

Original Research Article

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## Standardization of Recipes for Preparation of Pumpkin (*Cucurbita moschata*) Flour and its Quality Evaluation during Storage

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### ABSTRACT

#### Keywords

Dehydration, Pre-Treatments, Pumpkin Flour, Quality, Storage

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Pumpkin belongs to cucurbitaceae family grown widely in tropical and sub-tropical countries. Pumpkins are the sources of various functional compounds such as carotenoids, vitamins, minerals, dietary fibres, etc. Therefore, an attempt was made by drying of pumpkin for production of flour and its quality evaluation during storage. Different pre-treatments were applied to pumpkin shreds to standardize the method for preparation of pumpkin flour on the basis of chemical quality. The flour prepared from the best recipe (steam blanching for 5 minutes + dipping in 750 ppm KMS solution for 10 minutes followed by dehydration in mechanical cabinet drier (60±2 for 16-18 hours) was packed in low density polyethylene (LDPE) pouches and aluminium laminated pouches (ALP) and evaluated for quality attributes at intervals of 0, 3 and 6 months at ambient temperature. The pumpkin flour can be stored for 6 months at ambient temperature in LDPE as well as ALP with minimal changes in quality attributes. However, ALP was found to be comparatively better packaging material than LDPE pouches.

### Introduction

Pumpkin is one of the important vegetables of genus *Cucurbita* and family Cucurbitaceae. The genus *Cucurbita* is comprised of five domesticated species viz. *Cucurbita moschata*, *Cucurbita pepo*, *Cucurbita maxima*, *Cucurbita ficifolia* and *Telfairia occidentalis* (Caili *et al.*, 2006). *C. moschata*, *C. maxima* and *C. pepo* are the commonly grown and economically important species (Sharma and Rao, 2013).

The common varieties of pumpkin are CM-14, Pusha Vishwas, Arka Chandan, Arka Suryamukhi, CM-350, NDPK-24 (Kalloo *et al.*, 2006). There is a large variation in size, shape and color of pumpkin fruits. The average weight of fruit fluctuates between 8 and 10 kg and sometimes even up to 20 kg have been noticed (Seshadri, 1986). Pumpkin contains 88 per cent moisture, 4.08 per cent protein, 0.46 per cent fat, 15.27 mg/100 g  $\beta$ -carotene, 14.49 mg/100 g ascorbic acid, 1.018

per cent pectin, 0.62 per cent fiber, 8.3 °B TSS and 0.064 per cent acidity (Dhiman et al., 2018). The minerals present in pumpkin flesh are calcium, potassium, sodium, copper, iron, magnesium and manganese. Besides high nutritional value, pumpkin possesses many medicinal properties and is a rich source of biologically active compounds such as carotenoids, zeaxanthin, vitamin E, ascorbic acid, phytosterols, selenium and linoleic acid, which acts as antioxidant in human nutrition. Carotenoids play an important role in human health by acting as biological antioxidants, protecting cells and tissues from the damaging effects of free radicals and singlet oxygen (Jurgita et al., 2014).

Though pumpkin has been appreciated for high yields, good storage, longer period of consumption, high nutritive value yet, like most vegetables, it is a perishable crop whose characteristics change with time. Moreover, due to its bulkiness and large size, there are chances that it may get spoiled easily when it is cut open. Further, the large size and heaviness reduce its consumer acceptance and possess transportation problems (Pawar et al., 1985).

There are various methods which are used to preserve fruits and vegetables but most commonly used method is drying and dehydration. It is considered to be the oldest and the most important method of food preservation (Sacilik, 2007). Fruits and vegetables when converted into powders/flours have many benefits and economic potentials such as reduced volume, weight, packaging, easier handling, transportation, consumption and longer shelf life over their liquid counterpart (Phisut, 2012). Hence, keeping in view the abundant availability and functional significance of pumpkin the present study was undertaken to develop pumpkin flour and its quality evaluation during storage.

## **Materials and Methods**

The fully ripe pumpkins were procured from local market/*Sabzi mandi* of Solan and the packaging materials like Low Density Polyethylene (LDPE) pouches and Aluminum Laminated Pouches (ALP) were also brought from the Solan market.

## **Development and Standardization of technique for preparation of pumpkin flour**

The ripe pumpkins were washed and cut into halves. After removing the fluffy portion/brains/fibrous strands and seeds, the halves were cut into slices. The slices were peeled, washed, cut into pieces and grated to convert into shreds with the help of a grater. The shreds thus prepared were subjected to different pre-treatments for preparation of flour.

### **Control (T1)**

The pumpkin shreds used without any pre-treatment.

### **Blanching (T2)**

The prepared shreds were subjected to water and steam blanching treatments separately for different time period i.e. 1, 2, 3, 4, 5, 6 and 7 minutes in order to select the best treatment on the basis of peroxidase test and nutritional retention.

### **Blanching + Citric acid (T3)**

The blanched shreds were treated with different combinations of citric acid concentration (0.25, 0.5, 0.75 and 1.0 %) and dipping time (5, 10, 15 and 20 minutes). The shreds after treating were subjected to sensory evaluation by a panel of ten judges for selection of the best treatment.

### **Blanching + KMS (T4)**

The blanched shreds were treated using different concentration of KMS (250, 500, 750 and 1000 ppm) and time of dipping (5, 10, 15 and 20 minutes). The shreds were then subjected to sensory evaluation by a panel of ten judges for selection of the best treatment. The shreds of different selected pre-treatments were dried in different lots in a mechanical dehydrator at  $60 \pm 2$  °C for 16-18 hours prior to grinding into flours. The dried shreds were ground using a mechanical grinder. The grinded material was sieved through a 30 mesh metallic sieve to yield flour. The flour prepared was packed in two different packaging materials viz. Low density polyethylene (LDPE) pouches and Aluminum Laminated pouches (ALP). The packed flour was stored under ambient temperature for quality evaluation (chemical, functional and physical characteristics) at 0, 3 and 6 months intervals.

### **Physico-chemical, functional analysis and sensory evaluation**

The color of pumpkin flesh and peel was observed by Royal Horticulture Society color charts. Rehydration ratio, protein, fat,  $\beta$ -carotene, ascorbic acid and fiber content of pumpkin flour were estimated according to standard procedures by Ranganna (2009). Moisture and ash content of pumpkin flour was determined by method of AOAC (2012). Carbohydrate content and energy value was calculated by differential method of AOAC (1980). The water activity of pumpkin flour was estimated by computer digital water activity meter (HW<sub>3</sub> model, Rotronic International, Switzerland). Bulk density of pumpkin flour was measured by the method suggested by Rana *et al.*, (2015). Water and oil absorption capacity of pumpkin flour was determined as per the procedure of Sosulski *et al.*, (1976). Foaming capacity and foaming stability was calculated by the method

described by Narayana and Narsinga Rao (1982). Nine point hedonic scale method proposed by Amerine *et al.*, (1965) was followed for conducting the sensory evaluation of products. A panel of ten judges comprising of faculty members and post graduate students of the department of Food Science and Technology, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan (HP) were selected with care to evaluate the products for various sensory parameters such as color, texture, flavor, aroma and overall acceptability

### **Statistical analysis**

Data on physico-chemical characteristics of pumpkin and pumpkin flour before and during storage was analyzed by Completely Randomized Design (CRD) suggested by Cochran and Cox (1967). While Randomized Complete Block Design (RBD) as described by Mahony (1985) was used to analyze the data pertaining to sensory evaluation. The experiment for recipe standardization and storage studies was replicated three times.

### **Results and Discussion**

#### **Chemical characteristics of ripe pumpkin**

The data pertaining to chemical characteristics of ripe pumpkin are represented in Table 1.

#### **Standardization of method for preparation of pumpkin flour**

The results of blanching type and time treatment of pumpkin shreds are based upon the negative (-ve) peroxidase test. The pumpkin shreds showed negative peroxidase test after 4 minutes in water blanching and 5 minutes in steam blanching. Though the time duration in steam blanching was more than water blanching but keeping in view the retention of ascorbic acid and  $\beta$ -carotene which was more in steam blanching i.e. 83.26 and 80.54 per cent, respectively than water

blanching i.e. 75.13 and 71.1 per cent, respectively (Table 2). Therefore, steam blanching for 5 minutes was selected. The pumpkin shreds (steam blanching for 5 minutes) were subjected to different concentrations of citric acid solutions with varied time of dipping.

The data in (Table 3) shows that the highest mean scores for color (8.52), texture (8.50), flavor (8.45) and overall acceptability (8.55) are received by CA<sub>6</sub> (steam blanching for 5 minutes + 0.5 per cent citric acid dip for 10 minutes). Similarly, steam blanched pumpkin shreds were treated with different KMS solutions with varied time of dipping. The sensory evaluation data (Table 4) indicates that the maximum scores for color (8.67), texture (8.47), aroma (8.65), and overall acceptability (8.53) are obtained by KMS<sub>7</sub> (steam blanching for 5 minutes + 750 ppm KMS dip for 10 minutes).

**Chemical and functional characteristics of pumpkin flour**

The data on chemical and functional

characteristics of pumpkin flour with different treatments (T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub>) are shown in Table 5.

**Storage studies of pumpkin flour**

There was a non-significant effect of packaging material on rehydration ratio, foaming stability, fiber and ash content of pumpkin flour during storage period of 6 months. The overall effect of storage period reveals decrease in rehydration ratio from initial mean value of 6.03 to 5.91 during 6 months which was might be attributed to the reduction in water binding sites due to chemical and structural changes in major components of the product (Fig. 1a). Our findings are in conformity with the results of Karki (2009) in carrot pomace powder and Sharma *et al.*, (2011) in peach, plum and apricot fruit powders. Due to the overall effect of storage period of 6 months, foaming stability of pumpkin flour decreased from initial mean value of 6.76 to 6.14 per cent which was might be due to loss in functional quality of protein (Fig. 2e).

**Table.1** Chemical characteristics of ripe pumpkin

Characteristics	Pumpkin (Mean ± S.E)
Moisture (%)	86.10 ± 2.38
Total soluble solids (°B)	8.00 ± 0.72
Titration acidity (%)	0.06 ± 0.01
β-carotene (mg/100 g)	15.83 ± 1.01
Ascorbic acid (mg/100 g)	14.18 ± 0.94
Crude fibre (%)	0.64 ± 0.02
Ash (%)	0.88 ± 0.04
Crude Fat (%)	0.56 ± 0.10
Crude Protein (%)	1.45 ± 0.13
Carbohydrate (%)	10.35 ± 2.34
Energy value (Kcal)	52.29 ± 9.45

**Table.2** Effect of blanching on ascorbic acid and  $\beta$ -carotene content of pumpkin shreds

Blanching	Ascorbic acid (mg/100g)	Ascorbic acid (%)		$\beta$ -carotene (mg/100 g)	$\beta$ -carotene (%)	
		Retention	Loss		Retention	Loss
Without blanching	16.25	-	-	15.68	-	-
Water blanching	12.21	75.13	24.87	11.15	71.1	28.9
Steam blanching	13.53	83.26	16.74	12.63	80.54	19.46

**Table.3** Sensory evaluation score\* of pumpkin shreds treated with different concentration of citric acid and time of dipping

Treatment	Colour	Texture	Flavour	Overall acceptability
CA <sub>1</sub> (0.25 % for 5 minutes)	8.22	8.28	7.71	7.65
CA <sub>2</sub> (0.50 % for 5 minutes)	8.28	8.35	7.82	7.82
CA <sub>3</sub> (0.75 % for 5 minutes)	8.34	8.44	7.90	7.96
CA <sub>4</sub> (1.00 % for 5 minutes)	8.40	8.41	8.15	8.14
CA <sub>5</sub> (0.25 % for 10 minutes)	8.42	8.46	8.32	8.36
CA <sub>6</sub> (0.50 % for 10 minutes)	<b>8.52</b>	<b>8.50</b>	<b>8.45</b>	<b>8.55</b>
CA <sub>7</sub> (0.75 % for 10 minutes)	8.45	8.43	8.36	8.52
CA <sub>8</sub> (1.00 % for 10 minutes)	8.43	8.38	8.27	8.47
CA <sub>9</sub> (0.25 % for 15 minutes)	8.36	8.40	8.14	8.42
CA <sub>10</sub> (0.50 % for 15 minutes)	8.25	8.34	8.04	8.16
CA <sub>11</sub> (0.75 % for 15 minutes)	8.11	8.30	7.86	8.06
CA <sub>12</sub> (1.00 % for 15 minutes)	7.89	8.25	7.53	7.81
CA <sub>13</sub> (0.25 % for 20 minutes)	7.82	8.32	7.36	7.63
CA <sub>14</sub> (0.50 % for 20 minutes)	7.73	8.18	7.18	7.48
CA <sub>15</sub> (0.75 % for 20 minutes)	7.62	8.11	6.94	7.26
CA <sub>16</sub> (1.00 % for 20 minutes)	7.51	8.05	6.87	6.96
CD <sub>0.05</sub>	<b>0.07</b>	<b>0.06</b>	<b>0.04</b>	<b>0.04</b>

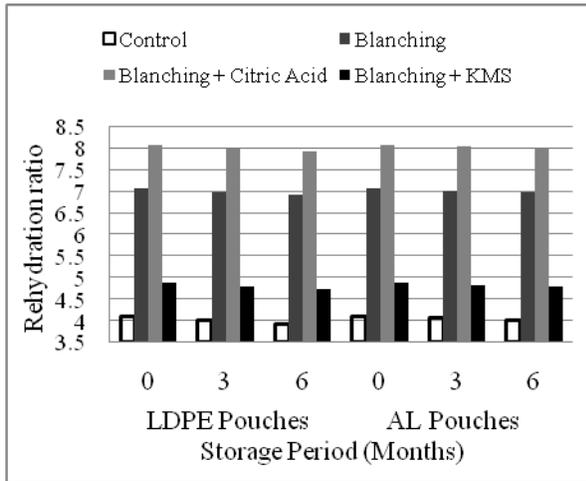
**Table.4** Sensory evaluation score of pumpkin shreds treated with different concentration of KMS and time of dipping

Treatment	Colour	Texture	Aroma	Overall acceptability
KMS <sub>1</sub> (250 ppm for 5 minutes)	8.12	8.24	7.84	7.94
KMS <sub>2</sub> (500 ppm for 5 minutes)	8.20	8.27	8.06	8.07
KMS <sub>3</sub> (750 ppm for 5 minutes)	8.36	8.32	8.15	8.15
KMS <sub>4</sub> (1000 ppm for 5 minutes)	8.32	8.35	8.31	8.23
KMS <sub>5</sub> (250 ppm for 10 minutes)	8.44	8.40	8.42	8.34
KMS <sub>6</sub> (500 ppm for 10 minutes)	8.51	8.43	8.53	8.46
KMS <sub>7</sub> (750 ppm for 10 minutes)	<b>8.67</b>	<b>8.47</b>	<b>8.65</b>	<b>8.53</b>
KMS <sub>8</sub> (1000 ppm for 10 minutes)	8.62	8.42	8.37	8.45
KMS <sub>9</sub> (250 ppm for 15 minutes)	8.60	8.37	8.16	8.36
KMS <sub>10</sub> (500 ppm for 15 minutes)	8.56	8.33	7.95	8.25
KMS <sub>11</sub> (750 ppm for 15 minutes)	8.48	8.28	7.77	8.18
KMS <sub>12</sub> (1000 ppm for 15 minutes)	8.40	8.24	7.53	8.07
KMS <sub>13</sub> (250 ppm for 20 minutes)	8.36	8.19	7.25	7.94
KMS <sub>14</sub> (500 ppm for 20 minutes)	8.30	8.14	7.06	7.82
KMS <sub>15</sub> (750 ppm for 20 minutes)	8.25	8.10	6.72	7.63
KMS <sub>16</sub> (1000 ppm for 20 minutes)	8.22	8.06	6.27	7.43
CD <sub>0.05</sub>	<b>0.03</b>	<b>0.04</b>	<b>0.02</b>	<b>0.02</b>

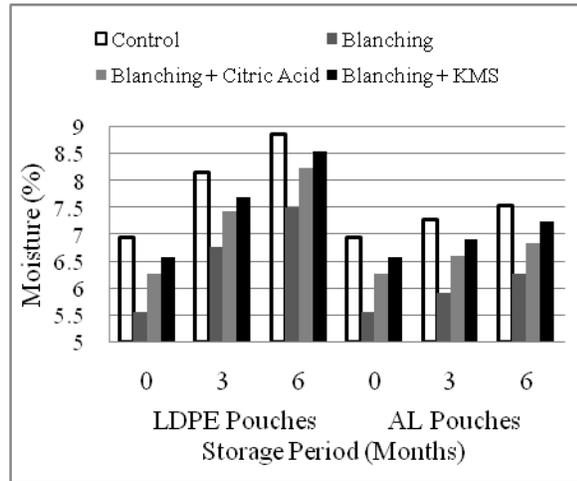
**Table.5** Chemical and functional characteristics of pumpkin flour

Chemical characteristics	(T <sub>1</sub> )	(T <sub>2</sub> )	(T <sub>3</sub> )	(T <sub>4</sub> )
Moisture (%)	6.94 ± 0.10	5.55 ± 0.31	6.27 ± 0.32	6.58 ± 0.25
Water activity (a <sub>w</sub> )	0.28 ± 0.03	0.21 ± 0.01	0.21 ± 0.01	0.24 ± 0.01
Ash (%)	5.54 ± 0.40	5.52 ± 0.08	5.51 ± 0.29	5.53 ± 0.07
Fat (%)	1.83 ± 0.30	1.56 ± 0.17	1.21 ± 0.12	1.40 ± 0.18
Fibre (%)	2.72 ± 0.04	2.67 ± 0.05	2.65 ± 0.04	2.70 ± 0.04
Protein (%)	5.72 ± 0.06	5.83 ± 0.05	5.64 ± 0.06	5.87 ± 0.04
Ascorbic acid (mg/100 g)	24.43 ± 0.66	19.37 ± 1.66	20.55 ± 1.03	21.60 ± 1.11
β-carotene (mg/100 g)	15.43 ± 0.95	18.36 ± 0.83	15.47 ± 0.71	19.55 ± 0.82
Carbohydrate (%)	77.25 ± 0.51	77.28 ± 0.37	78.72 ± 0.18	77.92 ± 0.34
Energy value (Kcal)	348.38 ± 1.01	346.51 ± 1.75	348.33 ± 1.30	347.76 ± 1.29
<b>Functional characteristics</b>				
Bulk density (g/ml)	0.60 ± 0.01	0.65 ± 0.01	0.59 ± 0.01	0.61 ± 0.01
Water absorption capacity (g/g)	2.56 ± 0.18	4.24 ± 0.12	7.55 ± 0.31	3.59 ± 0.08
Oil absorption capacity (g/g)	1.36 ± 0.10	1.67 ± 0.07	1.62 ± 0.08	1.69 ± 0.03
Foaming capacity (%)	6.54 ± 0.42	7.62 ± 0.40	5.46 ± 0.42	7.91 ± 0.34
Foaming stability (%)	6.06 ± 1.04	6.65 ± 1.06	5.56 ± 1.13	8.75 ± 0.97

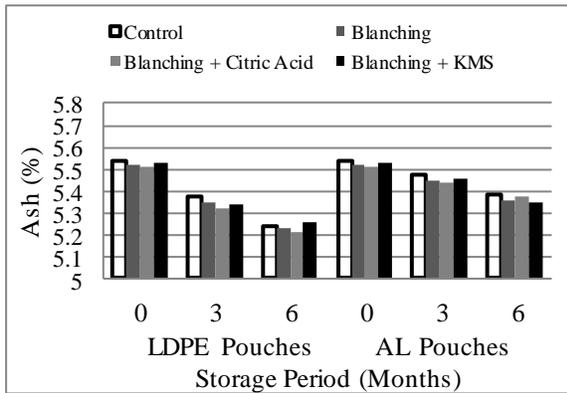
**Fig.1** Storage studies of pumpkin flour



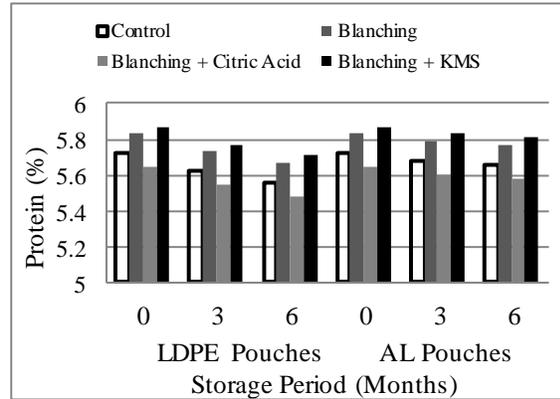
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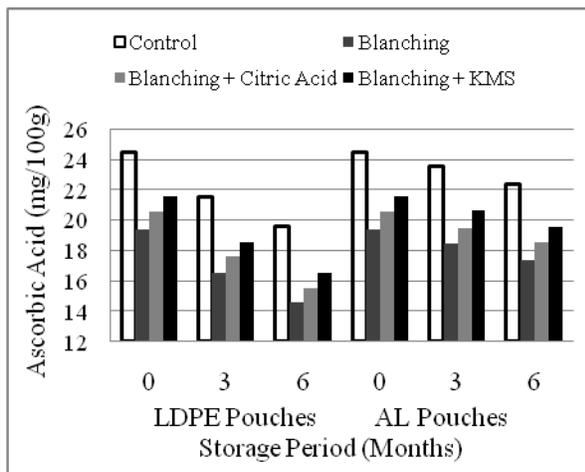
(b)



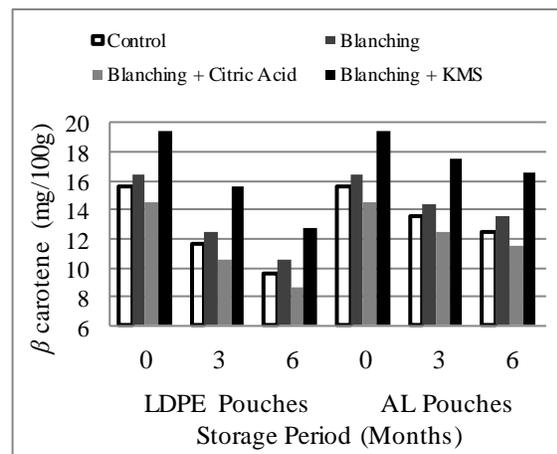
(c)



(d)

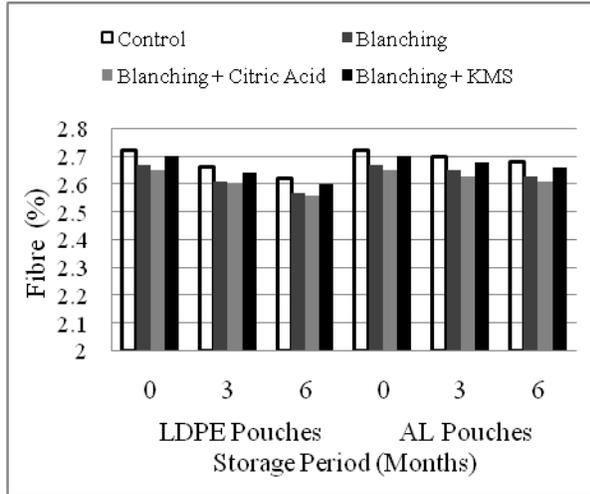


(e)

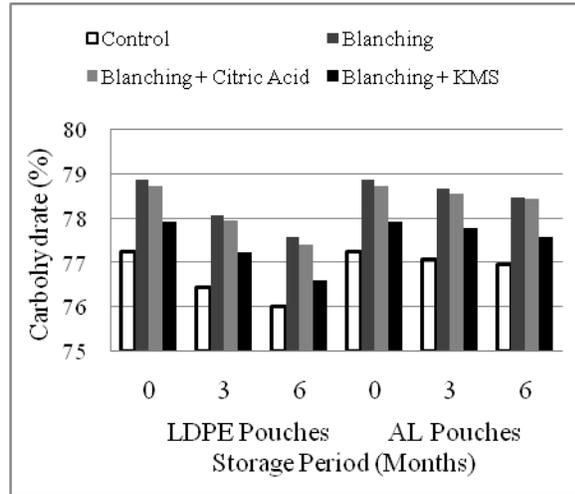


(f)

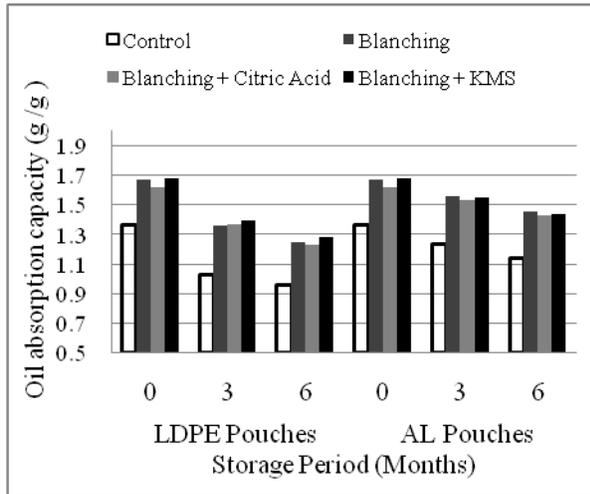
**Fig.2** Storage studies of pumpkin flour



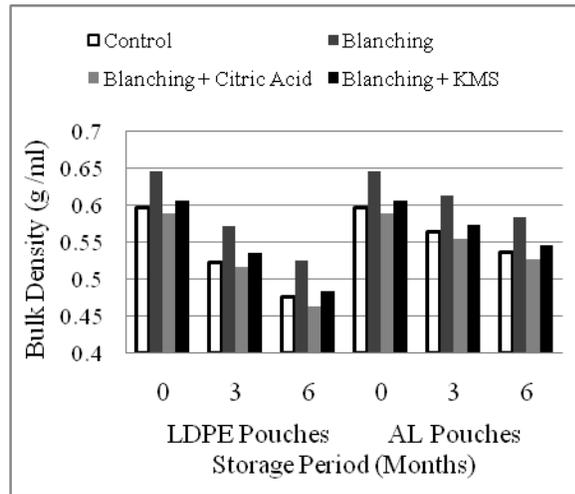
(a)



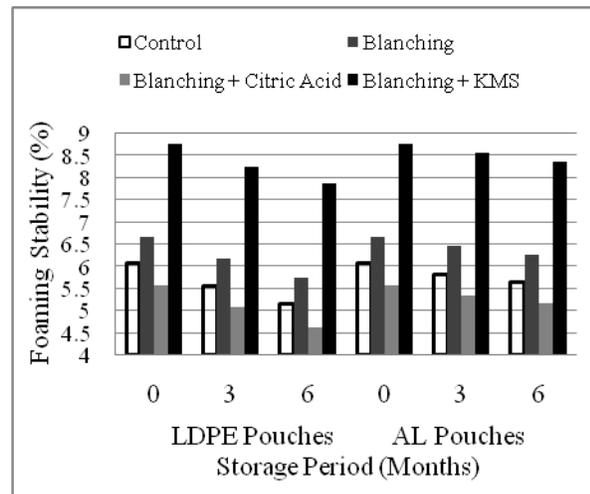
(b)



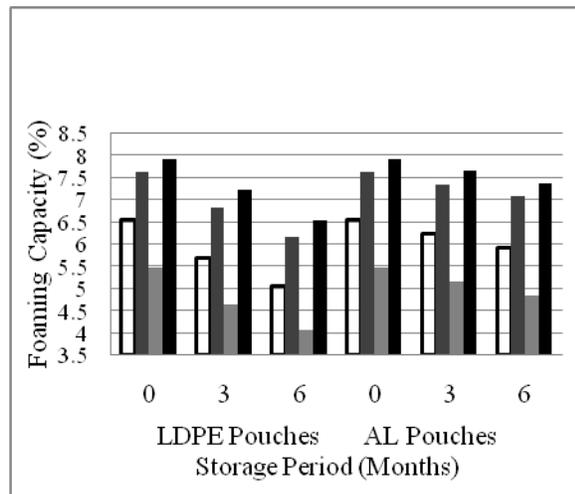
(c)



(d)



(e)



(f)

The overall effect of storage period reveals a decrease in fiber content of pumpkin flour from an initial mean value of 2.69 to 2.62 per cent during 6 months of storage which was might be due to solubilization of polysaccharides (Fig. 2a). The present results are in agreement with those of Misra and Kulshrestha (2003) and Obadina *et al.*, (2016) in potato flour and cocoyam flour, respectively. The overall effect of storage period of 6 months depicts decrease from initial mean value of 5.56 to 5.31 per cent in ash content which was might be either attributed to absorption of moisture by flour or due to biochemical activities by microorganisms (Fig. 1c). A similar decreasing trend for ash content during storage has been reported by Sharma *et al.* (2002) in lemon powder, Misra and Kulshrestha (2003) in potato flour and Kumar and Thakur (2017) in Indian horse chest nut flour.

The pumpkin flour showed a significant increase in moisture content from mean value of 6.33 to 8.28 and 6.98 per cent in LDPE pouches and ALP, respectively during storage of 6 months (Fig. 1b). The increase in moisture might be due to the hygroscopic nature of flour. The more uptake of moisture in flour packed in LDPE pouches might be due to high permeability to air and moisture. Almost the same trend of change in moisture content has been observed in apple powder by Sharma *et al.* (2003), in ginger powder by Rahman *et al.*, (2013) and in spray dried papaya powder Wong and Lim (2016).

A significant decrease in bulk density, oil absorption capacity, foaming capacity, protein, ascorbic acid,  $\beta$ -carotene, carbohydrate content was recorded in pumpkin flour during the storage period of 6 months. The bulk density was found to decrease from initial mean value of 0.609 to 0.487 g/ml in LDPE pouches and 0.548 g/ml in ALP (Fig. 2d). This may be attributed to the

increase in moisture content which affects the flour particle size. Similar trend of results has been revealed by Obadina *et al.*, (2016) in cocoyam flour, Kumar and Thakur (2017) in Indian horse chestnut flour, Adebawale *et al.*, (2017) in water yam flour. A decrease in oil absorption capacity from initial mean value of 1.58 to 1.18 and 1.37 g/g was observed in pumpkin flour packed in LDPE pouches and ALP, respectively (Fig. 2c).

The decrease was might be due to reduced ability of the flours to entrap fat to its apolar end of protein chain as a result of decrease in protein content (Adeleke and Odedeji, 2010). Similar trend of results have been reported by Adebawale *et al.*, (2017) in water yam flour and Akusu and Kinn (2013) in ogbono flour. Similarly, foaming capacity of pumpkin flour was also found to decrease from mean value of 6.88 to 5.45 per cent in LDPE pouches and 6.30 per cent in ALP during storage of 6 months (Fig. 2f). These results are in compliance with the findings of Giami *et al.*, (2000) in African breadfruit seed flour.

The protein content of pumpkin flour was found to decrease from initial mean value of 5.77 to 5.61 and 5.71 per cent in LDPE pouches and ALP, respectively during 6 months of storage which was might be due to their denaturation and breakdown into smaller peptides (Fig. 1d). Our results are in conformity with the findings of Misra and Kulshrestha (2003) in potato flour, Butt *et al.*, (2004) in wheat flour and Shahzadi *et al.*, (2005) in composite flour. A decrease in ascorbic acid content from mean value of 21.49 to 16.56 mg/100g in LDPE pouches and 19.47 mg/100g in ALP was recorded in pumpkin flour stored for 6 months (Fig. 1e). The decline was more in LDPE pouches due to reaction by light because of transparency in nature. The loss during storage might be attributed to its oxidation to dehydroascorbic acid followed by the hydrolysis of

dehydroascorbic acid to 2, 3-diketogluconic acids, which then undergoes polymerization to other nutritionally inactive products. The findings of the present study are in agreement with the results noticed by Sharma *et al.*, (2003), Rahman *et al.*, (2013) and Verma *et al.*, (2015) in apple powder, ginger powder and guava powder, respectively.

The  $\beta$ -carotene content of pumpkin flour was found to decrease from an initial mean value of 16.45 to 10.35 and 13.56 mg/100g in LDPE pouches and ALP, respectively during storage of 6 months (Fig. 1f). The retention was more in ALP was due to barrier properties to the light. The loss was might be due to the photosensitive nature, isomerization and epoxide forming nature of carotene and oxidative degradation of carotenoids during storage. These results are similar to the findings of Kulkarni and Joshi (2014) in pumpkin flour and Wong and Lim (2016) in spray dried papaya powder. The pumpkin flour showed a slight decrease in carbohydrate content from mean value of 78.19 to 76.90 per cent in LDPE pouches and 77.86 per cent in ALP during 6 months storage (Fig. 2b). The decrease was might be attributed to increase in moisture content which leads to rapid growth of microorganisms whose metabolic activities causes production of enzymes amylases that catalyze biochemical reactions which breakdown carbohydrates in food (Achi and Akubor, 2000). The results are in accordance with the findings of Obadina *et al.*, (2016) in cocoyam flour and Adebowale *et al.*, (2017) in water yam flour.

In conclusion, pumpkin can be dried and converted into flour of high nutritive value with health benefits. The pre-treatment standardized for preparation of pumpkin flour was steam blanching for 5 min + 750 ppm KMS dip for 10 minutes on the basis of chemical quality. The pumpkin flour can be stored for 6 months at ambient temperature in

LDPE pouches and ALP with minimal changes in quality attributes. However, comparatively fewer changes were observed in flour packed in ALP than LDPE pouches.

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