PAPER

EXPLORING THE EFFECT OF APRICOT ADDITION ON NUTRITIONAL, ANTIOXIDANT, TEXTURAL AND SENSORY CHARACTERISTICS OF COOKIES APRICOT SUPPLEMENTED FUNCTIONAL COOKIES

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ABSTRACT

Current study was designed to explore the nutritional and antioxidant potential of Pakistani apricot's varieties (Marghulam, Halman, Kakas and Shakanda). The highest values of moisture, crude fat, crude protein, fiber and ash (7.95±0.05%, 2.29±0.07%, 3.22±0.06%, 3.82±0.91% and 4.26±0.08%) were found in Marhulam. The maximum value of total phenolic contents (TPC) 30.75±0.09mg/100gGAE and DPPH 40.64±0.04% was determined in Marghulam and Halman respectively. Cookies were prepared with incorporation of apricot powder (10%) and evaluated for compositional, mineral, TPC, antioxidant activity, physical parameters, color, texture and sensory attributes. Based on sensory evaluation, cookies supplemented with 10% Marghulam flour got the highest score.

Keywords: antioxidants, apricots, cookies, organolyptic characteristics

1. INTRODUCTION

Fruits and vegetables are at the base of the food pyramid and rich source of nutrients, bioactive compounds i.e. phytochemicals (flavonoids, phenolics, and carotenoids), minerals, vitamins and fibers (LIU 2013). Vitamins A, B and C along with magnesium, potassium, calcium and iron are present in fruits like papaya, mango, pineapple, lemon, guava, jackfruit. Globally, people consume fruits as a staple food. For example, banana is eaten by South Americans as the main course of their meal. Our food shortages can be minimized to a considerable extent by banana, jackfruit, guava and pineapple (YAHIA *et al*., 2019). Apricot (*Prunus armenia* L.) is one of the nutritious fruit and a member of the Rosaece family. "Apricot" is a derivative of the Latin term *Praecocia*, meaning "early maturing" or "precocious". China started its farming, three thousand years before Christ (KARACA *et al*., 2019).

The total area destined to apricot's farming in Pakistan accounts for 31256 hectares. Moreover, in Punjab, the apricot cultivation area is 42 hectares. Furthermore, the highest production of 220276 tons of apricot is in Baluchistan, with a total area of 28901 hectares (KOUSAR *et al*., 2019). Apricots are greatly valued both fresh and dried. A dried fruit delivers a sufficient amount of energy and nutrients, which is particularly important for the population of the mountainous Karakoram zone (CHEN *et al*., 2020). Apricot cultivation significantly contributes to the agricultural income of the Pakistani province of Gilgit-Baltistan, where the local varieties Marghulam, Kakas, Halman and Shakanda are mostly cultivated.

Apricot has a distinctive nutritive value amongst stone fruits. It has a high content of proteins (8%), crude fiber (11.50%), fat (2%), minerals (4%), sugars (>60%), vitamins (A, B complexes, C and K) and organic acids (malic and citric acid), as well as a substantial amount of flavonoids and phenolics (KAFKALETOU *et al*., 2019). Dried apricots such as Marghulam and Halman are rich source of nutrients, minerals and vitamin C. Dried apricots can also be used for the preparation of different value-added food products (KIRALAN *et al*., 2019).

Previous efforts were made to increase the nutritional and organoleptic characteristics of cookies through supplementation. UCHOA *et al*. (2009) supplemented apple and guava pomace (dehydrated fruit powders) at different level. The cookies prepared with 15% and 20% substitution showed the best results in sensory evaluation. Similarly, TAŃSKA *et al*. (2016) incorporated fruit pomace (rosehip, rowan, blackcurrant and elderberry) and studied the effect of antioxidants on the properties of shortbread cookies. Likewise, PASQUALONE *et al*. (2019) studied the acorn flour substitution effect on the physicochemical and sensory properties of biscuits. Various authors (CHENG and BHAT 2016; ERTAŞ and ASLAN 2020; KAPOOR and RANOTE 2016; LEPIONKA *et al*., 2019; YOUSAF *et al*., 2013; ZUCCO *et al*., 2011) supplemented legume, pulses, seeds, cereals and evaluated the effect of substitution on quality of cookies.

Functional food can be described as the food that can deliver consumers with a health benefit beyond their basic nutrients. Functional bakery products are gaining much importance to improve the health and wellbeing of consumers. Different functional beverages, functional bakery products, functional cereal-based food and dairy-based foods are available in the market (NINFALI *et al*., 2019). Among bakery products, cookies are full of carbohydrates and fats, and have low levels of fiber, vitamins and minerals, but are largely consumed all around the world. Cookies are considered the most common and consumable bakery items (CURUTCHET *et al*., 2019). To improve the nutritional profile of cookies, the present study is designed to develop potentially functional cookies by supplementing them with dried powdered apricots After that, the quality testing of prepared cookies was carried out.

2. MATERIALS AND METHODS

The present study was carried out in the Food and Nutrition Laboratory, Government College Women University, Faisalabad, Pakistan. However, some of the product's analyses were carried out at the University of Agriculture, Faisalabad, Pakistan.

2.1. Raw materials

Apricots varieties Kakas, Marghulam, Halman and Shakanda were acquired from Mountain Agriculture Research Centre (MARC) located in Jaglot, in the Gilgit Baltistan province, Pakistan. The selected trees were seven-year-old and were subjected to the same agricultural practices. Three healthy plants of the same age of each variety were selected during the years 2018 and 2019. Apricots were harvested healthy and at full ripening stage (deep yellow color with red blush). All varieties were harvested on the same day to provide fruits with uniform maturity, color, size and firm texture. Particulates of herbicide, insecticide and dust present on fruit exterior were removed by washing. The commercial straight grade flour (SGF) and remaining ingredients for cookies formulation were purchased from the local market of Faisalabad, Pakistan. All reagents, chemicals and standards were bought from Sigma-Aldrich (Sigma-Aldrich Tokyo, Japan) and Merck (KGaA, Merck Darmstadt, Germany).

2.2. Preparation of apricot powder

Apricots were dehydrated by the sun-drying method. Initially, the apricots were washed, pitted, cut into small pieces (1.5 cm x 1.5 cm) and placed on wire mesh tray covered with cloth. The apricots were dried under direct sunlight with an overall maximum day time temperature (37°C) and a minimum night temperature (29°C) for 48 h until the final moisture (6.0%) was reached. Then the dried apricots were ground by using an electric grinder. The dry apricot powder was sieved, to ensure a homogeneous particle size, through a mesh sieve of 250 μm (Retsch Test Sieve, Germany). The powder was stored in sealed polyethylene bags at 4°C for further analyses.

2.3. Proximate and antioxidant analysis of apricot powder

Apricot powder of all varieties was analyzed individually for proximate composition and antioxidant potential. The proximate analyses (moisture, crude fat, crude protein, crude fiber, ash and NFE) were performed following the corresponding methods as stated in AOAC (2006). Folin-Ciocalteu's test was used to measure the total phenolic content and antioxidant activity (%) was assessed based on free radical scavenging action through 2, 2-diphenyl-l-picrylhydrazyl (DPPH) assay (IDRIS, 2019).

2.4. Mineral analysis of apricot powder

The mineral content of apricot powders was determined by the ashing method (AOAC, 2006). The acquired ash was digested with 5 mL of 6 M HCl in a water bath. Ca, Fe, Mn, Cu, Zn and Mg of apricot powders were determined in an Atomic Absorption Spectrophotometer whereas Na and K were determined by Flame Photometer and P by using UV-Spectrophotometer.

2.5. β-carotene content of apricot powder

β-carotene was isolated through column chromatography by using aluminum oxide with an absorbent column length of 10 cm. β-carotene moves down through the absorbent column afore all other pigments and is collected till the chosen pigment/s moved through the column and eluent becomes colorless. The color intensity of the eluent with known volume was measured with a spectrophotometer at 452 nm while acetone in petroleum ether (3 % v/v) used as blank (GIRÓN *et al*., 2019).

2.6. Preparation of cookies

Cookies were prepared from composite blends by using the method of HAN *et al*. (2004). The standardized cookie recipe was followed that includes wheat flour 40 g, butter 26 g, sugar 18 g, egg 9, milk 5 mL and yeast 1.6 g. Apricot powder and wheat flour (10:30) ratio was set based on different experimental trails while remaining ingredients remained the same. All the ingredients were mixed properly to make the dough. Then, the dough was rolled into cookies sheets. The cookies were baked at a temperature of 220 °C for 8 min. After baking, the cookies were cooled at room temperature and stored in polyethylene bags until further analyses.

2.6.1. Proximate, mineral, antioxidant and β-carotene of apricot supplemented cookies (ASC)

Proximate composition (moisture, fat, protein, fiber, ash and NFE) of apricot supplemented cookies was determined according to the standard procedures of AOAC (2006). The mineral content of apricot supplemented cookies was also determined (AOAC, 2006). Total phenolic contents were determined through Folin-Ciocalteu's method and antioxidant activity (%) was assessed through 2, 2-diphenyl-l-picrylhydrazyl (DPPH) assay (IDRIS 2019). β-carotene was estimated by the method described by GIRÓN *et al*. (2019).

2.6.2. Physical analysis of apricot supplemented cookies

Thickness and diameter of apricot supplemented cookies were measured with vernier caliper at two different positions for each cookie and the average was calculated. The spread ratio was calculated using the formula: diameter of cookies/height of cookies. The bake loss of cookies was calculated by weighing five cookies before and after baking. The average difference in weight was noted and represented as percent bake loss (CHAUHAN *et al*., 2016).

2.6.3. Color of apricot supplemented cookies

The colorimeter was used to measure the color of cookies based on L, a*, b* value. L* values range (0-100) and represents black to white, a* values represent the red color, and b* values show yellow color (CHAUHAN *et al*., 2016).

2.6.4. Texture analysis of apricot supplemented cookies

The texture was determined by Texture profile analysis (TPA) by using a Texture Analyzer (Brookfield, Middleboro, USA). The probe was P/75 aluminum, 75 mm diameter and the test speed was 0.5 mm/s. Sample cookies were always placed with the top upward. Texture profile analysis includes several parameters i.e. hardness, springiness, cohesiveness and chewiness (GUPTA *et al*., 2011).

2.6.5. Sensory evaluation of apricot supplemented cookies

Sensory evaluation of cookies was performed by a group of ten male and female semi-trained panelists (20-35 years of age). The assessment of the overall sensory value of cookies was experienced by the sense of sight, taste, and touch. The 9 points hedonic scale rating test was used to assess the degree of acceptance. The panelists were offered with an assessment method, which described several sensory criteria and score choices with number rankings. When all the assessment forms were completed, the data was analyzed. The cookies were evaluated for different sensory attributes like taste, texture, color, appearance, and overall acceptability (GANORKAR and JAIN, 2014).

2.7. Statistical Analysis

The obtained data were evaluated by one-way analysis of variance (ANOVA) with the help of Statistix 8.1 (Florida, USA). The level of significance (α 0.05%) was determined through the analysis of variance (ANOVA) method under the principles explained by MONTGOMERY *et al*. (2008).

3. RESULTS AND DISCUSSION

3.1. Proximate composition of apricot powder

The proximate analysis of different apricot varieties is presented in Table 1. The highest moisture content was observed in V_1 (7.95%) followed by V_2 (7.39%) while the lowest moisture content was observed in V_4 (6.09%). The present results are contradictory to the outcomes of ASHRAF *et al*. (2018), they reported that the apricot powder had moisture content (6.85%). The difference might be due to different varieties used in both studies. Storage stability, processing and value of food are linked with its low moisture content (HUSSAIN *et al*., 2006). Due to the nutritional differences, Marghulam had the highest moisture content as compared to other apricot varieties. The highest value of fat content was reported in V_1 (2.29) followed by V_2 (2.15%). The present outcomes on fat contents are in line with the finding of HUSSAIN *et al*. (2010), they reported that the apricot powder contains 2.31% fat content. Similarly, another researcher ARSHAD *et al*. (2010), reported that the fat content of three different varieties of apricot Marghulam, Halman and Shakanda was 3.10%, 2.2% and 4.56%, respectively. The compositional differences may be due to genetic and environmental variation (HACıSEFEROĞULLARı *et al*., 2007; ÖZCAN and HACıSEFEROĞULLARı, 2007).
The ash content is considered as an indicator of minerals present in any commodity. The highest value of ash content was observed in V_1 (4.26%) followed by V_2(4.21%). The results

of present study were according to the results of AKIN *et al*. (2008). The highest value of fiber content was observed in V_1 (3.82%) followed by V_2 (3.62%) and the lowest value was observed in V_4 (3.23%). ALI *et al*. (2014b) reported that the fiber content is 3.85% in apricot powder. Crude fiber is also a significant part of fruits and important in sustaining health through improving bowel movement and taking extra fat from the blood. Marghulam powder has the highest amount of fiber as compared to other apricot varieties. This compositional difference is common among varieties due to their differences in genotypes, geography and agricultural practices (ALI *et al*., 2014a).

Table 1. Proximate, antioxidant, β-carotene and mineral of apricot powder.

Apricot powder	V_1	V_2	V_3	V_4
Moisture (%)	7.95±0.05^a	7.39±0.04^b	6.75±0.03^c	6.09±0.02^d
Fat (%)	2.29±0.07^a	2.19±0.06^b	2.15±0.05^c	2.12±0.04^d
Protein (%)	3.22±0.06^a	3.18±0.05^b	3.15±0.04^c	3.12±0.03^d
Fiber (%)	3.82±0.09^a	3.62±0.08^b	3.42±0.07^c	3.23±0.06^d
Ash (%)	4.26±0.08^a	4.21±0.07^b	4.19±0.06^a	4.12±0.04^a
NFE (%)	78.50±0.09^d	79.50±0.10^c	80.02±0.11^b	80.06±0.012^d
DPPH (%)	32.77±0.07^b	40.64±0.06^a	30.54±0.05^c	28.43±0.03^d
TPC(mg/100gGAE)	30.75±0.09^a	29.64±0.04^b	28.54±0.02^c	27.43±0.03^d
ß-carotene (mg/100g)	46.12±1.00^a	40.07±0.02^b	35.41±0.07^c	30.74±0.04^d
Na (mg/100gdw)	22.05±1.30^a	18.71±0.60^b	15.79±0.23^c	14.30±0.60^d
K (mg/100gdw)	2240±38.00^a	1868±29.67^b	1730±30.00^c	1620±25.00^d
Ca (mg/100gdw)	111.30±3.20^a	105±2.40^b	98.40±2.28^c	76.71±0.72^d
Mg (mg/100gdw)	144.89±6.18^a	139.90±6.20^b	132.70±3.50^c	118. 90±4.30^d
Zin (mg/100gdw)	3.28±0.21^a	2.70±0.18^b	1.43±0.16^c	108±0.11^d
Fe (mg/100gdw)	9.96±0.50^a	6.34±0.41^b	4.04±0.31^c	3.90±0.24^d
Cu (mg/100gdw)	0.50±0.05^a	0.40±0.04^b	0.32±0.01^c	0.26±0.02^d
P (mg/100gdw)	250.80±7.24^a	247.90±5.30^b	212.40±3.48^c	190.60±3.10^d

Mean carrying same letters are not significantly different from each other.
Values are expressed as mean ±SD (n=3).
Whereas,
V_1: Marghulam, V_2: Halman, V_3: Shakanda, V_4: Kakas.

3.2. Total phenolic content (TPC) and antioxidant activity of apricot powder

The highest value of TPC was observed in V_1 (30.75 mg/100g GA) followed by V_2 (29.64 mg/100g GAE) and V_3 (28.54 mg/100g GAE) while the lowest TPC value was found in V_4 (27.43%) as presented in Table 1. The current outcomes of TPC are similar to the findings of (WANI *et al*., 2017), they reported that TPC contents of different varieties of apricot Harcot, Rival and Cuminis Haley were 25.44 mg/100g GAE, 32.86 mg/100g GAE and 24.87 mg/100g GAE, respectively.

DPPH value was highest in Halman while the maximum TPC content was found in Marghulam. The highest antioxidant value was observed in V_2 (40.64%) followed by V_1 (32.77%) whilst the lowest in V_4 (28.43 %). The current outcomes of DPPH are in coherence with the results of WANI *et al*. (2015) who reported that DPPH of three varieties of apricot Harcot, Rival and Cuminis Haley was 21.68%, 34.16% and 44.62% respectively. The difference in phenolic content and antioxidant might be due to varietal, genetic and geographical difference.

3.3. Mineral content of apricot powder

The potassium concentration was found to be highest in V_1 (2240mg\100gdw) followed by V_2 (1868mg\100gdw) and V_3 (1730mg\100gdw). The highest sodium content was found in V_1 (22.05 mg\100gdw) followed by V_2 (18.71 mg\100gdw). The highest calcium content was present in V_1 (111.30 mg\100gdw) followed by V_2 (105.18 mg\100gdw) and V_3 (98.40mg\100gdw). The maximum iron content was in V_1 (9.96mg\100gdw) followed by V_2 (6.34 mg\100gdw) and V_3 (4.04mg\100gdw). The present results of different apricot varieties are following the outcomes of ALI *et al*. (2014b). Mineral composition showed that apricot varieties contain considerable amounts of minerals. The mineral composition showed that Marghulam variety has high mineral content followed by Halman Shakanda and Khakhas. These conclusions are in line with the previous study on Turkish Apricots (HACıSEFEROĞULLARı *et al*., 2007). However, differences in data might be due to the genotype, geographical origin, environment and agronomic practices (CHEN *et al*., 2020).

3.4. β-carotene content of apricot powder

The β-carotene were found to be highest in V_1 (46.12mg/100g) followed by V_2 (40.07mg/100g) and V_3 (35.41mg/100g). The present results of apricot cookies are consistent with the outcomes of Ali *et al*. (2014), who reported that Marghulam β-carotene (50.12±1.00 mg/100g) followed by Shakanda (46.07±0.88 mg/100g), Jahangir (40.54±0.78 mg/100g), Shirini (39.45±0.740 mg/100g), Yagoo (36.41±0.700 mg/100g) and Halman (30.61±0.50 mg/100g). Bioactive compounds *i.e.* phenolics and carotenoids are important quality index parameters of fruits and vegetables (GIRÓN *et al*. 2019).

3.5. Proximate composition of apricot supplemented cookies

The proximate composition of apricot supplemented cookies varied significantly among different treatments (Table 2). The highest moisture content was found in T_1 (7.85%) followed by T_2 (7.80%) and the lowest moisture content was found in T_4 (6.24%). The present results of different apricot cookies are in accordance with the results of MUNDEJA and HIRDYANI (2014), they reported 6.38% moisture content in apricot cookies. Similarly, another research work of PETER IKECHUKWU *et al*. (2017), found that the moisture content of whole wheat flour cookies was 7.70%. The reduction in crude fat content might be due to the lipolytic activity of the enzymes i.e., lipase and lipooxidase (VARSHNEY *et al*., 2008). The protein content reduction in different cookies might be due to the hydrolysis of the peptide bond with the help of protease enzyme that results in the splitting of protein molecules (WANI *et al*., 2015). The difference in fiber content may be due to the deprivation of hemicelluloses and other structural polysaccharides. The highest ash content was found in T_1 (1.36%) followed by T_2 (1.30%). Similar results were reported by other researchers (GAYAS *et al*., 2012; PRATYUSH *et al*., 2015).

3.6. Total phenolic content and antioxidant activity of apricot supplemented cookies

The total phenolic content and antioxidant activity varied significantly for treatments (Table 2). Total phenolic content and the antioxidant value decreased in apricot cookies as compared to apricot powder due to the processing loss during baking. The maximum TPC value was found in T_1 (25.69 mg/100g GAE) followed by T_2 (24.60 mg/100g GAE). The highest DPPH value was found in Halman and the highest TPC value was found in T_1. DPPH is a free radical compound that has been widely used to estimate the free radical-scavenging activity (AMAROWICZ *et al*., 2004). The highest value of DPPH was found in T_2 (38.52%) followed by T_1 (31.60%) and T_3 (28.39%) while the lowest DPPH value was found in T_4 (25.30%).

3.7. Mineral content of apricot supplemented cookies

The mineral contents of different apricot cookies also varied significantly ($p<0.05$) among all treatments. Potassium, sodium, calcium and iron concentration was found to be highest in T_1, these values for these minerals were 1940 mg\100g, 20.05 mg\100g, 108.29 mg\100g and 8.90 mg\100g on dry weight basis respectively. The present results of various apricot cookies are consistent with the outcomes of İNCEDAYI *et al*. (2016). Similarly, AKIN *et al*. (2008) determined the K, Mg, Ca and Zn contents of eleven apricot varieties similar to the present study as 1227-3455 mg/100 g, 110.4-284.4 mg/100 g, 87-240.5 mg/100 g and 1.38-4.24 mg/100 g based on dry matter, respectively. The data about mineral contents (mg/100 g) revealed K as the predominant element. These mineral compounds are present in any part of the plant and their concentration differs concerning crop, variety, growth condition, irrigation, genetics, temperature fluctuation, seasons, pre-harvest and post-harvest treatments. K, Ca and Mg are considered major minerals of the apricot fruit (DROGOUDI *et al*., 2008). For the human body, minerals are vital for a diversity of basic physiological and metabolic processes that include enzyme activation, muscle contraction, bone health, conduction of nerve impulse, transport of oxygen, antioxidant activity, acid and immune function of blood. An adult requires almost 350 mg Mg, 3000 mg K and 1000 mg Ca intake per day (WILLIAMS, 2005).

3.8. β-carotene content of apricot supplemented cookies

Maximum ß-carotene content was found in T_1 (43.79 mg\100g) followed by T_2 (36.99 mg\100g) and T_3 (32.88 mg\100g). The present results of various apricot cookies are consistent with the results of IGUAL *et al*. (2012). The carotenoids content is lesser than that stated for fresh apricot, which can be elucidated by the detail that drying and baking may lead to degradation of carotenoids due to oxidation and high temperature (DRAGOVIC-UZELAC *et al*., 2007). In addition to β-carotene, apricot fruit and its products contain smaller amounts of α-carotene, γ-carotene, zeaxanthin and lutein (FRASER and BRAMLEY 2004).

3.9. Physical analysis of apricot supplemented cookies

Physical properties (thickness, diameter, spread ratio, and bake loss) of cookies are presented in Table 3. Results revealed that there was a significant difference ($p<0.05$) among each treatment in terms of thickness, diameter, spread ratio and bake loss. The highest diameter was noted in T_1 (53.99 mm) followed by T_2 (53.77 mm), T_3(52.96 mm).

Table 2. Proximate, antioxidant, β-carotene and mineral of apricot supplemented cookies.

Apricot cookies	T_0	T_1	T_2	T_3	T_4
Moisture (%)	5.85±0.06^e	7.85±0.11^a	7.80±0.10^b	6.84±0.09^c	6.24±0.08^d
Fat (%)	7.68±0.01^e	9.77±0.05^a	9.26±0.04^b	8.27±0.03^c	8.07±0.02^d
Protein (%)	5.15±0.01^e	5.75±0.05a	5.48±0.04^b	5.38±0.03^c	5.24±0.02^d
Fiber (%)	0.72±0.01^e	1.45±0.05^a	1.33±0.04^b	1.19±0.03^c	1.14±0.02^d
Ash (%)	1.17±0.01^e	1.36±0.05^a	1.30±0.04^b	1.25±0.03^c	1.22±0.02^d
NFE (%)	79.04±0.09^a	77.35±0.08^b	75.41±0.07^c	73.68±0.06^d	63.78±0.05^e
DPPH (%)	20.6±0.09 ^{e}	31.60±0.04^b	38.52±0.02^a	28.39±0.03^c	25.30±0.02^d
TPC(mg/100gGAE)	15.69±0.12^e	25.69±0.06^a	24.60±0.04^b	23.37±0.15^c	22.26±0.03^d
ß-carotene (mg/100g)	15.61±0.30^e	43.99±0.05^a	36.99±0.03^b	32.88±0.02^c	27.50±0.04^d
Na (mg/100gdw)	8.40±0.40^e	20.05±1.28^a	16.71±0.58^b	12.79±0.20^c	10.30±0.57^d
K (mg/100gdw)	1250±20.00^e	1940±36.00^a	1762±27.60^b	1690±24.00^c	1599±20.00^d
Ca (mg/100gdw)	50.92±0.60^e	108.29±3.10^a	102.16±2.38^b	94.40±2.25^c	72.71±0.69^d
Mg (mg/100gdw)	110±4.27^e	140.89±6.15^a	136.88±6.20^b	128.68±3.48^c	116.90±4.27^d
Zn (mg/100gdw)	0.99±0.07^e	2.99±0.17^a	1.69±0.16^b	1.40±0.14^c	1.06±0.09^d
Fe (mg/100gdw)	1.99±0.20^e	8.90±0.48^a	5.32±0.38^b	3.02±0.29^c	2.90±0.22^d
Cu (mg/100gdw)	170±3.06^e	240.79±6.24^a	236.77±4.28^b	208.38±2.45^c	188.58±2.09^d
P (mg/100gdw)	0.18±0.01^e	0.48±0.04^a	0.38±0.03^b	0.28±0.02^c	0.24±0.02^d

Mean carrying same letters are not significantly different from each other.
Values are expressed as mean ±SD (n=3).
Whereas,
T_0 Cookies prepared with straight grade flour, T_1 Cookies prepared with straight grade flour and Marghulam (90:10), T_2 Cookies prepared with straight grade flour and Halman (90:10), T_3 Cookies prepared with straight grade flour and Shakanda (90:10), T_4 Cookies prepared with straight grade flour and Kakas (90:10).

Table 3. Physical analysis of apricot supplemented cookies.

Treatments	Weight (g)	Thickness (mm)	Diameter (mm)	Spread ratio	Bake loss (g/100g)
T_0	12.16±0.10^e	9.78±0.41^a	51.11±0.04^e	5.60±0.03^e	16.99±14.8a^a
T_1	15.47±0.20a	8.75±0.11^b	53.99±0.17^a	6.99±0.09^a	16.36±14.87^b
T_2	15.38±0.21b	8.48±0.09^c	53.77±0.15^b	6.70±0.06^b	14.99±14.87^c
T_3	14.35±018^c	8.35±0.07^d	52.96±0.12^c	6.55±0.05^c	14.50±14.87^d
T_4	13.66±0.15^d	8.20±0.06^e	52.09±0.09^d	6.40±0.04^d	14.25±14.87^e

Mean carrying same letters are not significantly different from each other.
Values are expressed as mean ±SD (n=3).
Whereas,
T_0 Cookies prepared with straight grade flour, T_1 Cookies prepared with straight grade flour and Marghulam (90:10), T_2 Cookies prepared with straight grade flour and Halman (90:10), T_3 Cookies prepared with straight grade flour and Shakanda (90:10), T_4 Cookies prepared with straight grade flour and Kakas (90:10).

The present results for diameter are coherent with the results of SHARIF *et al*. (2009) who reported that the diameter of the cookies increases as the concentration of defatted rice bran increases. The current findings are contradictory to the work of KAMALJIT *et al*.

(2010), they reported that the pea flour combination reduces the diameter of the cookie. The highest weight was observed in T_1 (15.47g) followed by T_2 (15.38) and T_3 (14.48g). The present results are coherent with the results of CHAUHAN *et al*. (2016). Baking loss of treatment cookies was decreased compared to control. This is due to the water holding capacity of apricot powder compared to wheat flour due to its high-protein content.

3.10. Color analysis of apricot supplemented cookies

The color values varied significantly ($p<0.05$) among the treatments (Table 4). L* a* and b* values were highest in T_1 65.58, 24.27 and 47.76 respectively. The current results are in line with the findings of İNCEDAYI *et al*. (2016). HEGEDÚ´ S *et al*. (2010) described hue angle values of 62.63-84.63, L∗ values of 60.15-72.43 and chroma values of 51.66-68.48 of fruit flesh of selected apricot cultivars. Particularly, L* values were similar to the results of KAMALJIT *et al*. (2010). Many scientists have reported that the L* value is a measure of a browning index in fruits and fruit products. The difference in color might be due to the moisture level of the apricot supplemented cookies or variation in processing conditions. Color is a key factor for assessing the baking performance of cookies, which not only provides adequacy to the raw materials but also provides information regarding baking excellence (PASHA *et al*., 2011). It is one of the demanding characteristics to determine the quality of a product. Variation of color in cookies during baking is a dynamic process in which color changes as the baking proceeds (MEPBA *et al*., 2007).

Table 4. Color of apricot supplemented cookies**.**

Treatments	L*	a*	b*
T_0	50.79 ± 0.22^{e}	9.69 ± 0.99^{e}	27.70 ± 0.04^{e}
T_1	65.58 ± 0.16^{a}	24.27 ± 0.88^{a}	47.76 ± 0.09^{a}
T_2	$64.72^{c}\pm0.17^{b}$	18.15 ± 0.87^{b}	38.76 ± 0.07^{b}
T_3	61.74 ± 0.12^{c}	15.20 ± 0.80^{c}	$35.71^{d}\pm0.08^{c}$
T_4	57.79 ± 0.14^{d}	12.48 ± 0.82^{d}	31.72 ± 0.06^{d}

Mean carrying same letters are not significantly different from each other.
Values are expressed as mean ±SD (n=3).
Whereas,
T_0 Cookies prepared with straight grade flour, T_1 Cookies prepared with straight grade flour and Marghulam (90:10), T_2 Cookies prepared with straight grade flour and Halman (90:10), T_3 Cookies prepared with straight grade flour and Shakanda (90:10), T_4 Cookies prepared with straight grade flour and Kakas (90:10).

3.11. Texture profile of apricot supplemented cookies

The maximum hardness was found in T_1 (150.74N) followed by T_2 (145.66N) and T_3 (135.54N) (Table 5). Hardness is the textural property, which is one of the most important assessment parameters of baked food items. Maximum springiness was found in T_1 (74.55%) followed by T_2 (62.22%) and T_3 (57.66%). The lowest springiness was recorded in T_4 (50.66%). The current findings are comparable with PEREIRA *et al*. (2013), they reported that hardness, springiness, cohesiveness and chewiness of Maria type cookies was 158.74 N, 72.22%, 0.78 and 93.02 N, respectively. These differences might be due to varietal, genetic and geographical differences. These outcomes might be due to other reasons such as protein denaturation, irregular structure, water holding capacity, moisture content, solubilization of proteins, protein coagulation and fat content.

Table 5. Texture analysis of apricot supplemented cookies.

Treatments	Hardness (N)	Springiness (%)	Cohesiveness	Chewiness(N)
T_0	120.55±20.78^{e}	40.22±8.79^{e}	0.40±0.01^{d}	35.63±6.53^{d}
T_1	150.74±37.79^{a}	74.55±11.79^{a}	0.70±0.09^{a}	90.02±23.71^{a}
T_2	145.66±23.80^{b}	62.22±10.22^{b}	0.60±0.07^{ab}	69.10±21.54^{abc}
T_3	135.54±14.87^{c}	57.66±7.92^{c}	0.55±0.06^{c}	51.64±21.80^{bc}
T_4	130.88±20.80^{d}	50.66±6.22^{d}	0.50±0.04^{cd}	39.47±15.20^{c}

Mean carrying same letters are not significantly different from each other.
Values are expressed as mean ±SD (n=3).
Whereas,
T_0 Cookies prepared with straight grade flour, T_1 Cookies prepared with straight grade flour and Marghulam (90:10), T_2 Cookies prepared with straight grade flour and Halman (90:10), T_3 Cookies prepared with straight grade flour and Shakanda (90:10), T_4 Cookies prepared with straight grade flour and Kakas (90:10).

3.12. Sensory evaluation of apricot supplemented cookies

Sensory evaluation is important for quality assessment and commonly done by the panelist's judgment. Sensory evaluation of apricot supplemented cookies depicted significant effect ($p<0.05$) of apricot powder on different sensory parameters (color, flavor, taste, texture and overall acceptability). After control, T_1 got a maximum score for all the sensory parameters (Fig. 1). The color acts as an indicator of the final baked items and is linked to differences in taste and smell. The decreasing tendency in texture scores was probably owing to humidity from the atmosphere (SHARIF *et al*., 2009).

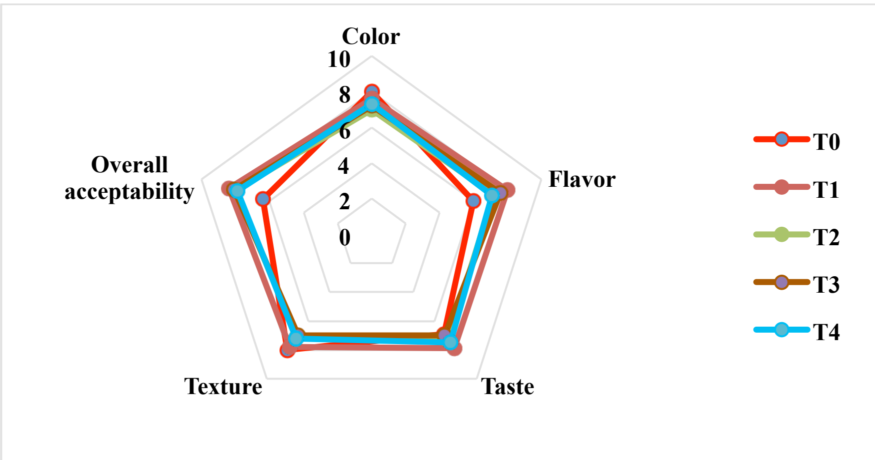

Figure 1. Sensory evaluation of apricot supplemented cookies.
T_0 Cookies prepared with straight grade flour, T_1 Cookies prepared with straight grade flour and Marghulam (90:10), T_2 Cookies prepared with straight grade flour and Halman (90:10), T_3 Cookies prepared with straight grade flour and Shakanda (90:10), T_4 Cookies prepared with straight grade flour and Kakas (90:10)

4. CONCLUSIONS

Apricot is one of the nutritious fruit, which is consumed either fresh or dried all around the globe. A blend of straight grade flour and apricot powder could make excellent baked product with improved economic worth. It not only improves the overall acceptability but also improves the nutritive value of the products without adding much to the cost of the product. This shows the effective utilization of apricot powder in baked goods. The result of the study revealed that the Marghulam variety has high antioxidant activity as compared to other varieties. The cookies made out of straight grade flour supplemented with 10% Marghulam apricot powder were satisfactory in terms of functional, nutritional and organoleptic characteristics as compared to control and other treatments. The results of the present study could be beneficial for the development of functional cookies.

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