

RESEARCH PAPER

## Effect of Different Packaging Material and Storage Duration on Osmo-Convective Dried Cashew Apple Flour Bagels

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Paper No.: 336

Received: 28-09-2025

Revised: 30-11-2025

Accepted: 09-12-2025

### ABSTRACT

This study was conducted to effect of different packaging material and storage duration on dried cashew apple flour bagels. Bagels were prepared using from Osmo-convective dried cashew apple flour, baked at a temperature 180°C and baking time is 25 minutes. Bagels can be stored up to 8 days. For storage duration Polypropylene (PP), and Low-Density Polyethylene (LDPE), packaging material are used. In comparison to the different packaging materials, it was observed that PP followed by best packaging material during the 8<sup>th</sup> days of storage studies. As the storage duration increases, the moisture content % and carbohydrate content % continues to increased and fat, protein, ash, fiber content % was decreased. Result revealed that the PP contain less amount of moisture and fat content % and good amount protein, ash, fiber, carbohydrate content %. compare to other packaging material During 8<sup>th</sup> days storage also results shows that the effect of different packaging material and storage duration on various sensory attributes. It was observed that as the storage duration increases the sensory score for colour, flavour, taste, texture and overall acceptability goes on decreasing.

**Keywords:** Osmo-convective dried Cashew apple powder, bagels, Shelf-life, Packaging material, Sensory attributes

The cashew tree or *Anacardium occidentale* belongs to the *Anacardiaceae* family, characterized by tropical and sub-tropical trees (Oliveira *et al.* 2020). Cashew is one of the major horticultural crops of Konkan region, mainly grown on hill slopes as rain-fed perennial crop (Desai *et al.* 2010). Cashew, an essential commercial cash crop of India, is also considered as 'Gold mine' from the wastelands. Cashew apple is highly nutritious and contains an enormous number of sugars, minerals, and vitamins. Several studies reported that cashew apple has three to six folds more Vitamin C than orange and ten times more than that of pineapple (Kannan *et al.* 2021).

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Dapoli, Maharashtra, has released and recommended the eight varieties of cashew viz., Vengurla 1, 2, 3, 4, 5, 6, 7 and 8; among which "Vengurla-4" is one of the preferred varieties by farmers of Konkan region because of larger size of cashew nut and higher productivity. Vengurla-4 has fruiting period in February-May months and the colour of apple is red. The Juice percentage was 76 %, number of nuts 140 per kg and mean nut yield 17.2 kg/tree (Anonymous, 2017).

**How to cite this article:** Yadav, S.S., Swami, S.B. and Salvi, S.P. (2025). Effect of Different Packaging Material and Storage Duration on Osmo-Convective Dried Cashew Apple Flour Bagels. *Int. J. Food Ferment. Technol.*, 15(02): 461-479.

Source of Support: None; Conflict of Interest: None



Drying of cashew apple into powder is an excellent alternative to increase its shelf life. It allows conversion of perishable materials into stabilized products by lowering the water activity into appropriate levels (Uchoa *et al.* 2009). The baking industry is one of the most vital sectors in the global food industry. It includes the production of baked goods like bread, cakes, cookies, biscuits, pastries, and bagels etc. Bagels are a unique and enduring product in the baking industry, known for their distinctive chewy texture, glossy crust and round shape. Originating from the Jewish communities of Poland in the early 17<sup>th</sup> century Balinska, (2008).

Bagels which are used in many ways as breakfast items, sandwich bases, or snacks. Their ability to pair with sweet or Savory fillings makes them popular with wide range of consumers (Lent and Grant, 2001).

The present study was carried out to assess the quality and shelf life of osmo-convective dried cashew apple flour supplemented bagels stored under different set of conditions. The aim of this study is therefore to evaluate the impact of different storage parameters on the shelf life of bagels.

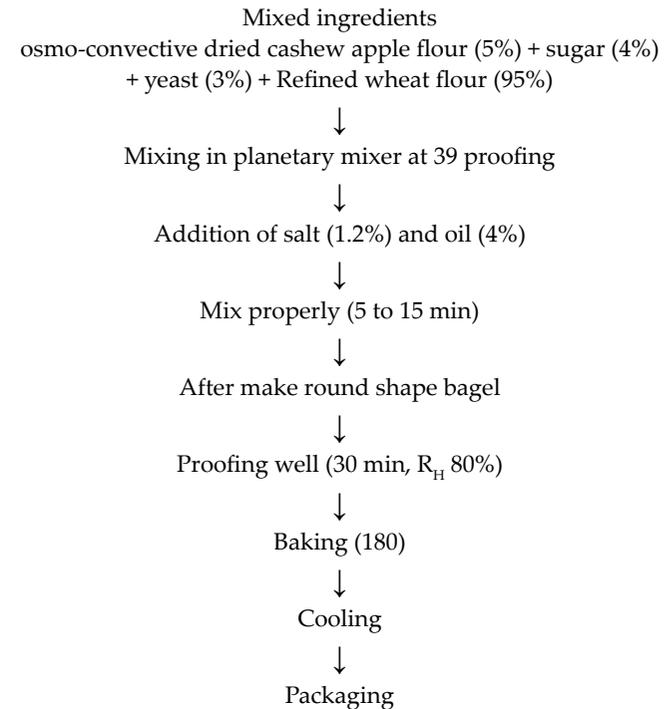
## MATERIALS AND METHODS

### Materials

Cashew apple required for experimentation was collected from the Vengurla, Tal. Vengurla, Dist. Sindhudurg. The cashew apple was cleaned, washed with water and the damaged, infected apples were removed before beginning of experiments. The cashew apple slices of 'Vengurla-4' variety having 5 mm thickness, 60 °B osmotic concentration and 50 °C syrup temperature and 210 minutes osmotic drying were dried in the convective hot air dryer at 50 °C were grounded by using hammer mill (Make: M/S. Sagar Engineering Works Pvt. Ltd, Kudal) and pass through the 0.150 mm sieve to obtain Osmo convective dried cashew apple powder. The experimental work was carried out in Department of Post harvest Engineering of Post Graduate Institute of Post Harvest Technology and Management, Killa Roha.

## Methods

### 1. Bagels Making



**Fig. 1:** Process flow chart for preparation of bagels from osmo-convective dried cashew apple flour

Fig. 1 shows the process technology for preparation of bagels from osmo-convective dried cashew apple flour. The osmo-convective dried cashew apple flour of best treatment C1 (5%) and refined wheat flour of level (95%) were mixed together. Mixed well up to foam formation, which was defected through visual observation. The mixture was added with the sugar (4%), yeast (1.2%), improver (1.2%) and salt (1.2%), edible oil (4%), water (50 ml) were used as per treatment combination to make flour composition, and it was added according to the treatment, and it was added into the earlier dough mass and the mixture was thoroughly mixed to a homogeneous mixture to form a dough. The dough poured proofing well and giving the round shape. The bagels were placed in baking tray and baked in oven at about 180° 25 minutes. The flour combination concentration C1 at baking temperature is 180° are present in Fig.1 shows the bagels prepared from best concentration/

treatment (C1T1). Control sample was procured from the market and considered as a control for comparison with the above treatment.

**Storage studies**

The bagels from cashew apple flour packed P1= Polypropylene and P2=Low-Density polyethylene samples were subjected to storage studies at ambient temperature (32±1°). The sample stored at ambient temperature were analysed 0, 2,4,6 and 8 days for physicochemical properties Moisture (%), Protein (%), Fat (%), Fiber (%), Ash (%), Carbohydrate (%), Colour and sensory qualities like colour, flavour, texture, taste and overall acceptability.

**Evaluation of Quality Parameter for development of bagels from osmo-convective dried cashew apple flour.**

**1. Moisture content (%)**

Initial moisture content of the sample osmo-convective dried cashew apple flour bagel packed in Polypropylene and Low-density polyethylene bags at 0,2,4,6 and 8 days storage duration were determined by AOAC (2010). 5 g of bagel sample taken into the

moisture box with lid. The initial weight of moisture box was recorded. The sample were exposed to 105°C ±1°C for 24 hr in a hot air oven (Make M/s: Aditi Associate, Mumbai. Model: ALO-136). The final weight was recorded. The moisture content of sample was determined by equation (1);

$$\text{Moisture content (\% db.)} = \frac{W_2 - W_1}{W_3 - W_1} \times 100 \quad \dots(1)$$

Where,

W<sub>1</sub> = Weight of moisture box, g

W<sub>2</sub> = Weight of moisture box + sample g

W<sub>3</sub> = Weight of moisture box + oven dried sample g

**2. Fat content (%)**

Fat content of bagel sample prepared from osmo-convective dried cashew apple flour packed in Polypropylene and Low-density polyethylene bags at 0,2,4,6 and 8 days storage duration were determined using Solvent extraction in a soxhlet apparatus as described by James, (1995). Two grams of each bagel sample wrapped in filter paper and placed in a Soxhlet reflux flask which is connected to a condenser on the upper side and to a weighted oil

**Table 1:** Shows the details of Packaging materials used for storage studies

Sl. No.	Name of the packaging material	Size of the packaging material	Thickness of packaging material	Capacity
1	Polypropylene	8 × 10 inch	75 Micron	2 pieces
2	Low density polyethylene	7 × 12 inch	+51 Micron	2 pieces



(a) Polypropylene



(b) Low density polyethylene

**Fig. 2:** Packaging material used for storage and packaging of bagels

extraction flask full with two hundred mili petroleum ether. The ether was brought to its boiling point; the vapour condensed into the reflux flask immersing the samples completely for extraction to take place on filling up the reflux flask siphons over carrying the oil extract back to the boiling solvent in the flask. The process of boiling, condensation, and reflux was allowed to go for hours before the defatted samples were removed. The oil extract in the flux was dried in the oven 60° for thirty minutes and weighted. The experiment was repeated for three times replication. The average reading reported.

$$\% \text{ Fat} = \frac{W_4 - W_3}{W_2 - W_1} \times 100 \quad \dots(2)$$

Where,

$W_1$  = Weight of oven dried thimble,

$W_2$  = Weight of sample used,

$W_3$  = Weight of round bottom flask,

$W_4$  = weight of round bottom flask with fat residue

### 3. Ash content (%)

The ash content of bagel sample prepared from osmo-convective dried cashew apple flour packed in Polypropylene and Low-density polyethylene bags at 0,2,4,6 and 8 days storage duration were determined using the method of AOAC (1990) porcelain crucible were dried and cooled in desiccators before weighing. Five grams of the bagel sample were weighted into the crucible and the weight was taken. The crucible containing the samples were placed into the muffle furnace at 500°. This temperature was maintained for three hours. The muffle furnace was allowed to cool; the crucible was then brought out, cooled and weighted. The ash content was calculated as follows the experiment was repeated for three times for replication the average reading reported.

$$\text{Ash content \%} = \frac{(W_2 - W_1)}{(\text{Weight of sample})} \times 100 \quad \dots(3)$$

Where,

$W_2$  = Weight of crucible + ash;  $W_1$  = Weight of empty crucible

### 4. Protein content (%)

Protein content of bagels sample prepared from osmo-convective dried cashew apple flour packed in Polypropylene and Low density polyethylene bags at 0,2,4,6 and 8 days storage duration were determined by a micro-Kjeldahl distillation method (AOAC, 1990). The sample were digested by heating with concentrated sulphuric acid ( $H_2SO_4$ ) in the presence of digestion mixture, potassium sulphate ( $K_2SO_4$ ) and copper sulphate ( $CUSO_4$ ). The mixture was made alkaline with 40% NaOH. Ammonium sulphate thus formed. Released ammonia which collected in 4% boric acid solution and titrated again with standard HCL. The percent nitrogen content of the sample was calculated by the formula given below. Protein content was calculated by using equation (4);

$$\% (N) = 1.4 \times (\text{ml HCL} - \text{ml blank}) \times \text{Conc.}$$

$$\text{of } \frac{HCL}{Weight} \text{ of sample (g)} \quad \dots(4)$$

$$\% \text{ Protein} = \% N \times \text{Factor (6.25)} \quad \dots(5)$$

### 5. Crude Fiber (%)

About 2 g fat free residue of bagel sample prepared from osmo-convective dried cashew apple flour packed in Polypropylene and Low-density polyethylene bags at 0,2,4,6 and 8 days storage duration were taken and then transferred to the digestion flask. 200 ml boiling sulphuric acid was added and immediately the flask was connected to condenser. The flask was heated, boiled by frequently rotating for 30 min. and the volume was maintained with hot water Then filtered through filter cloth in a fluted funnel. The residue was washed on cloth with hot water or potassium sulphate solution. The residue was returned to digestion flask by washing with hot water. 200 ml boiling sodium hydroxide was added and boiled for 30 min. The volume was adjusted with boiling water, filtered through the muslin cloth and the residue free of alkali was washed. The residue was transferred into crucible and washed with 15 ml alcohol and the crucible was dried at 110° for 2 hours. The crucible was cooled in desiccators and weighted the crucible was ignited in the furnace at

550° for 30 min then cooled and weighted. The loss in weight represented the crude fiber. The experiment was repeated three times and average reading was repeated.

$$\text{Crude Fiber (\%)} = \frac{(W_1 - W_2)}{\text{Weight of sample (g)}} \times 100 \quad \dots(6)$$

Where,

$W_1$  = Weight of material before ashing (g)

$W_2$  = Weight of material after ashing (g)

### 6. Carbohydrate (%)

Carbohydrate content fresh bagels sample prepared by osmo-convective dried cashew apple flour packed in Polypropylene and Low-density polyethylene bags at 0,2,4,6 and 8 days storage duration were determined by a subtracting the total sum of protein, fiber, ash and fat from the product sample James, (1995). The carbohydrate was calculated by using following equation (5);

$$\% \text{ Carbohydrate} = 100 - (\% \text{protein} + \% \text{ fat} + \% \text{ fiber} + \% \text{ ash} + \% \text{ moisture content}) \quad \dots(7)$$

### Sensory Evaluation

Sensory evaluation of dried cashew apple flour bagels baked at 180°C temperature for 25 min. baking time and stored in different packaging materials for 8 days of storage duration with the interval of 0, 2, 4, 6 and 8 days from storage day was conducted.

## RESULTS AND DISCUSSION

### Effect of different packaging material and storage duration on moisture content (%) of osmo-convective dried cashew apple flour bagels during 8 days storage duration

Fig. 2 Shows the effect of packaging material and storage duration (0, 2, 4, 6, 8) and on Moisture content (%) of bagels from osmo-convective dried cashew apple flour. The moisture (%) of bagels prepared from osmo-convective dried cashew apple flour. The moisture content varies in the range of 31.061±0.04 to 33.101±0.09 % and which was packed in PP bag increase from 31.061±0.04 to 33.072±0.01o for 0 to 8 days of storage period and for LDPE bag moisture content (%) increases from for 31.061±0.01 to 33.081±0.12 for 0 to 8 days of storage period respectively. And bagels

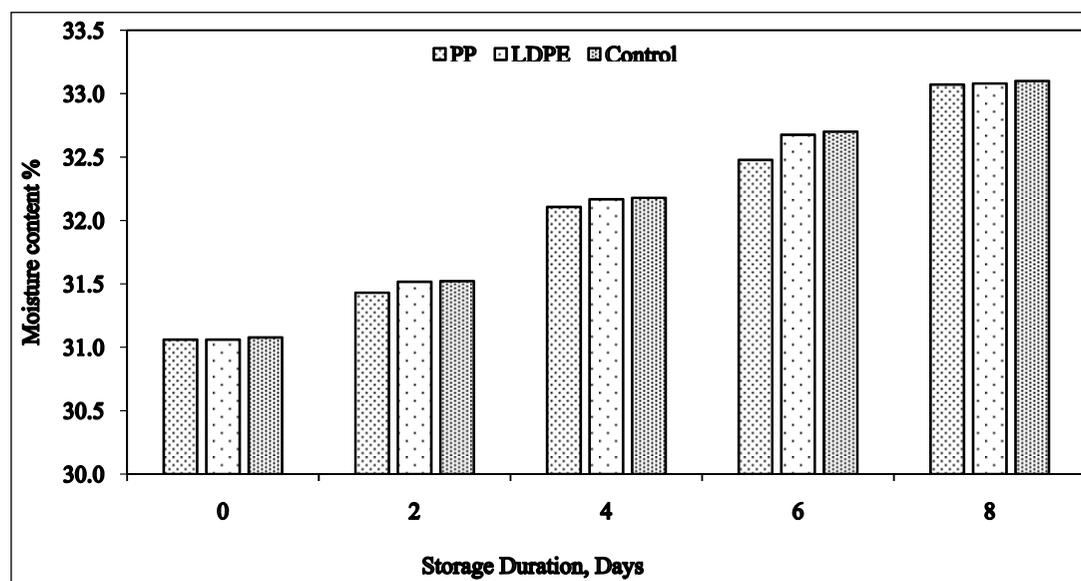


Fig. 2: Effect of various Packaging materials (PP=Polypropylene; LDPE=Low density polyethylene; C= Control) on moisture content % of osmo-convective dried cashew apple flour bagels during eight days storage duration

**Table 2:** Effect of different packaging material (PP=Polypropylene; LDPE=Low density polyethylene; C= Control) and storage duration (0, 2, 4, 6 and 8 Days) on moisture content (%) of stored osmo-convective dried cashew flour bagels, during 8 days of storage duration

Packaging Material (A)	Storage Duration (Days) (B)					Mean A
	0	2	4	6	8	
PP	31.061±0.04	31.431±0.34	32.107±0.01	32.479±0.10	33.072±0.01	32.03
LDPE	31.061±0.01	31.518±0.05	32.168±0.13	32.676±0.10	33.081±0.12	32.100
Control	31.079±0.05	31.523±0.17	32.179±0.12	32.701±0.07	33.101±0.09	32.116
<b>Mean B</b>	31.067	31.490	32.151	32.618	33.084	
<b>Factors</b>	<b>C.D.</b>			<b>SE(m)</b>		
Factor (A)	0.114			0.040		
Factor (B)	0.224			0.075		
Factor (A × B)	0.318			0.106		

which was control sample increase from 31.079±0.05 to 33.101±0.09%. From Fig. 2 it is clear that as storage period increases, the moisture (%) of bagel prepared from osmo-convective dried cashew apple flour packed in PP bags and LDPE bag increases.

Table 2 Shows the ANOVA for the effect of packaging material and storage duration on moisture content (%) of bagels prepared from osmo-convective dried cashew apple flour w.r.t packaging material, storage duration and their interaction. From Table 2 bagel prepared from osmo-convective dried cashew apple flour at  $p \leq 0.05$  and storage duration had significant influence on moisture (%) of bagel prepared from osmo-convective dried cashew apple flour at  $p \leq 0.05$ . The interaction of both packaging material and storage duration showed the non-significant influence on moisture content of bagels prepared from osmo-convective dried cashew apple flour significant at  $p \leq 0.05$ .

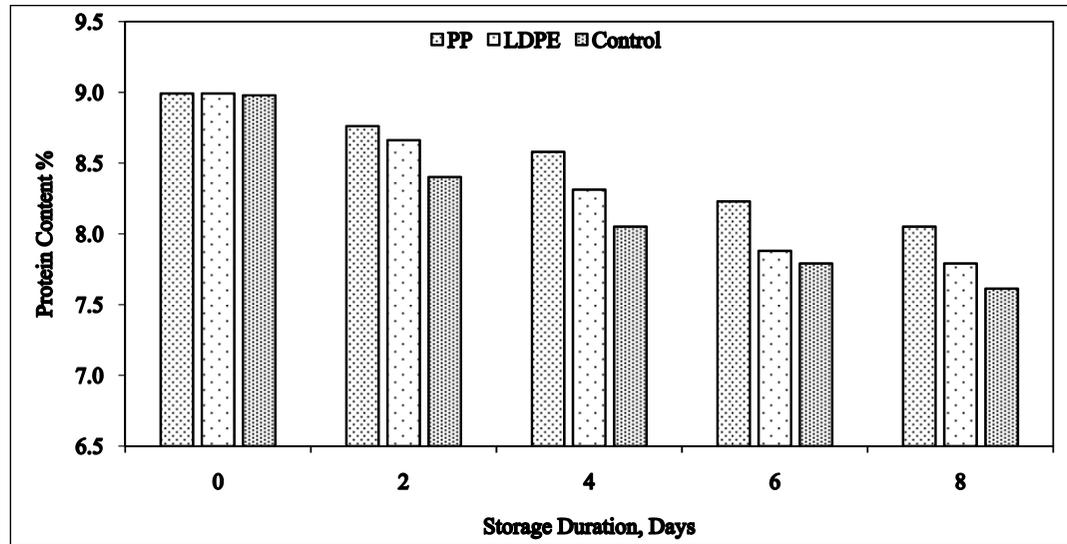
Similarly, Aliani *et al.* 2012 reported that the bagels prepared from milled flaxseed i.e. product increases moisture content from 28.17 to 29.09 %. Similarly, Lent and Grant, 2001 observed that the bagels prepared from xanthan gum or monoglyceride i.e. product increases moisture content from 29.08 to 31.56 % from 7 days storage period. According to Cross, (2007) reported that the bagels prepared from

rye flour i.e. product increases moisture content from 20.67 to 23.11 %.

Similarly, Saraaf *et al.* 2016 reported that the doughnut prepared from Oleaster Flour i.e. product increases moisture content 31.02 to 34.18 %. According to Eckert *et al.* 2018 reported that the doughnut prepared from barley and lentil flour i.e. product increases moisture content from 19.7 to 21.9%.

#### Effect of different packaging material and storage duration on protein content (%) of osmo-convective dried cashew apple flour bagels during 8 days storage duration

Fig. 3 Shows the effect of packaging material and storage duration (0, 2, 4, 6, 8) and on protein content (%) of bagels from osmo-convective dried cashew apple flour. The protein (%) of bagels prepared from osmo-convective dried cashew apple flour. The protein content varies in the range of 7.61 to 9.01% and which was packed in PP bag decrease from 8.992 to 8.05 % for 0 to 8 days of storage period and for LDPE bag protein content (%) decreases from 8.992 to 7.79 % for 0 to 8 days of storage period respectively. And bagels which was control sample decrease from 8.980 to 7.61%. Fig. 3, it is clear that as storage period increases, the protein (%) of bagel prepared from osmo-convective dried cashew apple flour packed in PP bags and LDPE bag decreases.



**Fig. 3:** Effect of various Packaging materials (PP=Polypropylene; LDPE=Low density polyethylene; C= Control) on protein content % of osmo-convective dried cashew apple flour bagels during eight days storage duration

**Table 3:** Effect of different packaging material (PP=Polypropylene; LDPE=Low density polyethylene; C= Control) and storage duration (0, 2, 4, 6 and 8 Days) on protein content (%) of stored osmo-convective dried cashew flour bagels, during 8 days of storage duration

Packaging Material (A)	Storage Duration (Days) (B)					Mean A
	0	2	4	6	8	
PP	8.992±0.01	8.762±0.18	8.580±0.07	8.230±0.13	8.052±0.09	8.523
LDPE	8.992±0.05	8.663±0.36	8.313±0.18	7.880±0.12	7.791±0.08	8.327
Control	8.980±0.07	8.402±0.13	8.052±0.09	7.791±0.10	7.613±0.09	8.167
<b>Mean B</b>	8.988	8.609	8.315	7.967	7.818	
<b>Factors</b>	<b>C.D.</b>		<b>SE(m)</b>			
Factor (A)	0.020		0.007			
Factor (B)	0.026		0.009			
Factor (A × B)	0.045		0.015			

Table 3 Shows the ANOVA for the effect of packaging material and storage duration on protein content (%) of bagels prepared from osmo-convective dried cashew apple flour w.r.t packaging material, storage duration and their interaction. From Table 2 bagel prepared from osmo-convective dried cashew apple flour at  $p \leq 0.05$  and storage duration had significant influence on protein (%) of bagel prepared from osmo-convective dried cashew apple flour at  $p \leq 0.05$ . The interaction of both packaging material and storage duration showed the non-significant

influence on protein content of bagels prepared from osmo-convective dried cashew apple flour significant at  $p \leq 0.05$ .

Similarly, Aliani *et al.* 2012 reported that the bagels prepared from milled flaxseed i.e. product decreases protein content from 9.17 to 8.15 %. According to Cross, (2007) reported that the bagels prepared from rye flour i.e. product decreases protein content from 8.41 to 7.09 %.

Similarly, Lent and Grant, 2001 observed that the bagels prepared from xanthan gum or monoglyceride i.e. product decreases protein content from 11.07 to 9.17 % from 7 days storage period. Similarly, Saraaf *et al.* 2016 reported that the doughnut prepared from Oleaster Flour i.e. product decreases protein content 8.02 to 7.18 %. According to Eckert *et al.* 2018 reported that the doughnut prepared from barley and lentil flour i.e. product decreases protein content from 9.4 to 5.9%.

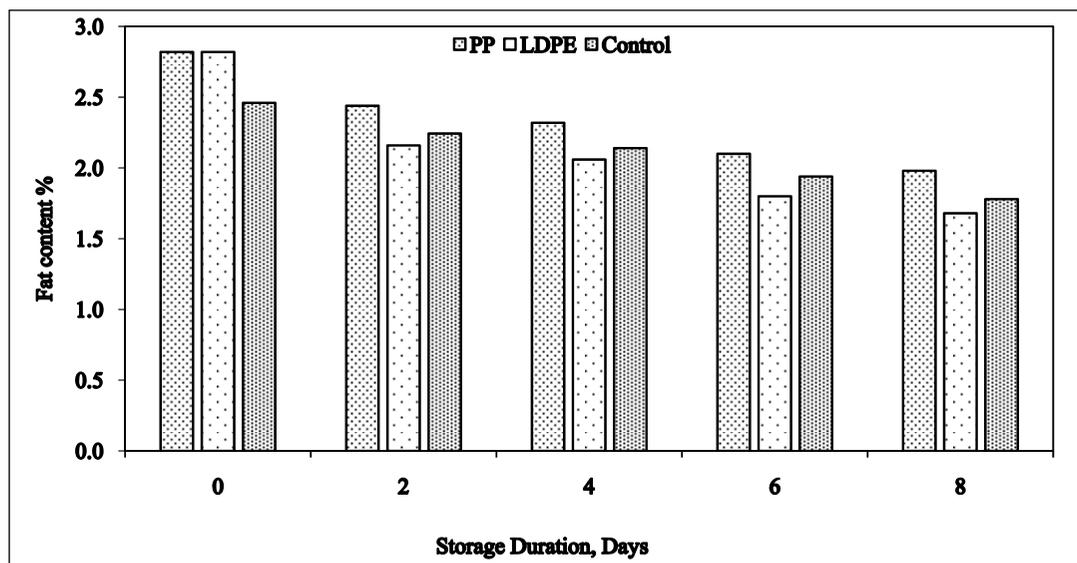
**Effect of different packaging material and storage duration on fat content (%) of osmo-convective dried cashew apple flour bagels during 8 days storage duration**

Fig. 4 Shows the effect of packaging material and storage duration (0, 2, 4, 6, 8) and on fat content (%) of bagels from osmo-convective dried cashew apple flour. The fat (%) of bagels prepared from osmo-convective dried cashew apple flour. The fat content varies in the range of 1.78 to 2.82 % and which was packed in PP bag decrease from 2.820±0.03 to 1.982±0.04 % for 0 to 8 days of storage period and for LDPE bag fat content (%) decreases from 2.820±0.01 to 1.680±0.04 % for 0 to 8 days of storage period respectively. And bagels which was control

sample decrease from 2.461±0.07 to 1.782±0.02%. Fig. 4 it is clear that as storage period increases, the fat (%) of bagel prepared from osmo-convective dried cashew apple flour packed in PP bags and LDPE bag decreases.

Table 4 Shows the ANOVA for the effect of packaging material and storage duration on fat content (%) of bagels prepared from osmo-convective dried cashew apple flour w.r.t packaging material, storage duration and their interaction. From Table 4 bagel prepared from osmo-convective dried cashew apple flour at  $p \leq 0.05$  and storage duration had significant influence on fat (%) of bagel prepared from osmo-convective dried cashew apple flour at  $p \leq 0.05$ . The interaction of both packaging material and storage duration showed the non-significant influence on fat content of bagels prepared from osmo-convective dried cashew apple flour significant at  $p \leq 0.05$ .

Similarly, Lent and Grant, 2001 observed that the bagels prepared from xanthan gum or monoglyceride i.e. product decreases fat content from 7.07 to 4.67 % from 7 days storage period. Similarly, Aliani *et al.* 2012 reported that the bagels prepared from milled flaxseed i.e. product decreases fat content from 8.17 to 5.19 %. According to Cross, (2007) reported that the



**Fig. 4:** Effect of various Packaging materials (PP=Polypropylene; LDPE=Low density polyethylene; C= Control) on fat content % of osmo-convective dried cashew apple flour bagels during eight days storage duration

**Table 4:** Effect of different packaging material (PP=Polypropylene; LDPE=Low density polyethylene; C= Control) and storage duration (0, 2, 4, 6 and 8 Days) on fat content (%) of stored osmo-convective dried cashew flour bagels, during 8 days of storage duration

Packaging Material (A)	Storage Duration (Days) (B)					Mean A
	Fat Content (%)					
	0	2	4	6	8	
PP	2.820±0.03	2.441±0.07	2.322±0.09	2.100±0.01	1.982±0.04	2.332
LDPE	2.820±0.01	2.161±0.04	2.060±0.07	1.803±0.03	1.680±0.04	2.104
Control	2.461±0.07	2.243±0.03	2.144±0.08	1.940±0.06	1.782±0.02	2.112
<b>Mean B</b>	2.700	2.281	2.173	1.947	1.814	
<b>Factors</b>	<b>C.D.</b>					<b>SE(m)</b>
Factor (A)	0.027					0.009
Factor (B)	0.019					0.007
Factor (A × B)	0.045					0.015

bagels prepared from rye flour i.e. product decreases fat content from 7.31 to 7.05 %.

According to Eckert *et al.* 2018 reported that the doughnut prepared from barley and lentil flour i.e. product decreases fat content from 19.4 to 16.6%. Similarly, Saraaf *et al.* 2016 reported that the doughnut prepared from Oleaster Flour i.e. product decreases fat content 6.43 to 4.35%.

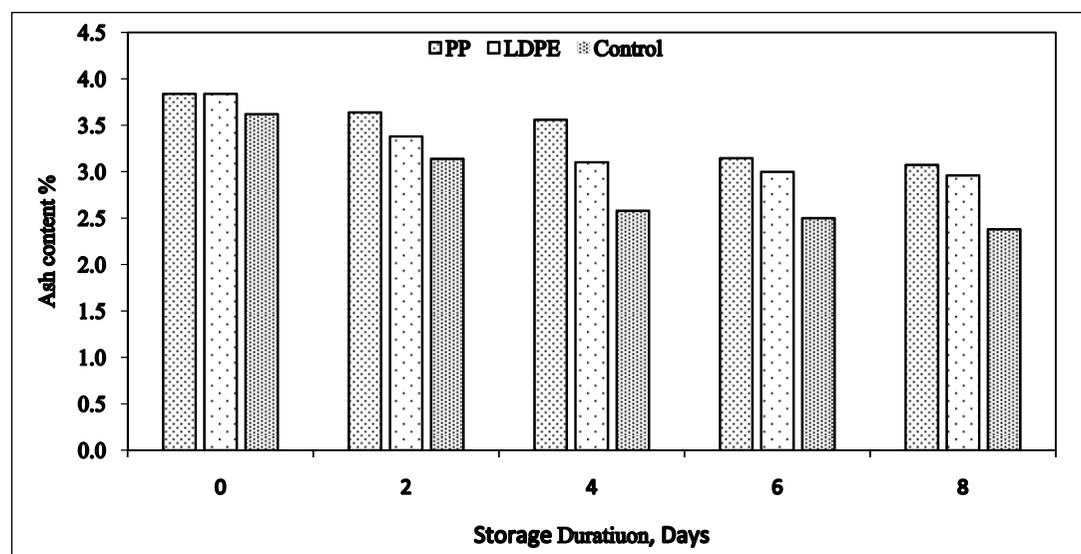
#### Effect of different packaging material and storage duration on ash content (%) of osmo-convective dried cashew apple flour bagels during 8 days storage duration.

Fig. 5 Shows the effect of packaging material and storage duration (0, 2, 4, 6, 8) and on ash content (%) of bagels from osmo-convective dried cashew apple flour. The ash (%) of bagels prepared from osmo-convective dried cashew apple flour. The ash content varies in the range of 2.38 to 3.98 % and which was packed in PP bag decrease from 3.840 to 3.07 % for 0 to 8 days of storage period and for LDPE bag ash content (%) decreases from 3.84 to 2.96 % for 0 to 8 days of storage period respectively. And bagels which was control sample decrease from 3.62 to 2.38% Fig. 5 it is clear that as storage period increases, the ash (%) of bagel prepared from osmo-convective dried cashew apple flour packed in PP bags and LDPE bag decreases.

Table 5 Shows the ANOVA for the effect of packaging material and storage duration on fat content (%) of bagels prepared from osmo-convective dried cashew apple flour w.r.t packaging material, storage duration and their interaction. From Table 2 bagel prepared from osmo-convective dried cashew apple flour at  $p \leq 0.05$  and storage duration had significant influence on ash (%) of bagel prepared from osmo-convective dried cashew apple flour at  $p \leq 0.05$ . The interaction of both packaging material and storage duration showed the non-significant influence on ash content of bagels prepared from osmo-convective dried cashew apple flour significant at  $p \leq 0.05$ .

Similarly, Aliani *et al.* 2012 reported that the bagels prepared from milled flaxseed i.e. product decreases ash content from 2.19 to 0.76 %. According to Cross, (2007) reported that the bagels prepared from rye flour i.e. product decreases ash content from 2.00 to 0.54 %.

Similarly, Lent and Grant, 2001 observed that the bagels prepared from xanthan gum or monoglyceride i.e. product decreases ash content from 1.19 to 1.03% from 7 days storage period. Similarly, Saraaf *et al.* 2016 reported that the doughnut prepared from Oleaster Flour i.e. product decreases fat content 3.19 to 1.07 %. According to Eckert *et al.* 2018 reported that the doughnut prepared from barley and lentil flour i.e. product decreases fat content from 1.5 to 1.1%.



**Fig. 5:** Effect of various Packaging materials (PP=Polypropylene; LDPE=Low density polyethylene; C= Control) on ash content % of osmo-convective dried cashew apple flour bagels during eight days storage duration

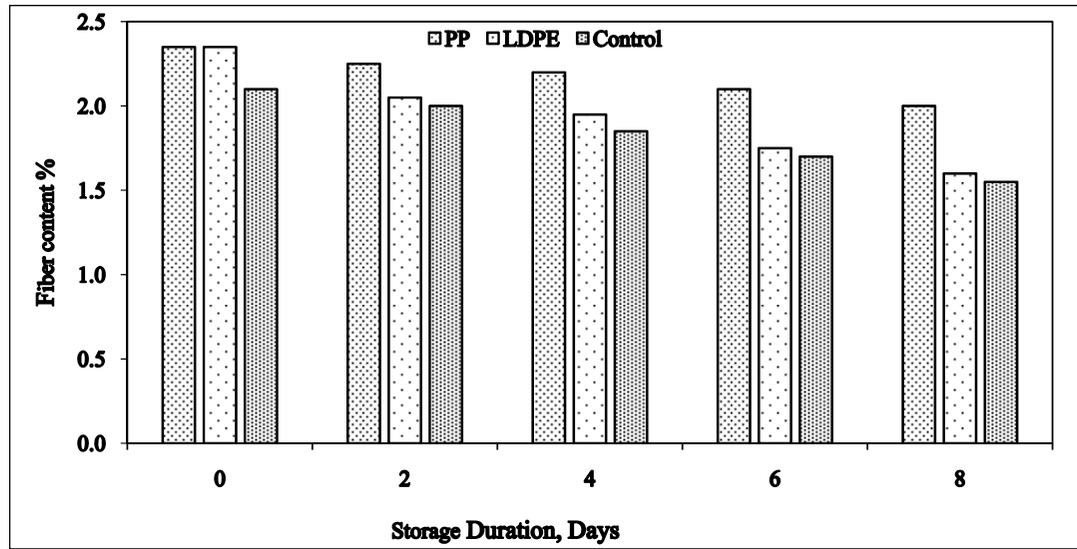
**Table 5:** Effect of different packaging material (PP=Polypropylene; LDPE=Low density polyethylene; C= Control) and storage duration (0, 2, 4, 6 and 8 Days) on ash content (%) of stored osmo-convective dried cashew flour bagels, during 8 days of storage duration

Packaging Material (A)	Storage Duration (Days) (B)					Mean A
	0	2	4	6	8	
PP	3.840±0.15	3.640±0.17	3.560±0.06	3.147±0.02	3.073±0.16	3.452
LDPE	3.840±0.09	3.380±0.15	3.103±0.07	3.000±0.04	2.960±0.12	3.257
Control	3.620±0.07	3.140±0.16	2.580±0.13	2.500±0.15	2.380±0.13	2.844
<b>Mean B</b>	3.766	3.387	3.081	2.882	2.804	
<b>Factors</b>	<b>C.D.</b>		<b>SE(m)</b>			
Factor (A)	0.027		0.009			
Factor (B)	0.035		0.012			
Factor (A × B)	0.061		0.021			

**Effect of different packaging material and storage duration on fiber content (%) of osmo-convective dried cashew apple flour bagels during 8 days storage duration**

Fig. 6 Shows the effect of packaging material and storage duration (0, 2, 4, 6, 8) and on fiber content (%) of bagels from osmo-convective dried cashew apple flour. The fiber (%) of bagels prepared from osmo-convective dried cashew apple flour. The fiber content varies in the range of 1.550±0.03 to 2.350±0.05% and

which was packed in PP bag decrease from 2.350±0.05 to 2.000±0.07 % for 0 to 8 days of storage period and for LDPE bag fiber content (%) decreases from 2.350±0.09 to 1.600±0.04 % for 0 to 8 days of storage period respectively. And bagels which was control sample decrease from 2.100±0.03 to 1.550±0.03% Fig. 6 it is clear that as storage period increases, the fiber (%) of bagel prepared from osmo-convective dried cashew apple flour packed in PP bags and LDPE bag decreases.



**Fig. 6:** Effect of various Packaging materials (PP=Polypropylene; LDPE=Low density polyethylene; C= Control) on fiber content % of osmo-convective dried cashew apple flour bagels during eight days storage duration

**Table 6:** Effect of different packaging material (PP=Polypropylene; LDPE=Low density polyethylene; C= Control) and storage duration (0, 2, 4, 6 and 8 Days) on fiber content (%) of stored osmo-convective dried cashew flour bagels, during 8 days of storage duration

Packaging Material (A)	Storage Duration (Days) (B)					Mean A
	0	2	4	6	8	
PP	2.350±0.05	2.250±0.02	2.200±0.03	2.100±0.02	2.000±0.07	2.180
LDPE	2.350±0.09	2.050±0.06	1.950±0.07	1.750±0.09	1.600±0.04	1.940
Control	2.100±0.03	2.000±0.01	1.850±0.06	1.700±0.01	1.550±0.03	1.840
<b>Mean B</b>	2.266	2.100	2.000	1.850	1.717	
<b>Factors</b>	<b>C.D.</b>		<b>SE(m)</b>			
Factor (A)	0.126		0.042			
Factor (B)	0.159		0.054			
Factor (A × B)	0.279		0.093			

Table 6 Shows the ANOVA for the effect of packaging material and storage duration on fiber content (%) of bagels prepared from osmo-convective dried cashew apple flour w.r.t packaging material, storage duration and their interaction. From Table 2 bagel prepared from osmo-convective dried cashew apple flour at  $p \leq 0.05$  and storage duration had significant influence on fiber (%) of bagel prepared from osmo-convective dried cashew apple flour at  $p \leq 0.05$ . The interaction of both packaging material and storage duration showed the non-significant influence on fiber content

of bagels prepared from osmo-convective dried cashew apple flour significant at  $p \leq 0.05$ .

Similarly, Lent and Grant, 2001 observed that the bagels prepared from xanthan gum or monoglyceride i.e. product decreases fiber content from 8.05 to 6.55% from 7 days storage period. Similarly, Aliani *et al.* 2012 reported that the bagels prepared from milled flaxseed i.e. product decreases fat content from 9.17 to 4.19 %. According to Cross, (2007) reported that the bagels prepared from rye flour i.e. product decreases fiber content from 6.31 to 5.03 %.

According to Eckert *et al.* 2018 reported that the doughnut prepared from barley and lentil flour i.e. product decreases fiber content from 7.16 to 5.13%. Similarly, Saraaf *et al.* 2016 reported that the doughnut prepared from Oleaster Flour i.e. product decreases fiber content 8.13 to 7.25%.

**Effect of different packaging material and storage duration on carbohydrate content (%) of osmo-convective dried cashew apple flour bagels during 8 days storage duration.**

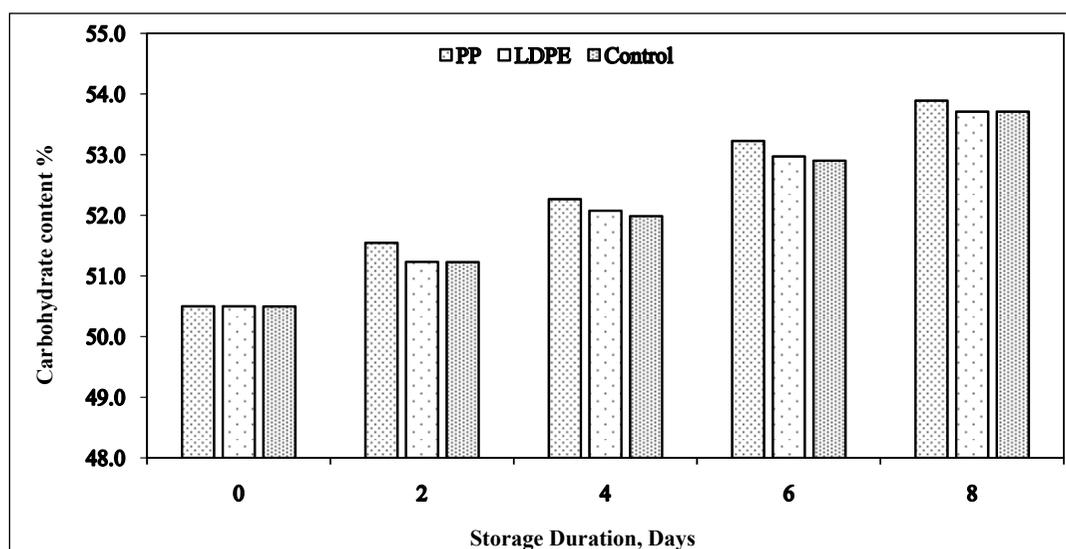
Fig. 7 Shows the effect of packaging material and storage duration (0, 2, 4, 6, 8) and on carbohydrate content (%) of bagels from osmo-convective dried cashew apple flour. The carbohydrate (%) of bagels prepared from osmo-convective dried cashew apple flour. The carbohydrate content varies in the range of  $50.498 \pm 0.07$  to  $53.893 \pm 0.03\%$ . and which was packed in PP bag decrease from  $50.504 \pm 0.01$  to  $53.893 \pm 0.03\%$  for 0 to 8 days of storage period and for LDPE bag carbohydrate content (%) decreases from  $50.501 \pm 0.05$  to  $53.717 \pm 0.01\%$  for 0 to 8 days of storage period respectively. And bagels which was control sample decrease from  $50.498 \pm 0.07$  to  $53.711 \pm 0.06\%$ . Fig. 7 it is clear that as storage period increases, the carbohydrate (%) of bagel prepared from osmo-

convective dried cashew apple flour packed in PP bags and LDPE bag decreases.

Table 7 shows the ANOVA for the effect of packaging material and storage duration on carbohydrate content (%) of bagels prepared from osmo-convective dried cashew apple flour w.r.t packaging material, storage duration and their interaction. From Table 2 bagel prepared from osmo-convective dried cashew apple flour at  $p \leq 0.05$  and storage duration had significant influence on carbohydrate (%) of bagel prepared from osmo-convective dried cashew apple flour at  $p \leq 0.05$ . The interaction of both packaging material and storage duration showed the non-significant influence on carbohydrate content of bagels prepared from osmo-convective dried cashew apple flour significant at  $p \leq 0.05$ .

**Effect of different packaging material and storage duration on standard plate count of osmo-convective dried cashew apple flour bagels during 8 days storage duration**

Microbial analysis is the perfect quality assessment protocol performed in food products quality. In the study of microbial quality of bagels from osmo-convective dried cashew apple flour, the study was undertaken examination of the total plate count



**Fig. 7:** Effect of various Packaging materials (PP=Polypropylene; LDPE=Low density polyethylene; C= Control) on carbohydrate content % of osmo-convective dried cashew apple flour bagels during eight days storage duration

**Table 7:** Effect of different packaging material and storage duration on standard plate count of osmo-convective dried cashew apple flour bagels during 8 days storage duration

Packaging Material (A)	Storage Duration (Days) (B)				
	Standard Plate Count (CFU/g)				
	0	2	4	6	8
PP	ND	ND	ND	ND	1.20×10 <sup>3</sup> CFU/g
LDPE	ND	ND	ND	ND	1.24×10 <sup>3</sup> CFU/g
Control	ND	ND	ND	ND	1.31×10 <sup>3</sup> CFU/g

**Table 8:** Effect of different packaging material (PP=Polypropylene; LDPE=Low density polyethylene; C= Control) and storage duration (0, 2, 4, 6 and 8 Days) on carbohydrate content (%) of stored osmo-convective dried cashew flour bagels, during 8 days of storage duration

Packaging Material (A)	Storage Duration (Days) (B)					Mean A
	Carbohydrate Content (%)					
	0	2	4	6	8	
PP	50.501±0.01	51.548±0.11	52.268±0.03	53.226±0.01	53.893±0.03	52.287
LDPE	50.501±0.05	51.234±0.10	52.076±0.13	52.973±0.07	53.717±0.01	52.099
Control	50.498±0.07	51.227±0.11	51.987±0.07	52.903±0.03	53.711±0.06	52.065
<b>Mean B</b>	50.500	51.336	52.110	53.034	53.771	
<b>Factors</b>	<b>C.D.</b>			<b>SE(m)</b>		
Factor (A)	0.156			0.052		
Factor (B)	0.291			0.097		
Factor (A × B)	0.411			0.137		

(TPC). The effect of packaging material Polypropylene (P1), Low Density Polyethylene (P2) and control and storage duration on microbial characteristics of bagels prepared from osmo-convective dried cashew apple flour stored at ambient temperature were recorded and presented in Table 7.

#### Effect of different packaging material and storage duration on sensory colour of osmo-convective dried cashew apple flour bagels stored for 8 days

Fig. 8 shows the effect of different packaging material PP = Polypropylene; LDPE = Low Density Polyethylene; C = Control and storage duration (0, 2, 4, 6 and 8 days) on sensory colour of osmo-convective dried cashew apple flour bagels stored for 8 days storage duration. Highest colour score was observed at PP bag and lowest was control sample. The average colour scores for osmo-convective dried cashew apple flour bagels stored in PP bag for 0, 2, 4,

6 and 8 days was 8.400±0.13, 8.233±0.12, 8.133±0.16, 8.033±0.18, 7.902±0.13 respectively, and LDPE for 0, 2, 4, 6 and 8 days were 8.200±0.11, 8.132±0.08, 8.073±0.07, 7.933±0.05, 7.821±0.15 and control sample for 0, 2, 4, 6 and 8 days were 7.967±0.13, 7.946±0.13, 7.750±0.08, 7.650±0.16, 7.600±0.11 respectively.

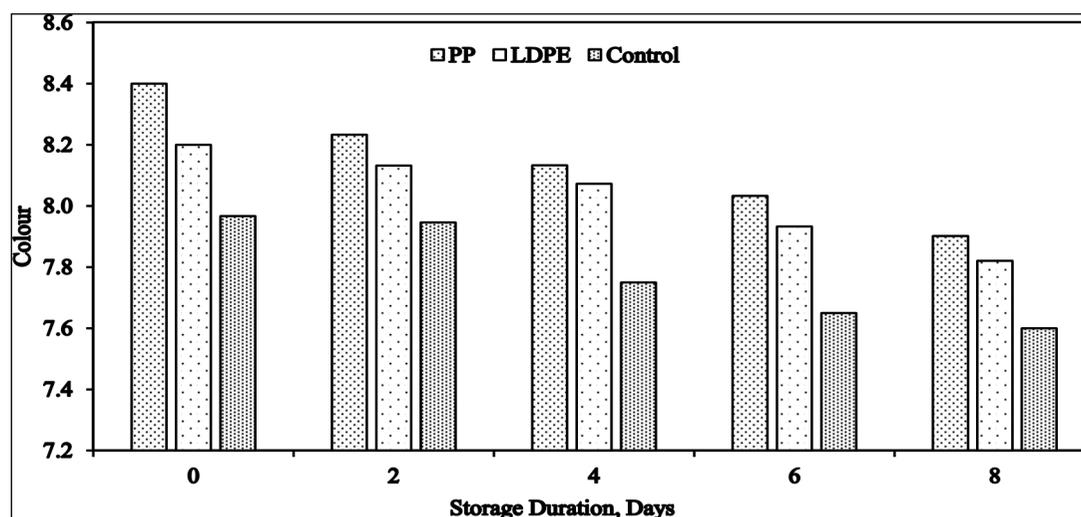
Table 8 shows ANOVA for colour of sensory analysis. It was observed that as the storage duration increases the sensory score for colour goes on decreasing. The range of sensory colour was from 7.600±0.11 to 8.400±0.13 for all storage duration of 8<sup>th</sup> days storage. The highest colour score was observed 8.40 for PP bag. The effect of packaging treatment had significant effect on colour of the bagels at  $p \leq 0.05$ . The effect of storage duration also had significant effect on colour of the bagels at  $p \leq 0.05$ . The interaction of packaging material and storage duration had also a significant effect and the colour of bagels prepared from osmo-convective dried cashew apple flour.

**Effect of different packaging material and storage duration on sensory flavour of osmo-convective dried cashew apple flour bagels stored for 8 days**

Fig. 9 shows the effect of different packaging material PP= Polypropylene; LDPE=Low Density Polyethylene; C= Control and storage duration (0, 2, 4,6 and 8 days) on sensory flavour of osmo-convective dried cashew apple flour bagels stored for 8 days storage duration. Highest flavour score was observed at PP bag and lowest was control sample. The average flavour scores for osmo-convective dried cashew apple flour bagels stored in PP bag for 0, 2, 4,

6 and 8 days was 8.241±0.08, 8.132±0.13, 7.903±0.14, 7.713±0.13, 7.630±0.11 respectively, and LDPE for 0, 2, 4, 6 and 8 days were 8.000±0.11, 7.901±0.16, 7.784±0.10, 7.709±0.08 7.609±0.15 and control sample for 0, 2, 4, 6 and 8 days were 7.987±0.11, 7.900±0.13 7.609±0.12, 7.601±0.10, 7.589±0.13 respectively.

Table 9 shows ANOVA for flavour of sensory analysis. It was observed that as the storage duration increases the sensory score for flavour goes on decreasing. The range of sensory flavour was from 7.589±0.13 to 8.241±0.08 for all storage duration of 8<sup>th</sup> days storage. The highest flavour score was observed 8.24 for PP



**Fig. 9:** Effect of various Packaging materials (PP=Polypropylene; LDPE=Low Density Polyethylene) on sensory colour of osmo-convective dried cashew apple flour bagels during eight days storage duration

**Table 9:** Effect of different packaging material PP=Polypropylene; LDPE=Low Density polyethylene; C= Control and storage duration (0, 2, 4,6 and 8 days) on sensory colour of osmo-convective dried cashew apple flour bagels stored for 8 days storage duration

Packaging Material (A)	Days (B)					Mean A
	0	2	4	6	8	
PP	8.400±0.13	8.233±0.12	8.133±0.16	8.033±0.18	7.902±0.13	8.140
LDPE	8.200±0.11	8.132±0.08	8.073±0.07	7.933±0.05	7.821±0.15	8.031
Control	7.967±0.13	7.946±0.13	7.750±0.08	7.650±0.16	7.600±0.11	7.782
Mean B	8.189	8.103	7.985	7.872	7.774	
<b>Factors</b>	<b>C.D.</b>		<b>SE(m)</b>			
Factor (A)	0.097		0.033			
Factor (B)	0.126		0.042			
Factor (A× B)	0.219		0.073			

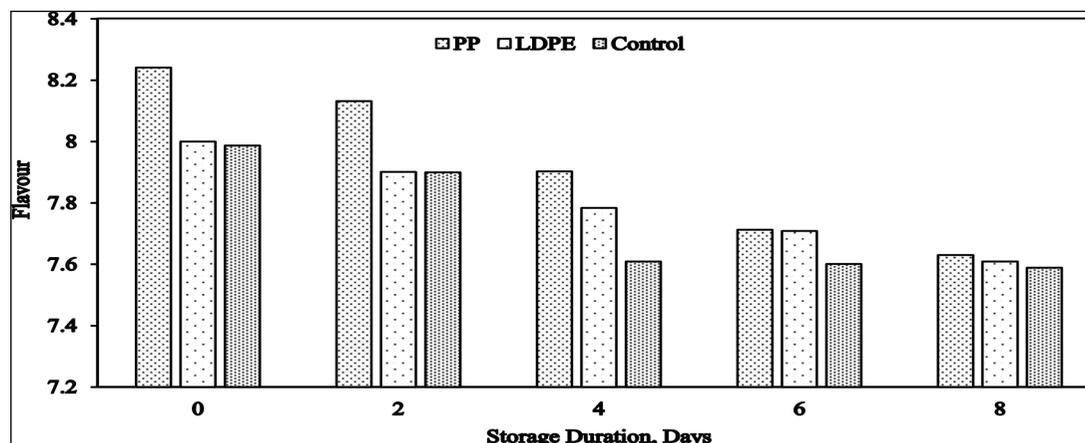
bag. The effect of packaging treatment had significant effect on flavour of the bagels at  $p \leq 0.05$ . The effect of storage duration also had significant effect on colour of the bagels at  $p \leq 0.05$ . The interaction of packaging material and storage duration had also a significant effect and the flavour of bagels prepared from osmo-convective dried cashew apple flour.

**Effect of different packaging material and storage duration on sensory taste of osmo-convective dried cashew apple flour bagels stored for 8 days.**

Fig. 10 shows the effect of different packaging material PP = Polypropylene; LDPE = Low Density Polyethylene; C = Control and storage duration (0, 2, 4,6 and 8 days) on sensory taste of osmo-

convective dried cashew apple flour bagels stored for 8 days storage duration. Highest taste score was observed at PP bag and lowest was control sample. The average taste scores for osmo-convective dried cashew apple flour bagels stored in PP bag for 0, 2, 4, 6 and 8 days was  $7.980 \pm 0.08$ ,  $7.880 \pm 0.10$ ,  $7.706 \pm 0.11$ ,  $7.699 \pm 0.08$ ,  $7.500 \pm 0.13$  respectively, and LDPE for 0, 2, 4, 6 and 8 days were  $7.800 \pm 0.19$ ,  $7.780 \pm 0.12$ ,  $7.700 \pm 0.10$ ,  $7.640 \pm 0.12$ ,  $7.489 \pm 0.16$  and control sample for 0, 2, 4, 6 and 8 days were  $7.789 \pm 0.12$ ,  $7.660 \pm 0.15$ ,  $7.600 \pm 0.11$ ,  $7.517 \pm 0.13$ ,  $7.402 \pm 0.07$  respectively.

Table 10 shows ANOVA for taste of sensory analysis. It was observed that as the storage duration increases the sensory score for taste goes on decreasing. The range of sensory taste was from  $7.402 \pm 0.07$  to



**Fig. 10:** Effect of various Packaging materials (PP=Polypropylene; LDPE=Low Density Polyethylene) on sensory flavour of osmo-convective dried cashew apple flour bagels during eight days storage duration

**Table 10:** Effect of different packaging material PP=Polypropylene; LDPE=Low Density polyethylene; C= Control and storage duration (0, 2, 4,6 and 8 days) on sensory flavour of osmo-convective dried cashew apple flour bagels stored for 8 days storage duration

Packaging Material (A)	Days (B)					Mean A
	0	2	4	6	8	
PP	$8.241 \pm 0.08$	$8.132 \pm 0.13$	$7.903 \pm 0.14$	$7.713 \pm 0.13$	$7.630 \pm 0.11$	7.923
LDPE	$8.000 \pm 0.11$	$7.901 \pm 0.16$	$7.784 \pm 0.10$	$7.709 \pm 0.08$	$7.609 \pm 0.15$	7.800
Control	$7.987 \pm 0.11$	$7.900 \pm 0.13$	$7.609 \pm 0.12$	$7.601 \pm 0.10$	$7.589 \pm 0.13$	7.732
<b>Mean B</b>	<b>8.076</b>	<b>7.977</b>	<b>7.765</b>	<b>7.674</b>	<b>7.609</b>	
<b>Factors</b>	<b>C.D.</b>		<b>SE(m)</b>			
Factor (A)	0.072		0.025			
Factor (B)	0.099		0.033			
Factor (A× B)	0.168		0.056			

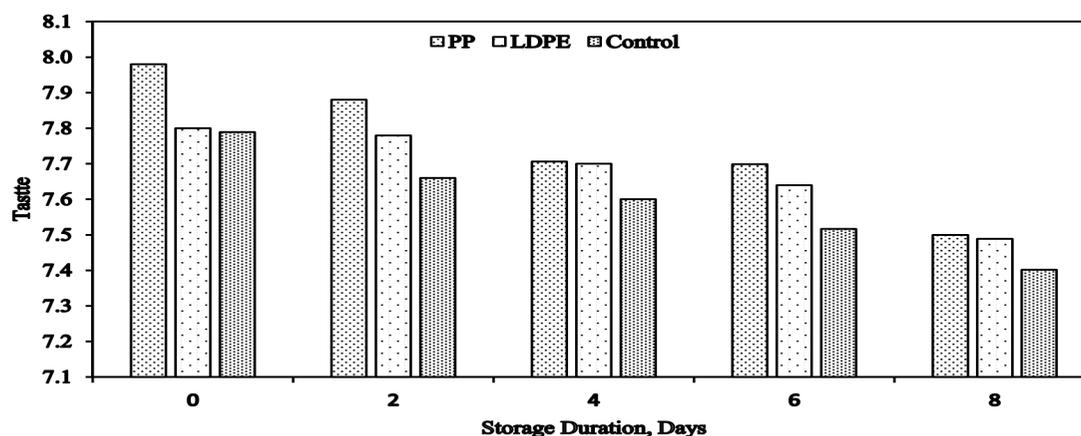
7.980±0.08 all storage duration of 8<sup>th</sup> days storage. The highest taste score was observed 7.98 for PP bag. The effect of packaging treatment had significant effect on taste of the bagels at  $p \leq 0.05$ . The effect of storage duration also had significant effect on taste of the bagels at  $p \leq 0.05$ . The interaction of packaging material and storage duration had also a significant effect and the taste of bagels prepared from osmo-convective dried cashew apple flour.

**Effect of different packaging material and storage duration on sensory texture of osmo-convective dried cashew apple flour bagels stored for 8 days**

Fig. 11 shows the effect of different packaging material PP = Polypropylene; LDPE = Low Density

Polyethylene; C = Control and storage duration (0, 2, 4,6 and 8 days) on sensory texture of osmo-convective dried cashew apple flour bagels stored for 8 days storage duration. Highest texture score was observed at PP bag and lowest was control sample. The average texture scores for osmo-convective dried cashew apple flour bagels stored in PP bag for 0, 2, 4, 6 and 8 days was 8.032±0.08, 7.957±0.15, 7.800±0.11, 7.740±0.12, 7.660±0.18 respectively, and LDPE for 0, 2, 4, 6 and 8 days were 8.003±0.13, 7.904±0.14, 7.789±0.15, 7.700±0.20, 7.640±0.12 and control sample for 0, 2, 4, 6 and 8 days were 7.981±0.17, 7.877±0.18, 7.701±0.12, 7.677±0.12, 7.620±0.11 respectively.

Table 11 shows ANOVA for texture of sensory analysis. It was observed that as the storage duration increases



**Fig. 11:** Effect of various Packaging materials (PP=Polypropylene; LDPE=Low Density Polyethylene) on sensory taste of osmo-convective dried cashew apple flour bagels during eight days storage duration

**Table 11:** Effect of different packaging material PP=Polypropylene; LDPE=Low Density polyethylene; C= Control and storage duration (0, 2, 4,6 and 8 days) on sensory taste of osmo-convective dried cashew apple flour bagels stored for 8 days storage duration

Packaging Material (A)	Days (B)					Mean A
	0	2	4	6	8	
PP	7.980±0.08	7.880±0.10	7.706±0.11	7.699±0.08	7.500±0.13	7.753
LDPE	7.800±0.19	7.780±0.12	7.700±0.10	7.640±0.12	7.489±0.16	7.681
Control	7.789±0.12	7.660±0.15	7.600±0.11	7.517±0.13	7.402±0.07	7.593
Mean B	7.856	7.773	7.668	7.498	7.463	
<b>Factors</b>	<b>C.D.</b>		<b>SE(m)</b>			
Factor (A)	0.078		0.026			
Factor (B)	0.094		0.033			
Factor (A× B)	0.174		0.058			

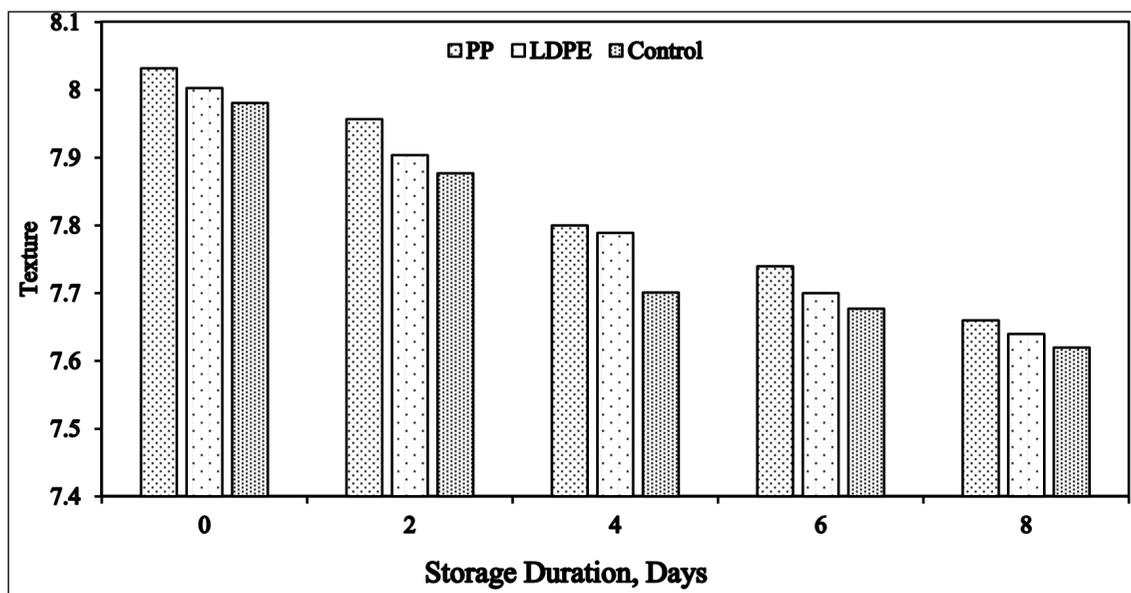
the sensory score for texture goes on decreasing. The range of sensory texture was from  $7.620 \pm 0.11$  to  $8.032 \pm 0.08$  for all storage duration of 8<sup>th</sup> days storage. The highest texture score was observed 8.032 for PP bag. The effect of packaging treatment had significant effect on texture of the bagels at  $p \leq 0.05$ . The effect of storage duration also had significant effect on texture of the bagels at  $p \leq 0.05$ . The interaction of packaging material and storage duration had also a significant effect and the texture of bagels prepared from osmo-convective dried cashew apple flour.

**Effect of different packaging material and storage duration on sensory overall acceptability of osmo-convective dried cashew apple flour bagels stored for 8 days**

Fig. 12 shows the effect of different packaging material PP = Polypropylene; LDPE = Low Density Polyethylene; C = Control and storage duration (0, 2, 4, 6 and 8 days) on sensory overall acceptability of osmo-convective dried cashew apple flour bagels stored for 8 days storage duration. Highest overall acceptability score was observed at PP bag and lowest was control sample. The average overall

acceptability scores for osmo-convective dried cashew apple flour bagels stored in PP bag for 0, 2, 4, 6 and 8 days was  $8.032 \pm 0.11$ ,  $7.921 \pm 0.15$ ,  $7.821 \pm 0.14$ ,  $7.800 \pm 0.16$ ,  $7.789 \pm 0.18$  respectively, and LDPE for 0, 2, 4, 6 and 8 days were  $7.987 \pm 0.10$ ,  $7.809 \pm 0.18$ ,  $7.700 \pm 0.15$ ,  $7.654 \pm 0.08$ ,  $7.602 \pm 0.13$  and control sample for 0, 2, 4, 6 and 8 days were  $7.893 \pm 0.16$ ,  $7.800 \pm 0.13$ ,  $7.677 \pm 0.12$ ,  $7.640 \pm 0.07$ ,  $7.550 \pm 0.11$  respectively.

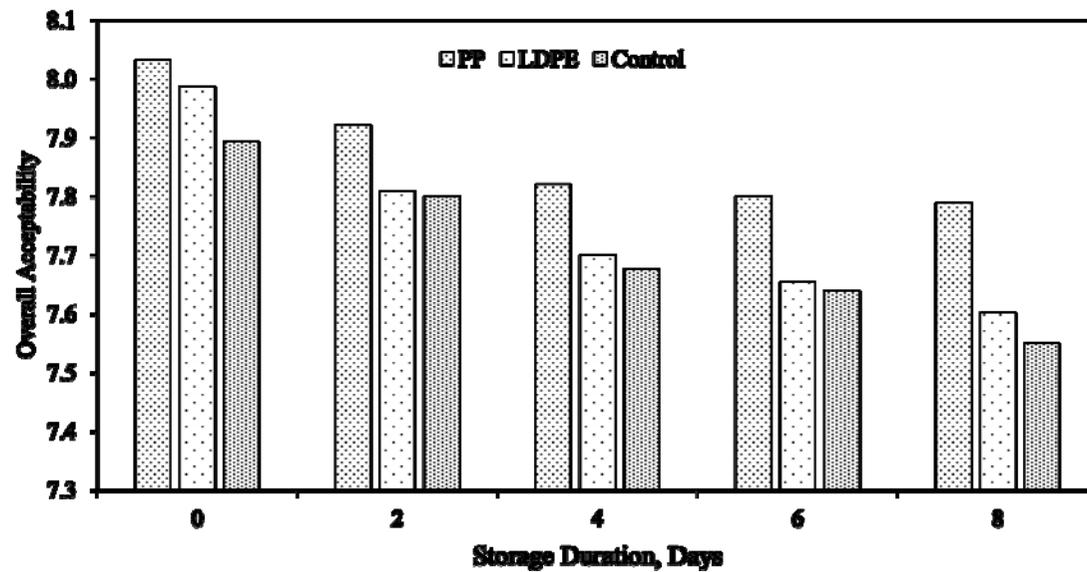
Table 12 shows ANOVA for overall acceptability of sensory analysis. It was observed that as the storage duration increases the sensory score for overall acceptability goes on decreasing. The range of sensory overall acceptability was from  $7.550 \pm 0.11$  to  $8.032 \pm 0.11$  for all storage duration of 8<sup>th</sup> days storage. The highest overall acceptability score was observed 8.032 for PP bag. The effect of packaging treatment had significant effect on overall acceptability of the bagels at  $p \leq 0.05$ . The effect of storage duration also had significant effect on overall acceptability of the bagels at  $p \leq 0.05$ . The interaction of packaging material and storage duration had also a significant effect and the overall acceptability of bagels prepared from osmo-convective dried cashew apple flour.



**Fig. 12:** Effect of various Packaging materials (PP=Polypropylene; LDPE=Low Density Polyethylene) on sensory texture of osmo-convective dried cashew apple flour bagels during eight days storage duration

**Table 12:** Effect of different packaging material PP = Polypropylene; LDPE =Low Density polyethylene; C = Control and storage duration (0, 2, 4,6 and 8 days) on sensory texture of osmo-convective dried cashew apple flour bagels stored for 8 days storage duration

Packaging Material (A)	Days (B)					Mean A
	0	2	4	6	8	
PP	8.032±0.08	7.957±0.15	7.800±0.11	7.740±0.12	7.660±0.18	7.837
LDPE	8.003±0.13	7.904±0.14	7.789±0.15	7.700±0.20	7.640±0.12	7.807
Control	7.981±0.17	7.877±0.18	7.701±0.12	7.677±0.12	7.620±0.11	7.771
Mean B	8.005	7.912	7.763	7.705	7.640	
<b>Factors</b>	<b>C.D.</b>		<b>SE(m)</b>			
Factor (A)	0.086		0.030			
Factor (B)	0.117		0.039			
Factor (A× B)	0.216		0.072			



**Fig. 13:** Effect of various Packaging materials (PP=Polypropylene; LDPE=Low Density Polyethylene) on sensory overall acceptability of osmo-convective dried cashew apple flour bagels during eight days storage duration

**Table 13:** Effect of different packaging material PP=Polypropylene; LDPE=Low Density polyethylene; C= Control and storage duration (0, 2, 4,6 and 8 days) on sensory overall acceptability of osmo-convective dried cashew apple flour bagels stored for 8 days storage duration

Packaging Material (A)	Days (B)					Mean A
	0	2	4	6	8	
PP	8.032±0.11	7.921±0.15	7.821±0.14	7.800±0.16	7.789±0.18	7.872
LDPE	7.987±0.10	7.809±0.18	7.700±0.15	7.654±0.08	7.602±0.13	7.750
Control	7.893±0.16	7.800±0.13	7.677±0.12	7.640±0.07	7.550±0.11	7.712
Mean B	7.970	7.843	7.732	7.698	7.647	
<b>Factors</b>	<b>C.D.</b>		<b>SE(m)</b>			
Factor (A)	0.099		0.033			
Factor (B)	0.129		0.043			
Factor (A× B)	0.225		0.075			

## CONCLUSION

Effect of different packaging material and storage duration on osmo-convective dried cashew apple flour bagels, the osmo-convective dried cashew apple flour bagels baked at 180° for 25 minutes and the treatment was C1T1 i.e., 95:5% (refined wheat flour and cashew apple flour) gives best tasty bagels. The bagels incorporated with 5% osmo-convective dried cashew apple flour and 95% refined wheat flour and baked at 180° packed in Polypropylene can be stored upto 8 days in good condition safely.

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