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Effect of replacement of wheat flour with apricot powder on nutritional and sensory quality of nut crackers

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Abstract
Nutritional and sensory quality characteristics of nut crackers made by mixing wheat flour and apricot powder were studied. Wheat flour and apricot powder were mixed in the ratio of 100:00, 97:03, 94:06, 91:09, 88:12, 85:15, 82:18, 79:21 and 76:24. The developed product was stored for 90 days to ascertain the changes in physico-chemical and sensory characteristics. The nutritional quality of nut crackers was positively influenced with the incorporation of apricot powder. The results of study indicated that samples of apricot powder added nut crackers, for all addition levels, contained more moisture, protein, fibre, ash, β-carotene, as compared to control sample. The result obtained in this study suggested that acceptable nut crackers in terms of physicochemical and sensory properties could be produced by incorporating apricot powder into wheat flour upto the level of 18 per cent flour weight basis. Thus, apricot powder could be successfully used to enrich nut crackers, giving alternative utilization opportunity to the producers and healthy choice option to the consumers.

Keywords: Proximate composition, sensory quality, nut crackers, apricot

Introduction
Wheat has been used in a variety of food products such as bread, biscuits, cakes, crackers (Lee *et al*., 2002; Pongjanta *et al*., 2006) [27, 39] Among all the bakery products, crackers which is prepared from wheat flour is more popular among the all age group. Crackers are generally prepared from the hard wheat flour dough and qualities of the crackers such as baking properties, color, taste and texture are more important affecting the consumer acceptance. In recent years, crackers are fortified with various nutrients to enrich them to become a complete food with all necessary nutrients. The base material used for the preparation of crackers i.e. wheat flour contains a limited amount of β-carotene which is considered as precursor of vitamin A which is available in variety of fruits and vegetables (Tee and Lim, 1991) [50]. In the present context, an attempt has been made to enhance the level of β – carotene in biscuit by using foam mat dried apricot powder as a source of β-carotene. Apricots are extensively grown in temperate regions and are high in β-carotene, which gives it a yellow or orange color (Bhaskarachary *et al*., 2008) [7]. β-carotene in plants that have pleasant yellow-orange color is a major source of vitamin A (Lee and Kader, 2000) [28]. Consumption of foods containing carotene helps in prevention of eye disorders, cancer and skin diseases (Bendich, 1989) [5]. 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 defciency (VAD) (Chandrashekhar and Kowsalya, 2002; Siems *et al*., 2005) [11,47]. The apricot powder was prepared from the flesh of apricot by foam mat drying technique in this study. The objective of this study was to determine the optimum level of substitution of carotene rich apricot powder in the formulation of nut crackers and to assess the effect of apricot powder incorporation on sensory and textural characteristics of nut crackers.

Material and Methods
Raw materials
The matured apricot (*Prunus armeniaca* L.) fruits and other ingredients for preparation of nut crackers were procured from the local market of Jammu. All chemicals used in the experiment were of analytical grade from reputed manufacturers.

Apricot powder production

The apricot fruit was converted into pulp and subjected for pre-treatments such as foaming and foaming was carried out using foaming agents (glycerol monostearate and egg albumin) prior to drying. The foamed of apricot fruit was dried for preparation of powder using hot air dryer at 55°C temperature. The apricot powder was analyzed for carotene content.

Preparation of nut crackers

The preparation of nut crackers involved the mixing of refined wheat with apricot powder in different proportions and other ingredients (water, baking powder, butter, sugar, salt) according to the formulation described by (Kohajdova *et al.*, 2013) [25]. Refined wheat flour was used for preparation of control crackers. Preparation of nut crackers included these operations: mixing all the wet ingredients along with (sugar, water and butter) in separate bowl to a creamy texture. All the dry ingredients (baking powder, milk powder, salt, nuts and refined flour) in another bowl and were mixed well. The dry ingredients were added into wet ingredients and mixed properly to form dough. The dough was allowed to rest for 10 minutes. Now with the help of floured rolling pin, dough was flattened into a large sheet. Using a cracker cutter the dough was cut into different shapes and placed into a lightly greased and floured oven tray. The nut cracker containing tray was placed in a preheated oven at 210°C for 8-10 minutes. The baked nut crackers were removed from the oven and allowed to cool at room temperature. The proximate composition, moisture, protein, fibre, ash, total sugars, β-carotene were determined according to the (Ranganna, 2007) [42]. Food energy was calculated by multiplying the value of crude protein, fat and carbohydrates by 4, 9 and 4 Kcal respectively and results were expressed in Kcal (FDA, 2004) [13].

Sensory Evaluation

Overall acceptability of the blended nut crackers was evaluated by trained panel from academic staff and food industry consisting of 6 persons using 9 point hedonic scale (from like extremely = 9 to dislike extremely = 1) (Watts *et al.*, 1989) [55].

Statistical Analysis

Statistical analysis was carried out using Complete Randomized Design (CRD) giving analysis of variance (AVOVA) for significance at 5% of each treatment (Panse and Sukhatme, 1985) [38].

Results and Discussion

Nutrient composition of apricot powder:

The data pertaining to nutrient composition of dried apricot powder in Table 1 revealed that the moisture, protein, fibre, fat, ash and total sugar were 5.85, 3.24, 3.85, 2.31, 4.29 and 59.18 per cent, respectively. However, β-carotene content were observed as 25.32 mg/100g, respectively.

Nutrient composition of wheat

The data on nutritional composition of wheat is shown in Table 1. Nutritional analysis of wheat showed that it contained 11.28 per cent moisture, 0.52 per cent ash, 0.56 per cent crude fibre, 9.23 per cent crude protein and 1.52 per cent fat. The sugar content was measured using titrimetric method and the value were 2.25 per cent.

Table 1: Nutritional composition of apricot and wheat flour

Parameter	Apricot powder	Wheat flour
Moisture (%)	5.85	11.28
Crude protein (%)	3.24	9.23
Crude fiber (%)	3.85	0.56
Crude fat (%)	2.31	1.52
Ash (%)	4.29	0.52
Total sugars (%)	59.18	2.25
Beta-carotene (mg/100g)	25.32	-

Effect of treatments and storage on nutritional quality of nut crackers

Moisture content

The data on moisture of nut crackers are shown in Table 2. With the progression of storage period, the moisture content increased from its initial value of 4.02 to 4.29 per cent. The increase in moisture content of crackers might be due to hygroscopic nature of apricot powder and wheat flour. This might also be due to increase in physical parameter such as thickness exposing the more area of crackers, thus increasing the moisture content. The moisture content of crackers fell within the maximum limit (6%) given by BIS for moisture content of crackers. Similar results were reported by Shalini and Sudesh (2005) [45] in fenugreek flour supplemented biscuits, Nagi *et al.* (2012) [34] in cereal bran biscuits, Sharma (2014) [46] in omega 3 fatty acids rich functional food and Slathia (2014) [49] in mungbean based noodles.

The maximum moisture content of 4.58 per cent was recorded in T_9 (76:24:: whole wheat flour :apricot powder) and minimum of 3.60 per cent was observed in T_1 (100 : 00 – whole wheat flour : cauliflower leaves). It was revealed that the increase in moisture content of nut crackers may be caused by the hydrogen bonds, which are constituted as a result of the interaction of hydroxyl groups within the structure of the dietary fibre components with water. Similar results were reported by See *et al.* (2007) [44] in bread, Eke *et al.* (2009) [12] in banana cake and Azmi *et al.* (2016) [3] in novel cookies prepared by supplementing with fresh turmeric flour (*Curcuma longa* L.).

Crude protein content

A perusal of data in Table 2 indicated that treatments significantly influenced the protein content of nut crackers and with the incorporation of apricot powder, the protein content increased. The treatment T_9 (76:24:: whole wheat flour : apricot powder) recorded highest protein content of 9.86 per cent whereas the lowest was recorded in treatment T_1 (100:00: whole wheat flour : apricot powder). Similar results were reported by Kaur (2011) [23] in flaxseed enriched cookies, Chakraborty *et al.* (2016) [10] tamarind kernel powder incorporated biscuits and Sharma (2014) [46] in omega 3 fatty acids rich functional food.

The mean crude protein content during 90 days of storage declined significantly from the initial level of 8.88 to 8.73 per cent. The decrease in protein content during storage might be due to hydrolysis of peptide bond by the help of protease enzyme that causes splitting of protein molecules during storage (Wani and Sood, 2014) [54]. Similar results were reported by Kumar and Barmanray (2007) [26] in button mushroom fortified biscuits, Kanchana *et al.* (2008) [22] in single cell protein biscuits, Nwabueze and Atuonwu (2007) [37] in African bread fruit seeds incorporated biscuits.

Table 2: Effect of treatment and storage on moisture, Crude protein and Crude fibre of foam mat dried apricot powder blended nut crackers

Treatment Combination*	Moisture (%)					Crude protein (%)					Crude fibre (%)				
WWF:AP	Storage period (days)					Storage period (days)					Storage period (days)				
	0	30	60	90	Mean	0	30	60	90	Mean	0	30	60	90	Mean
T_1 (100:00)	3.37	3.59	3.64	3.79	3.60	7.68	7.61	7.57	7.51	7.59	1.53	1.49	1.44	1.37	1.46
T_2 (97:03)	3.65	3.74	3.84	3.98	3.80	8.13	8.08	8.01	7.96	8.04	1.94	1.88	1.81	1.77	1.85
T_3 (94:06)	3.81	3.89	3.94	4.02	3.91	8.39	8.35	8.30	8.24	8.32	2.55	2.51	2.47	2.40	2.48
T_4 (91:09)	3.96	4.13	4.18	4.23	4.12	8.57	8.50	8.46	8.42	8.49	2.80	2.74	2.68	2.63	2.71
T_5 (88:12)	4.13	4.22	4.29	4.37	4.25	8.92	8.87	8.84	8.78	8.85	2.98	2.92	2.87	2.83	2.90
T_6 (85:15)	4.19	4.26	4.32	4.41	4.29	9.25	9.21	9.16	9.11	9.18	3.36	3.30	3.25	3.20	3.28
T_7 (82:18)	4.27	4.34	4.42	4.47	4.37	9.37	9.32	9.28	9.22	9.30	3.69	3.67	3.61	3.57	3.63
T_8 (79:21)	4.38	4.44	4.51	4.66	4.50	9.69	9.65	9.61	9.57	9.63	3.97	3.93	3.90	3.85	3.91
T_9 (76:24)	4.46	4.57	4.62	4.69	4.58	9.95	9.88	9.85	9.78	9.86	4.10	4.06	4.02	3.98	4.04
Mean	4.02	4.13	4.19	4.29		8.88	8.83	8.78	8.73		2.99	2.94	2.89	2.84	

Crude fibre content

The data on crude fibre content of nut crackers are shown in Table 2. However, after 90 days of storage the treatment T_9 (76: 24::whole wheat flour: apricot powder) recorded maximum mean crude fibre content of 4.04 per cent and the minimum crude fibre content of 1.46 per cent was recorded in case of treatment T_1 (100: 00:: whole wheat flour : apricot powder). The increase in crude fibre content might be due to higher content of the soluble and insoluble fibre in apricot powder. Similar results were reported by Gayas *et al.* (2012) [14] in soy fortified biscuits, Ribeiro *et al.* (2015) [43] in cauliflower flour blended biscuits, Pratyush *et al.* (2015) [41] in pumpkin powder fortified cookies, Sharma (2014) [46] in omega 3 fatty acids rich functional food.

With the advancement of storage period crude fibre content decreased from 2.99 to 2.84 per cent which might be due to the degradation of hemicelluloses and other structural polysaccharides during storage (Wani and Sood, 2011) [55]. Similar decline in crude fibre content was also reported by Wani and Sood (2011) [55] in cauliflower leaf powder supplemented biscuits, Mushtaq *et al.* (2010) [32] in xylitol blended nut crackers, Sharma (2014) [46] in omega 3 fatty acids rich functional food.

Crude fat content

The data on crude fat content of nut crackers are shown in Table 3. A general decrease in crude fat content was observed during storage period and it was found that crude fat decreased from the initial mean value of 8.93 to 8.56 per cent after 90 days of storage. The decrease in crude fat content might be attributed to the lipolytic activity of the enzymes i.e., lipase and lipooxidase (Haridas *et al.*, 1983, Leelavathi *et al.*, 1984) [17,29]. Similar results were also reported by Varshney *et al.* (2008) [52] in defatted peanut and cereal biscuits, Singh *et al.* (2008) [48] who reported that crude fat decreased with storage of biscuits.

The lowest crude fat content of 7.03 per cent was reported in T_9 (76 : 24- whole wheat flour : apricot powder) and the highest of 10.78 was recorded in T_1 (100 : 00 - whole wheat flour : apricot powder). The decrease in crude fat might be due foam mat dried apricot powder which is almost devoid of fat fraction and low oil absorption capacity of apricot powder in comparison with wheat flour. Similar decrease in fat content in pumpkin puree incorporated biscuits was reported by Gurung *et al.* (2016) [16] and Ahmed and Abozed (2015) [1] in *Hibiscus sabdarrifa* containing novel crackers.

Ash content

The data on ash content of nut crackers are shown in Table 3. A perusal of data in table revealed that the effect of treatments on ash content of nut crackers was significant. The treatment T_9 (76: 24: whole wheat flour: apricot powder) recorded the highest value of 4.24 per cent whereas the lowest ash content of 2.38 were recorded in T_1 (100: 00- whole wheat flour: apricot powder). Increase in ash content might be associated with the presence of greater ash content in the apricot powder than in wheat flour. Similar results were reported by Bala *et al.* (2015) [4] in cookies supplemented with cassava and water chestnut flour and Ho and Latif (2016) [18] in cookies supplemented with pitaya peel flour, respectively.

As the storage period advanced the mean ash content of the developed nut crackers decreased significantly from the initial levels of 3.35 to 3.23 per cent which might be due to binding of certain minerals with organic substances (Gopalan *et al.*, 1993) [15]. Similar decrease in ash content was reported by Butt *et al.* (2004) [9] while studying the effect of moisture and packaging on shelf life of wheat flour. The results are also in conformity with those of Kumar and Barmanray (2007) [26] in button mushroom fortified biscuits.

Total sugar content

As the storage period advanced the mean total sugar content of the developed nut crackers decreased significantly from the initial levels of 27.14 to 19.07 per cent (Table 3). The decrease in sugar content during storage might be due to the thermal degradation of sugars during baking and sugar polymerization during storage (Thivani *et al.*, 2016) [51]. Similar results were reported by Hosamani *et al.* (2016) [19] in carrot, jackfruit and aonla powder based biscuits.

Table 3: Effect of treatment and storage on crude fat, ash and total sugars of foam mat dried apricot powder blended nut crackers

Treatment Combination*	Crude fat (%)					Ash (%)					Total sugars (%)				
WWF:AP	Storage period (days)					Storage period (days)					Storage period (days)				
	0	30	60	90	Mean	0	30	60	90	Mean	0	30	60	90	Mean
T_1 (100:00)	10.94	10.82	10.75	10.62	10.78	2.43	2.38	2.38	2.35	2.38	19.74	17.17	14.84	11.13	15.72
T_2 (97:03)	10.53	10.47	10.34	10.25	10.40	2.73	2.69	2.65	2.62	2.67	23.30	20.60	17.85	14.39	19.03
T_3 (94:06)	9.82	9.68	9.53	9.43	9.61	2.92	2.88	2.85	2.83	2.87	24.12	22.28	19.28	15.55	20.30

T_4 (91:09)	9.37	9.22	9.08	8.96	9.20	3.11	3.08	3.05	2.98	3.05	25.70	23.42	20.45	17.16	21.68
T_5 (88:12)	8.60	8.53	8.37	8.21	8.43	3.27	3.20	3.14	3.12	3.18	27.04	25.16	22.83	20.34	23.84
T_6 (85:15)	8.48	8.36	8.22	8.13	8.30	3.43	3.38	3.33	3.29	3.36	28.90	24.44	23.33	21.48	24.54
T_7 (82:18)	7.80	7.71	7.63	7.45	7.65	3.81	3.75	3.73	3.70	3.75	30.15	27.02	24.26	22.99	26.10
T_8 (79:21)	7.57	7.43	7.31	7.19	7.37	4.17	4.12	4.09	4.04	4.10	31.93	29.84	25.55	23.42	27.68
T_9 (76:24)	7.24	7.08	6.97	6.82	7.03	4.32	4.27	4.21	4.17	4.24	33.39	30.19	28.06	25.24	29.22
Mean	8.93	8.81	8.69	8.56		3.35	3.30	3.27	3.23		27.14	24.46	21.83	19.07	

The lowest total sugars content of 15.72 per cent was reported in T_1 (100 : 00 - whole wheat flour : apricot powder) and the highest of 29.22 was recorded in T_9 (76 : 24- whole wheat flour : apricot powder). Increasing the foam mat dried apricot flour proportion in the blends significantly increased the sugar content of the nut crackers as apricot contains good amount of sugars. Similar results were reported by MahbubSobhan (2013) [30] in cassava flour fortified biscuits and Kabirullah *et al.* (1996) [21] in biscuits and Khapre *et al.* (2015) [24] fig powder incorporated cookies.

β-carotene content

Table 4 illustrates a general decrease in β-carotene content occurred during storage period of 90 days. β-carotene content decreased from the mean value of 0.89 to a value of 0.50. The decrease in β-carotene might be due to the oxidative degradation of colour pigment (Wani and Sood, 2014) [53]. Potter (1987) [40] also reported that carotenoids are very sensitive to oxidation which results in loss of colour. However, with the increasing level of incorporation of apricot powder, the β-carotene content increased which might be due to higher concentration of β-carotene in apricot fruit. The findings of Bhavani and Kamini (1997) [8] in extruded maize products also support the same results. Similar findings are also reported by Nagarajaiah and Prakash (2015) [33] in shelf stable of carrot pomace-incorporated cookies.

The highest value of β-carotene content was observed in T_9 (76:24- whole wheat flour : apricot powder) of 1.37 whereas the minimum value was obtained in T_1(100:00-whole wheat flour :apricot powder) of 0.08. Increase in β-carotene content of nut crackers, which might be due to higher amount of β-carotene in apricots. Similar results were reported by Wani and Sood (2014) [53] in biscuits prepared from cauliflower leaf powder, Gurung *et al.* (2016) [16] in pumpkin puree fortified biscuits, Bertagnolli *et al.* (2014) [6] in guava peel flour (GPF) fortified biscuits and Nanyen *et al.* (2016) [35] in cookies prepared from wheat, acha and mung bean composite flours, respectively.

Carbohydrates

Table 4 illustrates the effect of various treatments and storage on carbohydrate content of nut crackers. The data revealed that the treatments had a significant effect on carbohydrate content. Treatment T_1 (100:00::whole wheat flour: apricot powder) recorded the highest carbohydrate content of 74.18 per cent whereas lowest 70.24 per cent were recorded in T_9 (76:24:: whole wheat flour: apricot powder). The decrease in carbohydrate content might be due the fact that energy content was found by difference so when the other contents increased the carbohydrate content decreased in foam mat dried apricot powder. Similar findings were reported by Nisha and Bhatnagar (2014) [36] while carrying studied on utilization of mango peels as a source of phytochemicals in biscuits, Ajibola *et al.* (2015) [2] in physicochemical and antioxidant properties of whole-wheat biscuits incorporated with *Moringa oleifera* leaves and cocoa powder.

However, there was a significant increase in the carbohydrate content of nut crackers with the advancement in storage period. Highest mean carbohydrate content of 71.82 per cent was recorded at 0 day storage whereas lowest mean carbohydrate content of 72.45 per cent was recorded at 90 days storage which might be due to the breakdown of insoluble polysaccharides into simple sugars. The reports of Varshney *et al.* (2008) [52] in defatted peanut and cereal biscuits, Hussain (2016) [20] in biscuits blended with barley flour and buckwheat flour and Mohsen *et al.* (2009) [31] in soy protein substituted wheat cookies are in agreement with our findings.

Total energy

Table 4 illustrates the effect of various treatments and storage on total energy of nut crackers. The data revealed that the treatments had a significant effect on total energy. Treatment T_1 (100:00 :: whole wheat flour: apricot powder) recorded the highest total energy of 424.15 Kcal/100g whereas lowest 383.66 Kcal/100g were recorded in T_9 (76:24:: whole wheat flour: apricot powder). Decrease in total energy might be due to decrease in carbohydrate and fat content. Ahmed and Abozed (2015) [1] reported the decrease in total energy in novel snack crackers supplemented with *Hibiscus Sabdariffa* residue and Gurung *et al.* (2016) [16] in biscuits fortified with pumpkin puree powder respectively.

Table 4: Effect of treatment and storage on β-carotene, Carbohydrate and total energy of foam mat dried apricot powder blended nut crackers

Treatment Combination*	**β-carotene (mg/100g)**					**Carbohydrate (%)**					**Total energy(Kcal/100g)**				
WWF:AP	**Storage period (days)**					**Storage period (days)**					**Storage period (days)**				
	0	30	60	90	Mean	0	30	60	90	Mean	0	30	60	90	Mean
T_1 (100:00)	0.14	0.09	0.07	0.04	0.08	74.05	74.11	74.22	74.36	74.18	425.38	424.26	423.91	423.06	424.15
T_2 (97:03)	0.20	0.16	0.10	0.09	0.14	73.02	73.14	73.35	73.42	73.23	419.37	419.11	418.5	417.77	418.68
T_3 (94:06)	0.41	0.31	0.27	0.18	0.29	72.51	72.69	72.91	74.08	73.05	411.98	411.28	410.61	414.15	412.00
T_4 (91:09)	0.74	0.60	0.53	0.41	0.57	72.19	72.33	72.55	72.78	72.46	407.37	406.30	405.76	405.44	406.21
T_5 (88:12)	0.82	0.66	0.58	0.47	0.63	72.10	72.26	72.49	72.69	72.38	401.48	401.29	400.65	399.77	400.79
T_6 (85:15)	1.07	0.84	0.75	0.62	0.82	71.29	71.49	71.72	71.86	71.59	398.48	398.04	397.50	397.05	397.76
T_7 (82:18)	1.28	0.97	0.84	0.73	0.95	71.06	71.21	71.33	71.59	71.30	391.92	391.51	391.11	390.29	391.20
T_8 (79:21)	1.55	1.23	1.10	0.88	1.19	70.22	70.43	70.58	70.69	70.48	387.77	387.19	386.55	385.75	386.81
T_9 (76:24)	1.83	1.43	1.17	1.06	1.37	69.93	70.14	70.33	70.56	70.24	384.68	383.80	383.45	382.74	383.66
Mean	0.89	0.70	0.60	0.50		71.82	71.98	72.16	72.45		403.15	402.53	402.00	401.78	

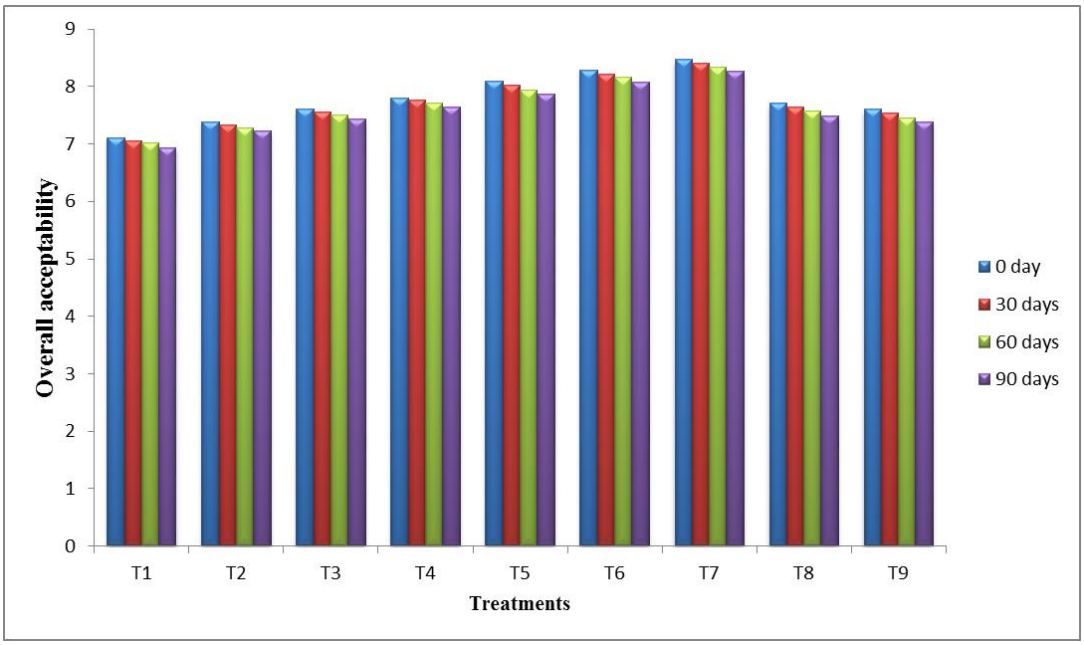

Fig 1: Effect of treatment and storage on overall acceptability scores of foam mat dried apricot powder blended nut crackers

However, there was a significant decrease in the total energy of nut crackers with the advancement in storage period. Highest mean carbohydrate content of 403.15 Kcal/100g was recorded at 0 day storage whereas, lowest mean carbohydrate content of 401.78 Kcal/100g was recorded at 90 days storage. Which might be due to decreased in protein, fat and carbohydrate. Similar decrease in total energy was reported by the results are also in conformity with those of Kumar and Barmanray (2007) [26] in button mushroom fortified biscuits.

Over all acceptability

A decrease in overall acceptability score was observed in all the treatments with the advancement of storage period was observed in Figure 1. At the beginning the maximum score of 8.47 was recorded in T_7 (82: 18- whole wheat flour: apricot powder) and the minimum of 7.11 in T_1 (100:00::whole wheat flour : apricot powder), which decreased to 8.26 and 6.94 after 90 days of storage, respectively

Conclusion

From the present studies, it is, therefore, concluded that incorporation of apricot powder in whole wheat flour nut crackers upto 18 per cent not only improves the overall acceptability but also improves the nutritive value of these products without adding much to the cost of the product. This shows the ample possibility for incorporation of apricot powder in baked products.

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