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Effect of apricot powder incorporation on physical, textural and organoleptic characteristics of nut crackers

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Abstract
Apricot is considered as a rich source of dietary fibre and it possesses both antioxidant and anticarcinogenic properties. The effect of baking on the physical and chemical characteristics of nut crackers incorporated with apricot powder was analyzed. The apricot powder was used for nut cracker preparation. It was incorporated into the traditional recipe to replace wheat flour at levels of 3, 6, 9, 12, 15, 18, 21 and 24% in preparation of nut crackers. It was observed that the ascorbic acid, antioxidant activity and total phenolic content increased with increase in apricot powder. The spread ratio decreased from 6.44 to 5.07 mm. The apricot containing nut crackers were characterized by a darker colour with a higher contribution of redness and yellowness, and by higher hardness. The overall organoleptic assessment showed that up to 18% of apricot powder did not influence the consumer acceptance.

Keywords: Apricot, nut crackers, baking, texture and organoleptic

Introduction
Apricot is a fruit of the prunus species *Prunus armeniaca* L. in the family Rosaceae. Cultivated apricot has its origin in North-Eastern China, whereas wild apricot, popularly known as zardalu, appears to be indigenous to India. It is a temperate fruit and grows in climates with well-differentiated seasons. It requires a fairly cold winter and moderately high temperatures in the spring and early summer (Ahmadi *et al.* 2008; Guclu *et al.* 2006) [3, 25]. In India, apricot is grown commercially in the hills of Himachal Pradesh, Jammu and Kashmir, Uttar Pradesh and to a limited extent in north eastern hills. Turkey, Spain, Italy, France and Greece are the countries having significant production of Apricots. Turkey is the world's leading apricot producer, with an output of 390.000 tons (2005). Apricots contain varied amounts of essential minerals and the major elements are potassium, phosphorus, calcium, magnesium, iron and selenium (Munzuroglu *et al.* 2003; Ali *et al.* 2011) [51, 7], while sodium, manganese, zinc and copper are also present in small amounts. Similarly, the vitamins found in apricot are pro-vitamin A, vitamins C, K, E, thiamin B_1, riboflavin B_2, niacin B_3, pyridoxine B_6, folic acid B_9 and pantothenic acid. (Chauhan *et al.*, 2001; Haciseferogullari *et al.* 2007) [19, 28]. Overall, apricot is especially rich in vitamin A and C (Lee and Kader, 2000) [46]. Apricot contains organic acids i.e. malic acid (500-900mg/100g) and citric (30-50mg/100g) as the major acids (Gurrieri *et al.* 2001) [26] and it is also found to be a good source of phenols, volatile compounds, esters and terpenoids (Ruiz *et al.* 2006) [56]. Being phyto-chemically rich, it also acts as an efficient source of antioxidants which restrict the destructive effects of oxidant reactions produced by free radicals (Sefer *et al.* 2006) [59]. Apricot is considered to be a good source of natural antioxidant for foods and functional food source against cancer, heart disease and other degenerative diseases (Yigit *et al.* 2009; Hussain *et al.* 2013) [72, 32]. Baking Industry is considered to be one of the major segments of food processing in India. Baked products have popularities in the people because of their availability, ready to eat convenience and reasonably good shelf life. Nut crackers are different from other baked products like bread and cakes because of their low moisture content which ensures less chance of microbial spoilage to provide a longer shelf life, making large scale production and distribution possible. However there is limited information on the potential for incorporating apricot powder in bakery products such as nut crackers.

Keeping in view the above functional and therapeutic properties of apricot the present work was carried out to incorporate apricot powder as a potential source of fibre in nut crackers at different levels and to evaluate the effect of fibre on the colour and physico-chemical properties 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

Preparation of apricot powder

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 incorporated in wheat flour at 0, 3, 6, 9, 12, 15, 18, 21 and 24% levels.

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) [40]. Refined wheat flour was used for preparation of control crackers. Preparation of nut crackers included these operations: mixing all the wet ingredients (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 of 2 mm thickness. 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 and dried for 8-10 minutes. The baked nut crackers were removed from the oven and allowed to cool at room temperature.

Physical and chemical parameters

Thickness

To determine the thickness (T), six cookies were placed on top of one another. The total height was measured in millimeters with the help of ruler. This process was repeated thrice to get an average value and results were reported in millimeters (mm) (AACC, 2000) [1].

Diameter

To determine the diameter (D), six cookies were placed edge to edge. The total diameter of the six cookies was measured in mm by using a ruler. The cookies were rotated at an angle of 90°C for duplicate reading. This was repeated once more and average diameter was reported in millimetres (AACC, 2000) [1].

Spread ratio

Spread ratio was calculated by dividing the average value of diameter (D) by average value of thickness (T) of biscuits (AACC, 2000) [1].

$$\text{Spread Ratio} = \frac{\text{Diameter}}{\text{Thickness}}$$

Hunter colour values (L*, a*, b*)

The colour of sample was measured using a Hunter's lab colour analyser (Hunter Lab Color Flex Reston VA, USA). The equipment was calibrated using white and black standard ceramic tiles. In the Hunter's lab colorimeter, the color of a sample is denoted by the three dimensions. L*, a* and b*. L* refers to lightness of the colour of the sample and ranges from black = 0 to white = 100. A negative value of a* indicates a green colour where the positive value indicates red-purple colour. A positive value of b* indicates a yellow colour and negative value a blue colour.

Ascorbic acid

Dilute 5ml of standard ascorbic acid solution with 5 ml of 3% metaphosphoric acid. Titrate the apricot pulp sample with dye solution till pink colour persists for 10 seconds (AOAC, 2012) [10]. Calculate the dye factor (mg of ascorbic acid per ml of dye as follows:

$$\text{Dye factor} = \frac{0.5}{\text{Titre}}$$

In case of a semi-solid or solid product, blend 10 gs of sample, with 3% HPO_3 and then make up to 100 ml and filter. Pipette 10 ml of filtrate into a conical flask and titrate with the standard dye to a pink end point. If a sample contains sulphur dioxide which reduces the dye and thus interferes with the ascorbic acid estimation, the following procedure is followed. Take 10 ml of filtrate, add 1 ml of 40% formaldehyde and 0.1 ml of HCL, allow to stand for 10 minutes and then titrate.

$$\text{Ascorbic acid (mg/100g)} = \frac{\text{Titre} \times \text{Dye factor} \times \text{Volume made up}}{\text{Volume of filtrate taken} \times \text{Wt. or volume of sample taken}} \times 100$$

Antioxidant activity

The antioxidant activity was determined by DPPH (1, 1, diphenyl-2 picryl hydrazyl) scavenging activity using DPPH as a free radical (Brand-Williams *et al.* 1995) [17]. 100 µl of sample extract solution was added to 1 ml of 0.01 per cent methanolic solution in a cuvette. The sample was then incubated for 30 minutes at room temperature. The reaction solution was examined at 515 nm using spectrophotometer. The inhibition percentage of DPPH was calculated according to the below equation:

$$\text{Inhibition (\%)} = \frac{AbS_{0\ min} - AbS_{30\ min}}{AbS_{0\ min}} \times 100$$

Where, Abs_{0min} = absorbance of DPPH at initial stage and Abs_{30min} = absorbance of DPPH after 30 minutes of incubation

Total phenolic content

Homogenized sample (1 g) was extracted three times with 80 per cent methanol. The extracts were centrifuged for 20 min. and the supernatants collected were dried under nitrogen. Total phenols were determined by Folin-Ciocalteu assay, which is an electron transfer based assay. To determine the total Phenolic, the residue obtained was re-dissolved in 5 ml

of distilled water followed by addition of 0.5 ml of Folin-Ciocalteu reagent. After 3 minutes, 2 ml of 20 per cent sodium carbonate solution was added (Waterhouse, 2002) [70]. The mixture was mixed thoroughly and incubated for 2 hr at ambient temperature. The absorbance was measured at 765 nm against a reagent blank using a UV- visible spectrophotometer (Model UV4, Unicam, Cambridge, UK).

Texture analysis of nut crackers (Hardness)

Mechanical properties of cookies were determined by breaking method using a texture analyzer (TA. HD. Plus, stable Micro Systems, Godalming, Surrey, U.K.) Equipped with a 500kg load cell. Pre-test speed of 1 mm/sec, test speed 3.00 mm/sec and post-test speed of 10.00mm/sec were maintained. The compression generated a curve with the force over distance. The highest first peak value was recorded as this value indicated the first rupture of cookie at one point and this value of force was taken as a measurement for hardness.

Sensory Evaluation

Sensory parameters such as Colour, Texture, Taste and 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) (Amerine *et al.* 1965) [9].

Statistical Analysis

Statistical analysis was carried out using Complete Randomized Design (CRD) giving analysis of variance (AVOVA) for significance at 5% of each treatment (Gomez and Gomez, 1984) [24].

Results and Discussion

Physical and chemical analysis of nut crackers

Diameter, Thickness and Spread Ratio

Nut crackers prepared with varying levels of replacement of wheat flour with foam mat dried apricot powder were evaluated for diameter, thickness and spread ratio. The results showed that all physical parameters were affected significantly with the addition of foam mat dried apricot powder (Table 1). It is evident from the results that the mean values for diameter of nut crackers decreased with increase in the apricot powder level into wheat flour. Mean diameter of nut crackers prepared from different treatments revealed that the highest significant value of 47.62 mm was observed for the control sample whereas the lowest value of 38.42 mm was found at 24 per cent supplementation level of foam mat dried apricot powder in nut crackers. The decrease in diameter of nut crackers could be attributed to more powder replacement and might be due to improper leavening during baking in high fiber content nut crackers. Sievert *et al.* (1990) [64] also reported a reduction of cookie diameter with the increase of bran incorporation. Similar findings were reported by Jeltema *et al.* (1983) [34] in biscuits, Nassar *et al.* (2008) [51] in the apple fiber and citrus by-products incorporated wheat biscuits and Mishra and Chandra (2012) [47] in rice bran and soy fortified biscuits.

Thickness of nut crackers showed gradual increase as the level of foam mat dried apricot powder was increased with values ranging from 7.40 mm observed in Control sample to 7.56 mm found in nut crackers containing 24 per cent foam-mat dried apricot powder. Increase in thickness might be due to the decrease in diameter. The results correlate with Bashir *et al*. (2006) [14] who replaced wheat flour with linseed flour in cakes and cookies and Hussain (2016) [31] in biscuits blended with barley flour and buckwheat flour. A similar finding for thickness was reported by Khalil *et al.* (2015) [36] in wheat flour oat bran blended. The changes in diameter and thickness were reflected in spread ratio of nut crackers.

The spread ratio of Control nut cracker was 6.44 mm and it decreased to 5.07 mm with the addition of foam mat dried apricot flour. This might be due to the gluten reduction effect of wheat flour. Ajila *et al*. (2008) [4] reported that the increased level of fiber and beta glucan absorb more water as a result the dough remained harder and consequently resulting in less spread ratio. Arshad *et al*. (2007) [11] also reported that spread ratio decreases due to high water absorption capacity of apricot powder. Mridula *et al.* (2007) [49] reported decrease in spread ratio of biscuit with increase in proportion of sorghum flour in wheat/sorghum composite biscuit. Similar results were reported by Singh *et al*. (1996) [65] and Hooda and Jood (2005) [30] who also reported reduction in spread ratio when soy flour and fenugreek flour were substituted in wheat flour, Sharma and Gujral (2014) [61] in barley blended cookies and Hussain (2016) [31] in biscuits blended with barley flour and buckwheat flour.

Table 1: Physical parameters of foam mat dried apricot powder blended nut crackers

Treatment Combination	Thickness (mm)	Diameter (mm)	Spread ratio (mm)
WWF: AP			
T_1 (100:00)	7.40	47.62	6.44
T_2 (97:03)	7.41	47.45	6.39
T_3 (94:06)	7.43	47.04	6.32
T_4 (91:09)	7.45	39.76	5.32
T_5 (88:12)	7.47	39.57	5.28
T_6 (85:15)	7.48	39.26	5.23
T_7 (82:18)	7.52	38.60	5.17
T_8 (79:21)	7.54	38.75	5.13
T_9 (76:24)	7.56	38.42	5.07

Hunter colour values (L*, a* and b*)

The mean values for lightness (L*) of nut crackers containing apricot powder varied from 74.95 to 57.28 (Table 2). However, the lowest L* value was observed in nut crackers containing 24 per cent level of apricot powder incorporation, which might be due to the loss of carotenoid pigments during baking and may be due to less concentration of baking powder. Lightness decreases due to enzymatic browning as reported by Ajila *et al.* (2008) [4] in biscuits incorporated with mango peel powder, Ashoush and Gadallah (2011) [12] also reported decrease in L*value of biscuits containing mango peel and seed kernel powders. Ingle *et al*. (2017) [33] reported that lightness decreased with the reduction in the proportion of wheat flour which resulted in the loss of white colour of the

flour and Sharma (2014) [62] in omega 3 fatty acids rich functional food.

Redness of nut crackers shows an increasing trend from the lowest value of 8.93 observed in T_1 (control) sample and highest value of 13.98 in nut crackers containing 24 per cent apricot powder. The *a** value above zero confirm that the red tone is dominating over the green in apricot fibre enriched dietary nut crackers. The increase in redness of nut crackers could be attributed to caramelization of sugar and darkening of apricot powder during baking at high temperature. Also it was revealed that the yellowness of nut crackers increases with the increase in apricot powder level. The *b** value above zero confirm that the yellow tone is dominating over the blue in fibre enriched nut crackers, with yellow tone being more expressed than the red tone which might be due to the inherent color of apricot powder. However, the b* value of the nut crackers ranged between 35.02 to 48.51. Similar results were observed by Kumar *et al.* (2010) [44] for soy fortified kutki biscuits substituted with millet flour. Jeltema *et al.* (1983) [34] also found that the fibre imparted the darkest brown color to the cookies and Sharma (2014) [62] in omega 3 fatty acids rich functional food.

With storage, L* value decreased from 66.36 to 65.24 whereas a* and b* value increased from 10.66 to 11.61 and 41.52 to 42.46, respectively after 90 days of storage. Similar results were observed in chiffon cake supplemented with konjac flour (Akesowan 2010) [6], Khouryieh and Aramouni (2012) [38] in flaxseed cookies and Sharma (2014) [62] in omega 3 fatty acids rich functional food.

Table 2: Effect of treatment and storage on L*, a* and b* value of foam mat dried apricot powder blended nut crackers

Treatment		Storage period (days)				Mean
		0	30	60	90	
T_1 (100:00: WWF: AP)	L*	76.00	75.45	74.65	73.72	74.95
	a*	8.35	8.57	9.29	9.52	8.93
	b*	34.45	34.82	35.24	35.56	35.02
T_2 (97:03: WWF: AP)	L*	73.75	73.52	73.27	72.68	73.30
	a*	8.83	9.16	9.56	9.87	9.35
	b*	36.02	36.27	36.48	36.83	36.40
T_3 (94:06: WWF: AP)	L*	71.67	71.24	70.56	70.15	70.90
	a*	9.32	9.63	10.19	10.32	9.86
	b*	38.46	38.76	38.98	39.12	38.83
T_4 (91:09: WWF: AP)	L*	68.83	68.62	68.12	67.93	68.37
	a*	9.87	10.18	10.42	10.81	10.32
	b*	40.16	40.28	40.57	40.70	40.43
T_5 (88:12: WWF: AP)	L*	66.39	66.06	65.70	65.54	65.92
	a*	10.13	10.52	10.78	11.02	10.61
	b*	42.03	42.25	42.53	42.83	42.41
T_6 (85:15: WWF: AP)	L*	63.15	62.92	62.76	62.45	62.82
	a*	10.93	11.27	11.54	11.73	11.37
	b*	43.56	43.72	44.28	44.51	44.02
T_7 (82:18: WWF: AP)	L*	60.53	60.28	59.97	59.42	60.05
	a*	12.28	12.62	12.97	13.19	12.76
	b*	44.95	45.16	45.51	45.78	45.35
T_8 (79:21: WWF: AP)	L*	59.12	58.91	58.63	58.49	58.79
	a*	12.75	12.98	13.27	13.68	13.17
	b*	46.12	46.58	47.05	47.53	46.82
T_9 (76:24: WWF: AP)	L*	57.83	57.46	57.05	56.78	57.28
	a*	13.52	13.86	14.17	14.39	13.98
	b*	47.91	48.24	48.63	49.28	48.51
Mean	L*	66.36	66.05	65.63	65.24	
	a*	10.66	10.98	11.35	11.61	
	b*	41.52	41.79	42.14	42.46	

Ascorbic acid content

With the incorporation of foam mat dried apricot flour, the ascorbic acid content increased significantly because of higher ascorbic acid content in apricot than in refined wheat. The highest mean ascorbic acid content 12.97 mg/100g was recorded in T_9 (76:24: WWF: AP) whereas, lowest of 1.30 mg/100g in treatment T_1 (100:00: WWF: AP) (Table 3). Similar findings were reported by Haque *et al.* (2016) [29] in cabbage powder fortified biscuits, Gurung *et al.* (2016) [27] in pumpkin puree fortified biscuits. Pratyush *et al.* (2015) [54] also reported increase in ascorbic acid in pumpkin powder fortified cookies.

Significant decrease in ascorbic acid content from initial value of 7.42 to 6.16 mg/100g was noticed during 90 days of storage period. The reduction in ascorbic acid might be due to its oxidation during storage at ambient storage temperature (Sharma *et al.* 2003) [60].

Antioxidant Activity

With the incorporation of foam mat dried apricot powder, the antioxidant activity increased in all treatments as apricot flour is rich source of antioxidants. The highest mean antioxidant activity of 30.28 per cent was recorded by T_9 (76:24: WWF: AP) whereas lowest of 13.92 per cent was recorded in treatment T_1 (100:000: WWF: AP) (Table 3). This might be due to the presence of higher amount of antioxidants in apricot flour. Phisut *et al.* (2013) [53] reported that the increase in the free radical scavenging may be attributed to the increase in the contents of polyphenols and ascorbic acid through the incorporation of mango peel powder fortified biscuits. Similar results were found by Pasqualone *et al.* (2014) [52] where biscuits made with grape marc extract inhibited 48 per cent of the DPPH radical scavenging activity. Sharma and Gujral (2014) [61] also reported that increase in antioxidant of nut crackers upon baking was attributed to the formation of brown coloured pigments due to Maillard browning during the baking process.

A significant decrease in antioxidant activity from 27.89 to 19.16 per cent was recorded during 90 days of storage. The phenol have been reported to be responsible for the antioxidant activity (Wong *et al.* 2006) [71]. The decrease in the antioxidant activity of phenolic compound is due to their ability to scavenge free radicals, donate hydrogen atoms or electrons, or chelate metal cations (Amarowicz *et al.* 2004) [8]. Similar trend of decrease in antioxidant activity during storage was reported by Betsy (2011) [15] in nutraceutical mango product and gluten free nut crackers, Molnar *et al.* (2015) [48] in biscuits enriched with black currant and jostaberry powder.

Total Phenolic Content

With the increase in the proportion of foam mat dried apricot powder in wheat flour, the total phenolic content of the nut crackers increased significantly at 5 per cent level of significance and the highest mean total phenolic content of 15.36 mg GAE/g was recorded in nut crackers with highest proportion 24 per cent foam mat dried apricot powder, while the lowest phenolic content of 0.42 mg GAE/g was recorded in T_1 (Control) (Table 3). This suggested that much of phenolic compounds may have originated from incorporation of apricot powder (Mahmoud *et al.* 2017) [46]. Ashoush and Gadallah (2011) [12] also reported an increase in total phenolic content in biscuits fortified with mango peels and seed kernels powders. Similar results were reported by Ajila *et al.* (2008) [4] mango peel powder enriched biscuits.

During 90 days of storage, the total phenolic content decreased significantly from 8.03 mg GAE/g to 7.06 mg

GAE/g. The decrease in total phenols during storage might be due to their condensation into brown pigments (Sheoran *et al.* 2007) [63]. Kim and Padilla- Zakour (2004) [39] also reported decrease in total phenolics which could mainly be resulted from oxidation, degradation of phenolic compounds and the polymerization of phenolic compounds with proteins. Similar results have been reported by Sedej *et al.* (2011) [58] in buckwheat crackers, Sharma (2014) [62] in omega 3 fatty acids rich functional food and Slathia (2014) [66] in mungbean based noodles.

Table 3: Effect of treatment and storage on ascorbic acid, antioxidant activity and total phenolic content of foam mat dried apricot powder blended nut crackers

Treatment Combination	Ascorbic acid (mg/100g)					Antioxidant activity (%)					Total Phenolic content (mg GAE/g)				
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)	1.63	1.38	1.23	0.96	1.30	15.85	14.72	13.65	11.48	13.92	0.62	0.47	0.32	0.28	0.42
T_2 (97:03)	2.15	1.89	1.49	1.12	1.66	19.18	17.85	16.92	13.74	16.92	1.72	1.27	1.03	0.87	1.22
T_3 (94:06)	3.98	3.23	2.56	2.28	3.01	22.20	20.45	18.82	15.76	19.31	3.75	3.24	2.89	2.56	3.11
T_4 (91:09)	4.75	4.12	3.84	3.42	4.03	25.81	22.72	19.60	16.42	21.14	6.11	5.64	5.32	5.19	5.56
T_5 (88:12)	7.28	6.83	6.47	6.09	6.67	27.14	24.03	20.94	18.75	22.71	7.22	6.78	6.49	6.18	6.67
T_6 (85:15)	9.12	8.75	8.36	8.04	8.57	30.92	25.84	21.77	20.57	24.77	9.82	9.53	9.08	8.92	9.34
T_7 (82:18)	11.21	10.77	10.33	10.05	10.59	33.21	28.15	24.96	22.72	27.26	12.22	11.85	11.65	11.22	11.73
T_8 (79:21)	12.28	11.94	11.67	11.39	11.82	37.24	31.16	27.03	25.86	30.32	14.82	14.29	13.72	13.48	14.07
T_9 (76:24)	14.36	12.98	12.48	12.07	12.97	39.43	33.35	29.21	27.12	32.28	15.96	15.46	15.18	14.85	15.36
Mean	7.42	6.88	6.49	6.16		27.89	24.25	21.43	19.16		8.03	7.61	7.30	7.06	

Texture analysis of nut crackers

Texture is another important physical parameter to evaluate nut crackers. Hardness is measured by peak force to break or snap the nut cracker and is a very important property that contributes to the quality of baked products (Zucco *et al.* 2011) [73]. Breaking strength of nut crackers measured using a texture analyzer, indicated a significant ($p \leq 0.05$) increase in the force required to break/snap the nut cracker as the level of substitution increased from 3 per cent to 24 per cent. The highest peak force, which determines the crispness, was observed in cookies prepared from 24% apricot powder incorporation (Table 4). In the formulation of the baked products such as bread, cookies, crackers etc, water plays a major role to determine the conformational state of biopolymers as well as affecting the nature of interactions between the various constituents of the formulation (Eliasson and Larsson, 1993) [23]. Thus, dough structuring of the nut cracker, can be said, affected by the amount of water used in the formulation of the cookies. Sai Manohar and Haridas Rao (1999) [57] stated that if the proportion of water is too low, the dough becomes brittle and not consistent.

The low amount of water causes delays or prevents starch gelatinization or pasting during baking process of cookies (Baltsavias *et al.* 1999) [13]. Consequently, some of the starch granules remained in their native condition during baking process and did not form a continuous structure (Kulp *et al.* 1991) [43]. Apart from that, proteins do not aggregate and hydrate enough to form a gluten network (Chevallier *et al.* 2002) [20]. Addition of foam mat dried apricot powder lead to the increase in hardness of the crackers as apricot powder competes with water used for cracker formulation obtained. This trend can be observed in the formulation of cookies with Tanduk banana flour (TBF) substitution where Tanduk banana flour (TBF) incorporated cookies showed increased hardness compared to the Control cookies. The same pattern was found by Ajilata *et al.* (2008) [5] where the hardness of soft dough biscuits increased as substitution of mango peel flour was increased. Zucco *et al.* (2011) [73] confirmed that substitution of cookies with other flour increases the hardness. Kohajdova *et al.* (2011) [41] also confirmed in their study that greater hardness of cookies with higher supplementation of apple fibre powder. The control sample got the lowest peak force which may be due to non-substitution of apricot powder, resulted in fine crispness of cookies from rest of the samples.

Table 4: Effect of treatment on texture analysis (hardness g) of foam mat dried apricot powder blended nut crackers

Treatment Combination	Hardness (g)
WWF:AP	
T_1 (100:00)	2500
T_2 (97:03)	2600
T_3 (94:06)	2650
T_4 (91:09)	3652
T_5 (88:12)	3700
T_6 (85:15)	4400
T_7 (82:18)	4560
T_8 (79:21)	4950
T_9 (76:24)	5600

Sensory evaluation of blended nut crackers

Colour

Colour is very important parameter in judging properly baked biscuits that not only reflects the suitable raw material used for the preparation but also provides information about the formulation and quality of the product (Abu-Salem and Abou-Arab, 2011) [2]. The sensory scores for colour decreased significantly in all the treatments during 90 days of storage. The highest mean score for colour was 8.53 in T_7 (82:18: WWF: AP) whereas, lowest was recorded in treatment T_1 (100:00: WWF: AP) having score of 7.13 (Table 5). This might be attributed to the higher concentration of foam mat dried apricot flour which imparted darker colour to the product. Khapre *et al.* (2015) [37] reported similar results using fig powder enriched cookies and Bhat and Ahsan (2015) [16] in cookies prepared with tomato pomace powder.

During storage period, there was significant decrease in the mean score from 7.96 at initial day to 7.74 during 90 days of storage period. The darker colour may be due to the non-enzymatic reaction (Maillard reaction) between reducing sugar molecules and lysine protein explained by Decker *et al.* (2002) [22] and Tsuji *et al.* (2001) [69]. Swapna and Rao (2016) [68] also reported decrease in colour score during storage of 90 days, Choudhary (2018) [21] in fibre rich oat-wheat flour blended biscuits using mango peel and Sharma (2014) [62] in flaxseed flour blended crackers.

Texture

Good texture indicates good quality. A general decrease in texture was observed during storage. The highest mean texture score of 7.61 was observed in treatment T_7 (82:18: WWF: AP) whereas, lowest of 7.16 was observed in treatment T_1 (100:00: WWF: AP). Results revealed that the nut crackers had acceptable texture upto 18 per cent of apricot powder as compared to the control (Table 5). The high replacement of apricot powder resulted in harder nut crackers due to the greater water absorption capacity as reported by Ashoush and Gadallah (2011) [12]. Similar results have been reported by Bhat and Ahsan (2015) [16] in physico-chemical characteristics of cookies prepared with tomato pomace powder and Kaur (2011) [35] in flaxseed blended cookies.

During storage period, there was significant decrease in the mean score from 7.48 at initial day to 7.31 during 90 days of storage period. The textural changes are expected to take place in biscuits during storage because of conformational changes that continue even during static storage of processed foods as reported by Brennan (2006) [18]. Swapna and Rao (2016) [68] reported that as the storage increased body and texture score of the nut crackers decreased from 0 to 90 days.

Taste

A significant decrease in taste scores were observed with the advancement in storage period as well as with the incorporation of foam mat dried apricot flour. The highest mean score of 8.80 for taste was observed in treatment T_7 (82:18: WWF: AP) and lowest mean score of 7.02 was observed in treatment T_1 (100:000: WWF: AP) (Table 5). The increase in taste score with the addition of foam mat dried apricot powder might be due to apricot which imparted good taste. Kulkarni and Joshi (2013) [42] also reported that biscuits replacement with pumpkin powder had better taste when stored at ambient temperature and Sharma (2014) [62] in flaxseed flour blended crackers.

During storage period, there was significant decrease in mean score from 7.96 to 7.74. Similar findings were reported by Choudhary (2018) [21] in fibre rich oat-wheat flour blended biscuits using mango peel, Sharma (2014) [62] in flaxseed flour blended crackers and Hooda and Jood (2005) [30] whose sensory results showed that a maximum of 10 per cent fenugreek flour can be incorporated to prepare acceptable quality biscuits and can be safely stored in polypropylene bags upto one month without altering their organoleptic properties.

Overall Acceptability

A decrease in overall acceptability score was observed in all the treatments with the advancement of storage period. Among the treatments, treatment T7 (82:18: WWF: AP) obtained maximum mean score of 8.36 and lowest of 7.03 was observed in T1 (100:00: WWF: AP). The reduced acceptability of crackers at 21 and 24 per cent incorporation of apricot powder may be attributed to the poor flavour and colour contributed by apricot powder at higher levels. The overall acceptability of treatment T7 (82:18: WWF: AP) was found acceptable as compared to Control (Table 5). Similar results have been reported by Khapre *et al.* (2015) [38] in fig powder enriched cookies, Purohit and Rajyalakshmi (2011) [55] in defatted groundnut cake flour and Sharma (2014) [62] in flaxseed flour blended crackers.

The mean overall acceptability decreased from 7.78 to 7.59 during 90 days. Swapna and Rao (2016) [68] reported that overall acceptability score of cheese incorporated oat biscuit showed decreasing trend from 0 to 90 days but were all in acceptable range. Similar results have been reported by Stojceska *et al.* (2008) [67] in cereal based ready to eat expanded snacks using cauliflower by products, Hussain (2016) [31] in biscuits blended with barley flour and buckwheat flour.

Table 5: Effect of treatment and storage on colour, texture taste and overall acceptability of foam mat dried apricot powder blended nut crackers

Treatment Combination	Colour					Texture					Taste					Overall acceptability				
WWF:AP	Storage period (days)					Storage period (days)					Storage period (days)					Storage period (days)				
	0	30	60	90	Mean	0	30	60	90	Mean	0	30	60	90	Mean	0	30	60	90	Mean
T_1 (100:00)	7.21	7.15	7.10	7.06	7.13	7.22	7.19	7.15	7.09	7.16	7.13	7.05	6.98	6.91	7.02	7.11	7.06	7.01	6.94	7.03
T_2 (97:03)	7.54	7.49	7.43	7.37	7.45	7.26	7.22	7.18	7.13	7.20	7.51	7.42	7.33	7.29	7.39	7.39	7.33	7.27	7.22	7.30
T_3 (94:06)	7.75	7.71	7.65	7.60	7.67	7.42	7.38	7.33	7.27	7.35	7.72	7.68	7.61	7.52	7.63	7.60	7.55	7.50	7.43	7.52
T_4 (91:09)	7.89	7.82	7.78	7.75	7.81	7.55	7.52	7.48	7.42	7.49	7.92	7.86	7.78	7.61	7.79	7.80	7.76	7.71	7.64	7.72
T_5 (88:12)	8.21	8.14	8.05	7.96	8.09	7.60	7.55	7.47	7.40	7.50	8.43	8.37	8.29	8.21	8.32	8.09	8.02	7.93	7.86	7.97
T_6 (85:15)	8.48	8.39	8.31	8.24	8.35	7.67	7.61	7.54	7.46	7.57	8.62	8.57	8.51	8.44	8.53	8.29	8.22	8.16	8.08	8.18
T_7 (82:18)	8.67	8.60	8.48	8.39	8.53	7.72	7.65	7.58	7.51	7.61	8.89	8.84	8.77	8.72	8.80	8.47	8.41	8.33	8.26	8.36
T_8 (79:21)	7.98	7.92	7.84	7.71	7.86	7.55	7.48	7.43	7.34	7.45	7.74	7.68	7.62	7.56	7.65	7.71	7.65	7.58	7.49	7.60
T_9 (76:24)	7.92	7.83	7.74	7.62	7.78	7.31	7.27	7.23	7.16	7.24	7.68	7.61	7.53	7.46	7.57	7.60	7.53	7.46	7.39	7.49
Mean	7.96	7.89	7.82	7.74		7.48	7.43	7.38	7.31		7.96	7.89	7.82	7.74		7.78	7.72	7.66	7.59	

Conclusion

Bakery products such as nut crackers can sometimes be used as a vehicle for incorporation of different nutritionally rich ingredients. Addition of dietary fibre to bakery products increases fibre intake and decreases the caloric density of baked goods. Apricot powder was incorporated in wheat flour based nut crackers as a value added functional ingredient up to 24% at different levels. There was a linear increase in ascorbic acid, antioxidant activity, total phenolic content, Redness and yellowness index of cookies while as diameter, spread ratio and whiteness index of nut crackers decreased with increase in substitution level. Sensory characteristics of nut crackers showed that T7 sample scored more in terms of colour, texture taste and overall acceptability when compared with control. It was also concluded that the apricot powder incorporated at 18% level showed no substantial influence on the overall acceptability of nut crackers when compared with control sample. Also the hardness of cookies increased with the increase in apricot powder. The results presented here indicate that apricot powder can be used in nut crackers, partially replacing wheat flour to improve its nutritional quality with acceptable sensory, textural characteristics and also presented a reasonable consumer acceptance.

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