et al.,* (2009) mention that decrement in vitamin C may be due to unstable nature by the action of heat. For these reasons it was important to evaluate the vitamin C content in different pumpkin jam treatments.

Data in figure (2) show that there was a significant increment in the vitamin C content where the highest increment was observed with the PO60 treatment (37.01 mg/100g) followed by the PO40 and PO20 (35.71 mg/100g and 26.98 mg/100g) while the lowest vitamin C content was obtained with the PC treatments (16.76 mg/100g). So the addition of orange juice to the pumpkin jam caused loss compensation in vitamin C content that happened during jam processing.

Color of pumpkin jam:

Many reactions could take place during thermal processing and concentration process that affect product color (pigment degradation), especially, carotenoids, anthocyanin and chlorophyll, browning reactions such as the Maillard reaction, enzymatic browning and oxidation of ascorbic acid (Fratiani *et al.* 2010). The L* value is related to the appearance of jam samples. The average of *L** values of PO20 and PO40 (52.413 and 49.437) were higher than PC and PO60 (48.137 and 47.113), respectively.

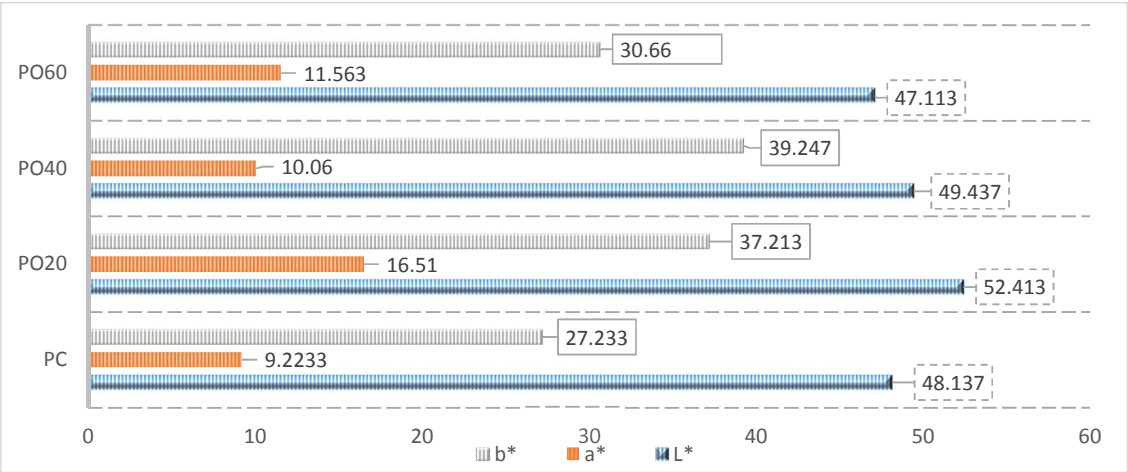

Fig. 3: color of pumpkin jam.

Also the average of b* value of PO20, PO40 and PO60 treatments (37.213, 39.247 and 30.66) was higher than the PC treatments (27.233), indicating more yellowness. The b* value of PO20 and PO40 were more than PO60 the same trend obtained with the L* values for the same treatments and so become lighter than PC and PO60, respectively. The lowest a* value obtained with the PC treatment followed by PO60 and PO40, respectively. Where the highest a* value was obtained with the PO20 treatments indicating more redness.

Sensory attributes of pumpkin jam:

The mean scores of color, odor, texture, taste and overall acceptability of jam treatment are given in figure (4). Though there were a high sensory scores were observed with the PC treatment followed by PO20 then PO40 and PO60 treatments but these scores were not significantly different. Thus, it could be concluded that the pumpkin jam showed a good sensory acceptability where the overall acceptability values were 8.9, 8.7, 8.5 and 8.5 for PC, PO20, PO40 and PO60 treatments, respectively.

Nutritional value of Pumpkin blended cake:

The nutritional value of cake prepared by substitution of wheat flour with different percentages of pumpkin powder were determined, results revealed that substitution of pumpkin powder significantly affected the nutritional compositions of cake.

From data in table (2) clarified that moisture, ash, crude fiber contents were significantly increase in the pumpkin blended cake treatments in comparison with the control treatment, whilst the crude protein, ether extract and carbohydrates content of pumpkin blended cake treatments dose not significantly differ compared to the control treatment. These results were in agreement with those obtained by Bhat and Bhat (2013) and Jesmin *et al*., (2016) for the increment of moisture, ash and crude fiber contents but not in accordance for the crude protein, ether extract and carbohydrates content where they found that they decreased in the cake containing pumpkin powder.

Also, our findings are not on the same line with Pongjanta *et al*. (2006) who reported that the use of pumpkin powder in baked products to substitute wheat flour resulted products with high fat and carbohydrate contents, however, they are lower in fiber content. Moreover, Kulkarni and Joshi (2013) ascertained that moisture and crude protein contents were lower in biscuits blended with pumpkin than that in control ones.

El-Demery (2011) evaluated the physico-chemical properties of toast breads fortified with pumpkin (*Cucurbita moschata*) flour and found that moisture and ash percentages were increased where the carbohydrate and protein percentages were decreased with increasing the replacement level of pumpkin flour with respect to the control treatment. Mansour *et al.* (1999) reported that addition of pumpkin and canola proteins to wheat flour for processed bread resulted in an increase in water absorption. See *et al.,* (2007) mentioned that by increasing the level of pumpkin flour in bread manufacturing, the moisture content increased.

Table 2: Nutritional value of pumpkin blended cake.

Proximate analysis	C	PC5	PC10	PC15
Moisture	8.819^{d} ±0.01	11.407^{b} ±0.01	10.458^{c} ±0.01	12.476^{a} ±0.01
Ash	1.496^{a} ±0.01	1.712^{a} ±0.01	1.758^{a} ±0.01	1.808^{a} ±0.01
Crude Fibre	5.48^{d} ±0.08	7.66^{c} ±0.07	8.59^{b} ±0.08	9.43^{a} ±0.06
Crude Protein	10.75^{a} ±0.14	10.66^{a} ±0.15	10.19^{a} ±0.08	10.84^{a} ±0.13
Ether extract	23.58^{a} ±0.06	23.35^{a} ±0.05	23.57^{a} ±0.08	23.45^{a} ±0.08
Total Carbohydrate	64.174^{a} ±0.15	64.278^{a} ±0.14	64.482^{a} ±0.13	63.902^{b} ±0.01

(C) is control cake, (PC5) is the cake treatment with 5% pumpkin powder, (PC10) is the cake treatment with 10% pumpkin powder, (PC15) is the cake treatment with 15% pumpkin powder.
Mean value ± Standard deviation of three replicates, means sharing the same letter in a raw are not significantly different at $p \geq 0.05$.

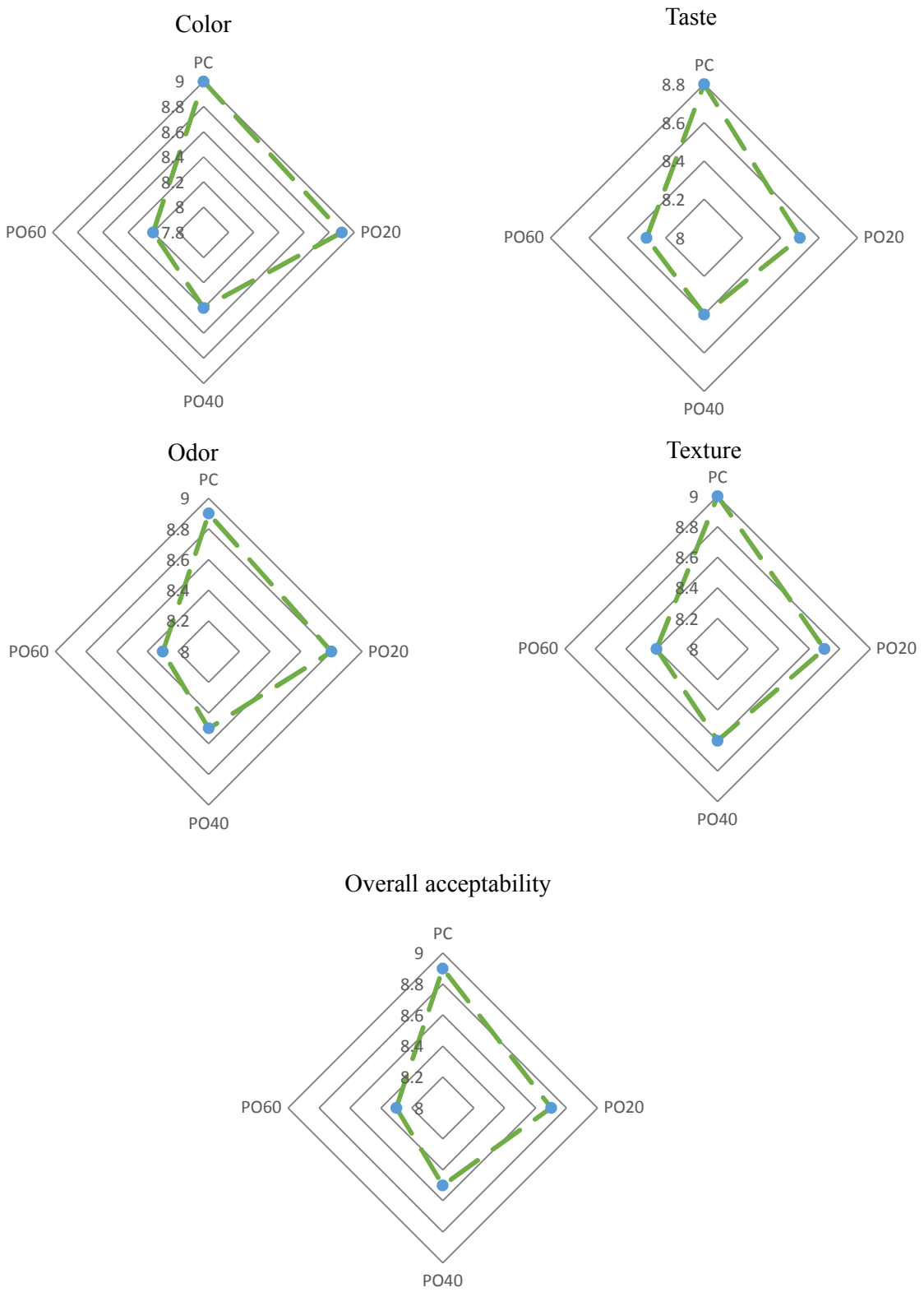

Fig. 4: Sensory properties of pumpkin jam.

Bhat and Bhat (2013) attributed the increase in moisture content in the pumpkin blended cake may be due to hygroscopic nature of the composite flour (pumpkin powder and wheat flour) and so the higher water absorption capacity compared to wheat flour. Also, they mentioned that, the higher crude fiber and ash in pumpkin blended cake were due to the higher ash content and higher insoluble dietary fiber content in pumpkin powder.

Physical Characteristics of pumpkin blended cake:

The effect of pumpkin powder on cake physical properties was considered, data illustrated in table (3) showed that there was a significant increment effect on the cake weight for both PC10 and PC15 treatments. The mean weight values were 46.6 gm and 46gm for PC10 and PC15 treatments, respectively, where the mean weight values of the PC5 treatment was equaled to the mean weight of the control treatment (42.6gm). These results were in agreement with See *et al.,* (2007) who illustrated that the increasing levels of pumpkin flour in bread manufacture (0-15%) significantly increased the weight of loaf among samples and attributed this increasing in weight to the pumpkin fiber content which increased the water absorption capacity.

Table 3: Physical Characteristics of pumpkin blended cake.

Treatments	Weight (g)	Volume (cm^3)	Specific volume (cm^3/g)
C	$42.6^c \pm 3.51$	$75.0^b \pm 2.00$	$1.76^b \pm 0.10$
PC5	$42.6^c \pm 1.15$	$74.0^c \pm 1.73$	$1.74^b \pm 0.09$
PC10	$46.6^a \pm 1.53$	$84.3^a \pm 6.03$	$1.80^a \pm 0.08$
PC15	$46.0^b \pm 1.73$	$75.0^b \pm 0.00$	$1.63^c \pm 0.06$

(C) is control cake, (PC5) is the cake treatment with 5% pumpkin powder, (PC10) is the cake treatment with 10% pumpkin powder, (PC15) is the cake treatment with 15% pumpkin powder.
Mean value ± Standard deviation of three replicates, means sharing the same letter in a raw are not significantly different at $p \geq 0.05$.

The PC10 treatment had the highest significant cake volume and specific volume as compared to the other treatments. The PC15 and PC5 treatments were in close with the volume values of the C treatment and lower than the specific volume of the C treatment. A similar observation was reported by Ptitchkina *et al.,* (1998), where the addition of 0.5 -1.0% pumpkin flour showed a massive increase in loaf volume which decreased with further level of pumpkin flour. So, the incorruption of pumpkin powder by 10% into cake processing improved the physical properties of the processed cake which is considered to be a good nutritional supplement.

Vitamin C content in pumpkin blended cake:

Figure (5) presents the content of vitamin C in pumpkin blended cake treatments. It was found that the substitution of wheat flour by pumpkin powder significantly enhanced the vitamin C content in the pumpkin blended cake treatments in comparison to the control cake treatments (100% wheat flour), these results were in the same line with those obtained by Kiruthiga and Krishnaprabha (2015). The higher significantly increment in vitamin C mean value was observed with the PC15 treatment (18.981 mg/100gm) where the lowest significant vitamin C mean value was observed with the control treatment. Thus, it could be concluded that the composite of pumpkin powder and wheat flour increased vitamin C in processed cake and so cake prepared with pumpkin powder would help to lower the vitamin C deficiency.

Sensory evaluation of pumpkin blended cake:

Sensory evaluation of the incorporation of different variations of pumpkin powder were evaluated and compared with control treatments (100% wheat flour). Addition of pumpkin powder affected the color, odor, taste, crumb color, crust color and overall acceptability of cakes.

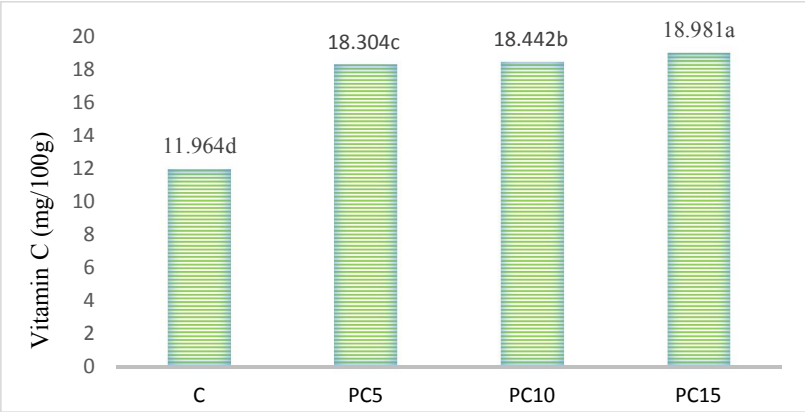

Fig. 5: Vitamin C content in pumpkin blended cake.

Data represented in figure (6) revealed that the treatments recorded a very good sensory scores, the highest overall acceptability score was found with the PC10 and PC5 treatments, whereas the PC15 treatment was scored with lowest value, but this decrement found to be not significant. Thence, PC10 treatments was most accepted, followed by PC5 treatments, where both the control and PC15 were least preferred overall acceptability. These obtained results were completely in accordance with those results obtained by Jesmin *et al*., (2016) who also mentioned that the different results in sensory attributes of pumpkin added cakes may be due to the color and stronger flavor of pumpkin powder. Roongruangsri and Bronlund (2016) clarified that adding pumpkin powder to the cake enhanced the flavor of the cake.

Similar trend was observed with See *et al.,* (2007), who also stated a significant difference in sensory attributes between 10% and 15% pumpkin powder bread. Also, Ali (2015) reported that the sensory characteristics of spongy cake processed using 5%, 10% and 15% of pumpkin meal were acceptable to most members regarding to taste, odor, texture, crust color, crumb color, general appearance and overall acceptability.

Conclusion:

Pumpkin is one such underutilized vegetable crops which is rich source of nutrients and its utilization is limited to using it as a fresh vegetable. From the obtained results it could be deduced that pumpkin is suitable for use as value added products where the processed pumpkin jam treatments scored a very good acceptability sensory attributes with perfect nutritional properties, model pH value. Moreover, the addition of orange juice improves color, viscosity and vitamin C content of the processed pumpkin jam. Furthermore, it was clearly observed that the substitution of wheat flour with pumpkin powder enhanced the moisture, ash and crude fiber contents of cake without any negative effect on both protein and carbohydrate contents, reinforce the vitamin C contents.

Also, it was clearly observed that the substitution of wheat flour with 10% of pumpkin powder was the most sensory preferred treatment to the panelist among other treatments with a perfect physical characteristic and thus, providing people a nutritional enrichment cake. Finally, pumpkin could be successfully preserved in the form of value added jam product, as well as the dried pumpkin that could be used in the manufacture of cake with a remarkable health benefits.

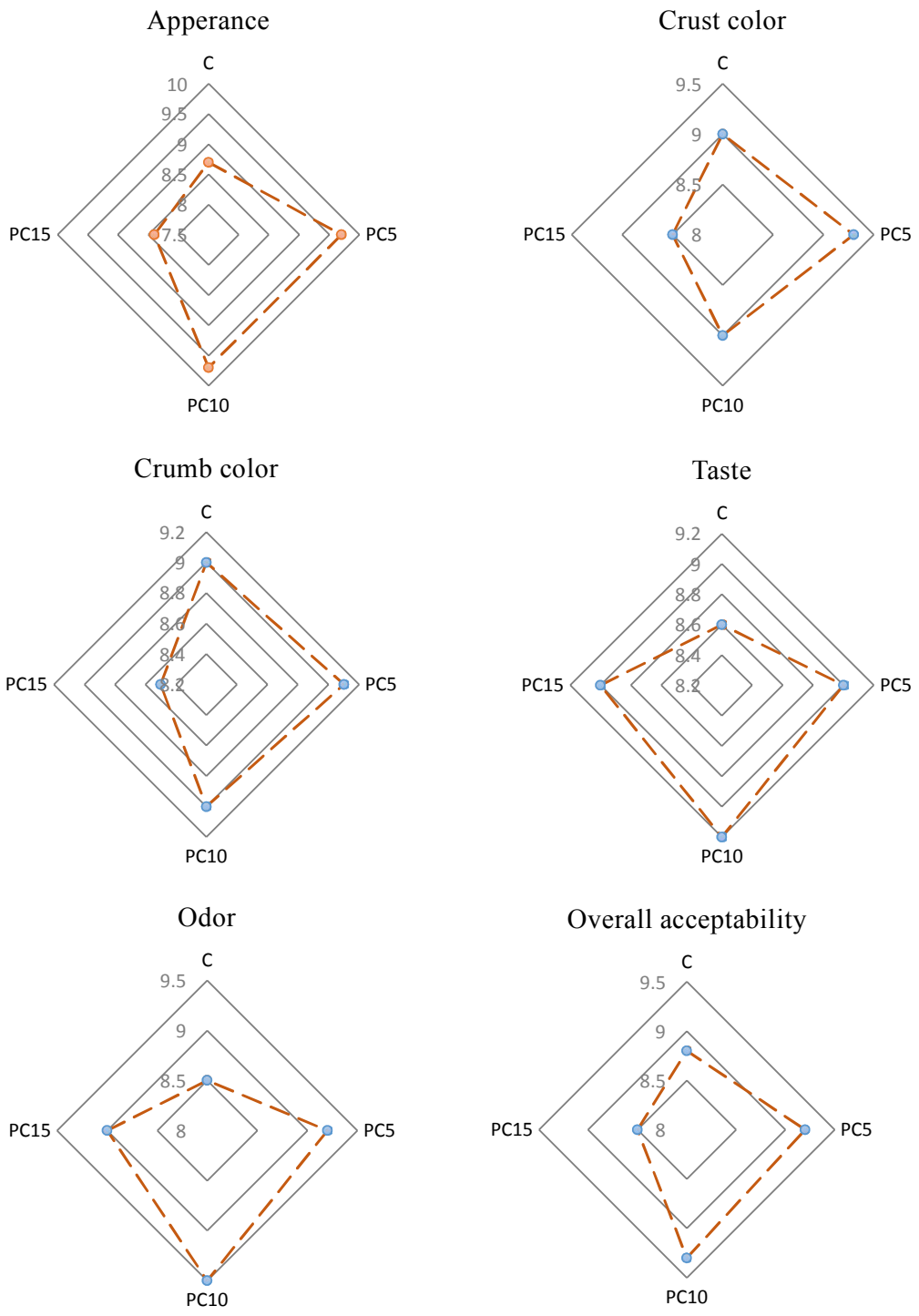

Fig. 6: Sensory evaluation of pumpkin blended cake.

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