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TEXTURAL, PHYSICOCHEMICAL AND ORGANOLEPTIC PROPERTIES OF PARTIALLY REPLACED FAT COOKIES INCORPORATED WITH APRICOT KERNEL FLOUR

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ABSTRACT

This study was conducted to respond the current demand of health-conscious consumers towards reduced-fat and fiber enriched foods. Apricot kernel flour (AKF) had significant amount of total phenol contents and 2, 2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging activity (83.89±3.53%). Different concentrations (20%, 40%, 60%, 80% and 100%) of AKF were used to replace the shortening in supplemented cookies. In supplemented cookies, fat content reduced from 23.53±0.23% to 3.82±0.03% by increasing level of AKF. Spread value decreased in high percentage AKF supplemented cookies. Total dietary fibers (TDF) and texture values (by Texture Analyzer) increased significantly ($p \leq 0.05$) from 2.63±0.09% to 31.82±1.11% and 3.27±0.11 N/kg to 6.02±0.21 N/kg by enhancing AKF supplementation respectively. Total calories reduced due to partially replaced fat content of supplemented cookies. Cookies (supplemented with 60% and 40% AKF) were recommended better for eating quality on the basis of physico-chemical properties, calories count, texture and organoleptic attributes.

1. Introduction

Functional food helps in specific body functions in addition to supplying basic nutrients (Gul et al. 2017). Trend of functional food increased worldwide due to concern of consumer to healthy food (Das et al. 2011). Apricot kernels can be consumed as roasted and salted contain many different bioactive compounds such as tocopherol and β-carotene (Sharma et al. 2014; Mahloko et al. 2019). In Pakistan, it is native to the inside valley of Baluchistan, Kurram Agency, Hunza, Gilgit and Ladakh (Manzoor et al. 2012). Globally, Turkey is leading country for apricot production that ranges about 9,000 tons per annum and most commonly used as kernels source (Gezer & Dikilitas, 2002). The compositional profile of the apricot shows that it contains good proportion of dietary fibers and minerals like potassium, selenium, zinc, phosphorous, calcium, iron and magnesium. It possesses high nutritional profile due to presence of vitamin A, C, niacin, thiamin and riboflavin (Chandi & Sogi, 2007).

Current cholesterol intake level is increasing risk of cardiovascular disease. According to various studies, excessive consumption of high fat-food leads to health problems as obesity and heart disease (Kyungwon et al. 2005). It is a challenge for food industry to search new alternatives for fat in foods without losing quality. Commonly fat is replaced by altering the food formulation with carbohydrate-based, protein-based and lipid-based constituents. Even though a variety of fat replacers have been developed, yet no ideal fat replacer completely functions like conventional fat (Lim & Lee, 2014).

Wheat flour is source of carbohydrates as well as it also provide other important nutrients like B-group vitamins, dietary fiber, protein and minerals (Nuttall et al. 2017). All over the world, cookies are one of the most popular, widespread and appealing foodstuffs having higher nutritional, sensorial and textural profile, ready to eat, and cost competitiveness as well. Biscuits with low glycemic index, more protein will increase the dietary fiber intake and decrease in calorie and carbohydrates of baked foods that ultimately improve the health and product quality (Adeola & Ohizua, 2018). Fat content highly influenced the cookies quality. It is recommended that daily fat intake should not more than 30% of total calorie in a diet (Seker et al. 2010).

This study was design to address current demand of reduced-fat and fiber enriched foods. Purposely, apricot based product was developed and assessed for various physicochemical and sensory attributes. The main objective was to develop partially reduced fat cookies supplemented with AKF.

2. Materials and methods

2.1. Sample preparation

Apricot collected in cotton boxes from local market of Rawalpindi and stored at ambient temperature overnight. Next day, pits were removed and washed with tap water. Pits were manually cracked after sundrying and soaked in boiled water for 1 hour to remove kernel coats by hands. Kernels were dried for 2 hour at ambient temperature and ground by coffee grinder for 1 minute to prepare apricot kernel flour. AKF were packed in air tight polythene bags and stored at 10°C. AKF flour was prepared fresh before 1 hour of cookie production to prevent the rancidity and oxidation.

Traditional method was used to prepare cookies as reported in previous study (Singh et al. 2015). Dough was prepared by taking different proportion of ingredients like flour (500 g), grounded sugar (200 g), sodium bicarbonate (2.0 g), sodium chloride (2.0 g), skim milk powder (40 g) and water (as per dough requirement). Shortening was added according to experimental design. Treatments were set by changing the ratio of shortening and AKF percentages, as T_0 (100:0), T_1 (80:20), T_2 (60:40), T_3 (40:60), T_4 (20:80) and T_5 (0:100) respectively. Premix was made by mixing flour, ground sugar, skim milk powder, and sodium bicarbonate. Dough was prepared and converted into 0.5 cm thick sheet. After sheeting next step was to cut the dough sheet by using circular mold. Baking was conducted by baking oven at 170°C for 15 min. Last step was cooling of cookies at room temperature and then packaging in precoded airtight polythene bags for further analysis.

2.2. Proximate analysis of apricot kernel flour

The moisture content of kernel was measured by using an air forced draft oven at a temperature of 100 ± 5°C by following the procedure described in AACC (2000) method No. 44-15A. Moisture (%) = Wt. of original sample – Wt. of dried sample/ Wt. of original sample × 100

The ash content of kernel powder was measured by following the procedure outlined in AACC (2000) method No. 08-01. The samples were taken in pre-weighed crucibles and charred on bunson burner before incinerating in the muffle furnace where a temperature of 550°C was maintained till the sample converted to grayish white residue. Ash (%) = Weight of ash/ Sample weight × 100

The Soxhlet apparatus was used for the determination of crude fat of powder according to AACC (2000) method No. 30-25. Crude fat from 5g of powder was extracted with hexane at up to 5 washing. After distilling excess hexane, the residue of hexane was dried at 100°C for 30 minutes until a constant weight attained. Crude fat (%) = Wt. of extract in sample/ Wt. of sample × 100

Crude fiber contents were determined by following the procedure mentioned in AACC (2000) method No. 32-10. The crude fiber was tested in 2g fat free sample and digested with 200 ml boiling 1.25% H_2SO_4 filtered and washed three time with distill water. Then samples were again digested with 200 ml of boiling 1.25% NaOH for 30 minutes, filtered and washed thrice. The resultant residue was dried at 130°C for 2 hours and weighed. Dried residue was ignited at 550°C ± 15°C, cooled and reweighed. Crude fiber (%) = Wt. of residue left – Wt. of ash/ Wt. of sample × 100

Crude protein was calculated by nitrogen content of sample. The nitrogen contents were determined by Kjeldahl's method as described in AACC (2000) method No. 46-10. Then the recorded observation was used for protein contents calculation in sample. The sample (1 g) was first digested with 25 mL concentrated sulphuric acid in the presence of digestion mixture for 5-6 hours or till light green or transparent color of the sample. The sample was diluted to 250 mL with distilled water. The distillation was done by taking 10 mL of diluted sample and 10 mL of 40% NaOH solution in distillation apparatus. The ammonia thus liberated was collected in 2% boric acid solution containing methyl red as indicator. Finally the sample containing ammonium borate was titrated against 0.1 N H2SO4 solutions till golden brown end point. The nitrogen percentage was determined by the following expression.

N (%) = Vol. of H2 SO4 used × Vol. of dilution × 0.0014/ Wt. of sample × Vol. of sample taken × 100

The protein percentage was calculated by multiplying % nitrogen with a factor 6.25.

2.3. Preparation of extract

10 % (w/v) extract of kernel powder was prepared with 70% ethanol. Then homogenate was centrifuged at 13500 rpm for 30 minutes at 4°C and the resulting supernatants were analyzed for future experiment.

2.4. Total phenol content

Total phenolic contents (TPC) kernel extracts were measured using Folin-Ciocalteu method (Chan et al., 2008) that was based on the reduction of phosphotungstic acid to phosphotungstic blue and as result absorbance increased due to rise in number of aromatic phenolic groups. For the purpose, 50 µL of kernel extract was separately added to test tube containing 250 µL of Folin-Ciocalteu's reagent, 750 µL of 20% sodium carbonate solution and volume was made up to 5mL with distilled water. After two hours, absorbance was measured at 765 nm using UV/visible light Spectrophotometer (CECIL CE7200) against control that has all reaction reagents except sample extract. Total polyphenols was estimated and values were verbalized as gallic acid equivalent (mg gallic acid equivalents/100g). Total phenolic compounds of each extract in gallic acid equivalents (GAE) was calculated by

$$C=c\times V/ m \qquad (1)$$

C = Total phenolic contents (mg/g plant extract, in GAE); c = Concentration of gallic acid (mg/mL); V = Volume of extract (mL); m = Weight of kernel extract (g)

2.5. Radical scavenging activity by using DPPH method

DPPH (1,1-diphenyl-1-picrylhydrazyl) highly colored and stable oxidizing radical that result in formation of a yellow colored hydrazine (DPPH-H) associated with abstraction of free hydrogen atoms from phenolic antioxidants. Protocol of Gupta and Prakash (2009) was followed to determine DPPH (1, 1-diphenyl-2-picrylhydrazyl) free radical scavenging activity of kernel extract. Sample solution was prepared by dissolving 0.025 mL of sample extract in 10 mL of respective solvent. 3 mL of freshly prepared DPPH solution in respective solvent (6×10-5M) was mixed with 77 µL sample extract. Each sample was kept in dark place for about 15 minutes at room temperature and decrease in absorbance was measured at 517 nm on UV/visible light spectrophotometer. Note done the blank sample absorbance having the same amount of solvent and DPPH solution except extract was prepared and absorbance was estimated at same wavelength on UV/visible light spectrophotometer. The free radical-scavenging activity of kernel extract can be presented as percentage reduction in DPPH due to given amount of each extract.

$$\text{Reduction of absorbance (\%)} = [(AB - AA) / AB] \times 100 \qquad (2)$$

AB = Absorbance of blank sample at t = 0 minute; AA = Absorbance of tested extract solution at t = 15 minutes

2.6. Mineral analysis

The composite flour samples were analyzed for K, Mg Fe and Zinc by wet digestion according to method given in AOAC (2006).Flour sample (0.5) was first digested at low temperature (60-70^{o}C) with 10mL of HNO3 for 20 min in 100mL conical flask on hot plate, then it was digested at high temperature (190^{o}C) with 5mL 60% HClO4 till the contents of flask became clear. The mineral contents of the samples were determined by using the respective standard curve prepared for each element. Aliquots were used to estimate Na and K by flame photometer (Flame Photometer Model-EEL). The minerals, such as calcium and magnesium were determined with an atomic absorption spectrophotometer (Perkin–Elmer Model 5000).The samples were quantified against standard solutions of known concentration that were analyzed concurrently.

2.7. Evaluation of Cookies

Prepared cookies were subjected to analysis for following parameters:

2.7.1. Physical analysis of cookies

The width, thickness and spread factor for cookies were estimated according to the method described in AACC (2000).

In order to determine the width (cm) of a cookie, six cookies were placed next to each other horizontally and the total diameter was measured. They were rotated by 90° and the diameter was re-measured. After repeating two more times, the average of four measurements was divided by six to calculate the diameter of a cookie.

The thickness (cm) of cookies was measured by placing six cookies on one another and the total height was measured. After re-stacking them in different order, the height was re-measured and the height of a cookie was calculated from the mean of two height measurements.

Spread factor was calculated according to method no. 10-53 described in AACC, (2000). The spread factor was calculated according to the following formula:

$$SF = \frac{W}{T} \times CF \times 10 \qquad (3)$$

Where CF = Correction factor at constant atmospheric pressure (1.0 in this case).

2.7.2. Color analysis

Color value was determined with CIELAB color meter. It was first calibrated with the standards. Random samples of biscuits were ground and filled in the Petri dishes. The surface was made smooth by removing the extra sample material. Optimum reflection of light was obtained by the photo cells of color meter. Reading was noted from the display and compared with the standard. According to Manzoor et al. (2012), L* value indicates (lightness), a* and b* values are chromaticity coordinates (a* from red (+) to green (-) and b*, from yellow (-) to blue (-).

2.7.3. Textural analysis

Texture was analyzed by using texture analyzer (Mod. TA-XT2, stable micro system, Surrey, UK) interfaced with a computer which controls the instrument and records the data. To measure the reading, the texture expert program version 1.21 was used. Probe speed and position of texture analyzer were adjusted to 0.5mm/s and 3mm respectively. Reported values were average of triplicate (Ozbasr et al. 2010).

2.7.4. Chemical analysis

Cookies were analyzed for moisture, ash, fat, protein and crude fiber according to standard respective methods (AACC, 2000) as described above for apricot kernel flour.

2.7.5. Energy value

Energy value of the cookies was determined by using Oxygen Bomb Calorimeter (IKA-WERKE, C2000 Basic, GMBH and CO., Germany) as described by Krishna and Ranjhan (1981). Sample was taken in the metallic decomposition vial. The vial was unscrewed and fastened by a cotton thread onto the middle of the ignition wire with a loop before loading the sample. Then the screw cap was tightened. The decomposition vial was guided into the filler head to the open measuring cell cover until it was in place. The start button was pushed and the measuring cell cover closed. The sample within the vial was burnt through electric spark and heat produced displayed in the form of a graph denoting the temperature against time on digital panel of Bomb Calorimeter. It gave number of calories per gram of a sample.

2.7.6. Total dietary fiber (TDF)

The flour was analyzed for total dietary fiber content, soluble dietary fiber and insoluble dietary fiber according to method No. 32-05, 32-07 and 32-20 respectively as described in (AACC, 2000) by using Megazyme Assay Kit. The samples were dispersed in a buffer solution and incubated with heat-stable α-amylase at 95-100°C for 35 minutes. After cooling, these samples were incubated at 60°C for 30 minutes by adding 100µL protease solution. Furthermore, α-amylase and protease treated samples were incubated with amyloglucosidase at 60°C for 30 min. Fiber contents were precipitated by the addition of alcohol in 1:4 ratios and filtered. Residues were washed with alcohol and acetone. A blank sample was run in a similar manner. TDF was determined by using the following formula:

TDF (%) = Residue wt (g) – protein (g) – ash (g) – blank (g)/ Sample weight (g) x 100

2.7.7. Water activity

An electronic Hygropalm water activity meter (Rotronic Hygropalm Model AW-DIO Huntington NY) was used for estimating the water activity at regular storage intervals following the procedure described in (AOAC, 2006).The cookies samples were placed in the cup and probe was inserted into the sample that connected with digital display unit. Then enter key was pressed and water activity displayed on display unit along with temperature.

2.7.8. Sensory evaluation of biscuits

Each sample was evaluated by 16 judges (8 males and 8 females from 30 to 45 years age group) for sensory properties of cookies. Coded polyethylene pouches of cookies were distributed with score cards. Each assessor evaluated cookies for sensory attributes like color, flavor, taste, texture and overall acceptability at 9-points hedonic scale (Ackbarali & Maharaj, 2014). Results were recorded as average of triplicate readings.

2.8. Statistical analysis

All the tests were conducted in replication (n=3) and mean values stated with standard deviations. Duncan's test was performed to find the significant differences among mean values of different treatments. Statistical interpretation of data was carried out by SPSS software (SPSS version 17, Inc., USA).

3. Results and discussion

3.1. Proximate and mineral analysis

Proximate analysis of AKF indicated considerable amount of moisture content (4.21±0.15%), crude fiber (3.20±0.11%), crude fat (52.47±1.84%), crude protein (17.22±0.60%), ash (2.25±0.08%) and nitrogen-free extract (20.65±0.72%). Apricot kernel flour was subjected to mineral profile analysis. Results revealed that potassium (523±5.23 mg/100g) is present in maximum amount followed by magnesium (273±2.73 mg/100g) whilst, iron (2.52±0.25 mg/100g) and zinc (2.21±0.021 mg/100g) are found only in considerable amounts. Slight variation in the proximate composition and mineral contents might be due to the appropriate cultivar of apricot utilized and the location of that apricot.

Soil profile is key contributor for difference in minerals content of apricot kernel flour.

Present findings are in accordance to previous study of Seker et al. (2010), who reported 4.21% moisture content. Protein, fat and fiber content (21.80, 40.20 and 35.83% respectively) were slightly different from results of present findings. This slight difference may be due to apricot cultivars and area of production. Alpaslan & Hayta (2006) revealed that minerals (mg/100g) of apricot kernel flour are within range: K, 473-570; Mg, 113-290; Fe, 2.14-2.82; Zn, 2.33-3.15. Slight difference exists in Zn value due to variation in apricot variety and location.

Mori et al. (2007), reported apricot kernel composition as moisture content 2.83%, crude protein 24.11%, crude fat 50.90%, crude fiber 2.43% and ash 2.21%. Likewise, Gezer et al. (2000) stated that apricot kernel contains moisture 5.52%, crude protein 21.51%, crude fat 44.23%, crude fiber 16.41% and ash content 2.80%. Ozcan (2000) recorded apricot kernel composition profile including crude protein, ash, crude fiber, moisture and crude fat (20.22, 2.3, 18.01, 3.4 and 44.64%, respectively).

3.2. Phytochemical screening

The assessment of apricot kernel polyphenols is indispensable to determine associated health benefits as they are major antioxidant contributor. Their antioxidant activity is attributed to the free radical quenching or electrons donating potential. Methanolic extract of apricot kernel contained significant amount of total phenolic contents i.e. 43.41±15.41 mg GAE/g on fresh weight basis.

Total phenol content in apricot kernel extract depends on various factors; cultivar, variety, extraction time, temperature etc. Many researchers have elaborated this relationship and measured total phenolic contents using Folin Ciocalteu's method. Present findings are in-accordance with Korekar et al. (2011), who studied the antioxidant profile of apricot kernel and noticed that aqueous ethanol extract of apricot kernel mildly acidified with HCl exhibited 492.01±63 mg GAE/100 g total phenol contents on fresh weight basis. Similarly, Kamiloglu et al. (2014) concluded that aqueous metabolic extract of sweet apricot kernel possess 1.67±0.83 mg GAE/100 g and bitter almond 0.84±0.21 total phenol contents on fresh weight basis.

Yildirim et al. (2010) concluded that black carrots juice exhibited 0.84±0.24 micro g GAE/100 mL of total phenol contents. Health promoting effects of various phenols have necessitated their inclusion in various food products. TPC value of apricot kernel was recorded as 43.41±1.65 mg GAE/100g. Korekar et al. (2011) measured the phenol content of methanol extracts of apricot kernel i.e. 58.31±0.78 mg GAE/100 g. Apricot kernel oil polyphenols impart positive effects on human health as they are highly effective antioxidant agents. Apricot kernel oil is the richest source of natural polyphenols that possess more significant antioxidant potential than vitamin C.

3.3. DPPH scavenging capacity assay

Means for DPPH free radical scavenging activity demonstrated that free radical activity of apricot kernel is 83.89±3.53 % which was comparatively high as compared to other nuts. Higher antioxidant activity of apricot contributed to DPPH free radical scavenging activity. Similar results were obtained by Korekar et al. (2011), who measured the DPPH radical scavenging activity as 43.77 to 123.35 mg/ml. Tian et al. (2011) determined apricot kernel DPPH radical inhibition activity as 0.05–0.8 mg/mL for white apricot kernel oil.

3.4. Moisture content of cookies

Moisture contents play significant role as it has direct impact on shelf life and strongly influence the quality of bakery products. The moisture is one of the most important and commonly recorded characters of food products. It is measured for a number of reasons including legal and label requirements, economic importance of quality and storage stability considerations.

Moisture content of apricot kernel flour supplemented cookies is presented in Table 1. Maximum moisture contents were observed in T_5 (100% AKF supplemented cookies) followed by T_4 (80% AKF supplemented cookies) and T_3 (60% AKF supplemented cookies) respectively. Whereas, the minimum moisture contents were recorded in T_0 followed by T_1 (20% AKF supplemented cookies) and T_2 (40% AKF supplemented cookies). The result indicates that treatments had significant effect on the moisture content of cookies. Fiber content of apricot kernel flour might be responsible for significant difference in moisture percentage of treatments.

Previous study demonstrated similar trend of moisture percentage for various treatments, like T_0 (Wheat flour 100%: Malted barley bran 00%) had 3.34% and T_4 (Wheat flour 50%: Malted barley bran 50%) 3.69% (Ikuomola et al. 2017). The current findings are in harmony with previous work reflecting that during the storage of cookies the moisture contents increases, may be due to hygroscopic nature of some ingredients (Tian et al. 2011). Furthermore same trend was evaluated in cookies for moisture due to the increase level of sweeteners (Ikuomola et al. 2017).

3.5. Ash content of cookies

The statistical results regarding ash contents of cookies supplemented by various concentrations of apricot kernel flour are represented in Table 1. The results indicate that treatments exhibited highly significant effect on ash contents. Minimum ash contents were observed in T_0 (control) followed by T_1 (20% AKF supplemented cookies). Whereas, maximum ash contents were recorded in T_5 (100% AKF supplemented cookies) followed by T_4 (80% AKF supplemented cookies) and T_3 (60% AKF supplemented cookies) respectively. Slight difference in ash content was recorded with treatments due to increase in fiber percentage at higher concentration of apricot kernel flour.

It was shown in past work that ash content significantly varied within treatment. Ash content was increased by addition of bran portion containing mineral contents. Ash percentage was high in T_4 (Wheat flour 50%: Malted barley bran 50%) 1.88% as compare to T_0 (Wheat flour 100%: Malted barley bran 0%) (Ikuomola et al. 2017).

3.6. Fat content of cookies

Apricot kernel flour is a rich source of energy. Fat interact with protein due to surfactant effects thus it is supposed that it will also affect the baking quality of flour. Mean squares regarding fat contents of apricot kernel flour supplemented cookies highly significant results regarding treatments. Maximum fat contents were observed in T_0 (control) followed by T_1 (20% AKF supplemented cookies). While, minimum fat contents were recorded in T_5 (100% AKF supplemented cookies) followed by T_4 (80% AKF supplemented cookies) and T_3 (60% AKF supplemented cookies) as shown in Table 1. Findings revealed that decrease in fat percentage might be due to increase in fiber content.

The trend of this trait is in harmony with the findings of Mushtaq et al. (2010), who recorded a non-significant ($P>0.05$) influence of xylitol replacement on fat contents of cookies. Same results were observed by Pasha et al. (2002), who concluded non-significant effect on fat contents of biscuits during storage.

3.7. Fiber content of cookies

Crude fiber is an organic residue and insoluble which obtained after acid base dilution. The mean squares regarding crude fiber contents of cookies supplemented with apricot kernel flour are presented in Table 1. The results indicate that treatments had significant and their interaction exhibited non-significant impact on crude fiber contents of apricot kernel supplemented cookies. Maximum crude fiber contents were recorded in T_5 (100% AKF supplemented cookies) followed by T_4 (80% AKF supplemented cookies) and T_3 (60% AKF supplemented cookies). Whereas the lowest crude fiber contents were determined in T_0 (Control) followed by T_1 (20% AKF supplemented cookies). Apricot kernel flour is a good source of fiber, by improving the concentration of apricot kernel flour for cookies resulted in increase of fiber content.

Ajila et al. (2008) recorded the same pattern for crude fiber contents of biscuits with increasing level of mango kernel powder. The current findings are also in harmony with the Mushtaq et al. (2010), who explained a non-significant impact of storage on crude fiber content of biscuit. Furthermore, same results were supported by the Pasha et al. (2002), who recorded that crude fiber content of biscuits ranged from of 0.08 to 0.13%.

3.8. Protein content of cookies

Protein content have important role in baking quality of cookies. It reflects dough strength, elasticity and extensibility. It is considered as a vital quality parameter related to functional and nutritional characteristics of flour. Mean squares regarding protein content of cookies supplemented with apricot kernel flour are shown in Table 1. Treatments had significantly effect on protein content of AKF supplemented cookies. Minimum protein contents were reported in T_0 (Control) followed by T_1 (20% AKF supplemented cookies). Whereas, maximum protein contents were recorded for T_5 (100% AKF supplemented cookies) followed by T_4 (80% AKF supplemented cookies) and T_3 (60% AKF supplemented cookies) respectively.

Table 1. Moisture, ash, fat, fiber, protein, NFE and color (L, a*, b*) of flour/AKF supplemented cookies

Treatments		T_0	T_1	T_2	T_3	T_4	T_5
Physico-chemical Properties	Moisture%	2.78 ± 0.09^{a}	3.65 ± 0.12^{b}	4.52 ± 0.15^{c}	5.45 ± 0.19^{d}	6.26 ± 0.21^{e}	7.13 ± 0.25^{f}
	Ash%	0.57 ± 0.06^{a}	0.72 ± 0.25^{ab}	0.86 ± 0.26^{abc}	1.01 ± 0.01^{ab}c	1.16 ± 0.25^{bc}	1.30 ± 0.26^{c}
	Fat %	23.53 ± 0.23^{a}	19.23 ± 0.19^{b}	13.66 ± 0.13^{c}	9.28 ± 0.09^{d}	5.74 ± 0.05^{e}	3.82 ± 0.03^{f}
	Fiber%	0.13 ± 0.01a	0.74 ± 0.07^{b}	1.36 ± 0.13^{c}	1.88 ± 0.18^{d}	2.41 ± 0.24^{e}	2.75 ± 0.27^{e}
	Protein %	6.78 ± 0.07^{a}	9.47 ± 0.09^{b}	13.65 ± 0.14^{c}	16.83 ± 0.17^{d}	20.31 ± 0.20^{e}	24.69 ± 0.25^{f}
	NFE %	44.04 ± 0.91^{a}	66.21 ± 0.62^{b}	66.11 ± 0.82^{b}	65.98 ± 0.98^{b}	65.90 ± 1.61^{b}	65.72 ± 2.98^{b}
	Color						
	L-value	71.39 ± 4.28^{a}	69.47 ± 4.17^{a}	69.62 ± 4.18^{a}	70.46 ± 4.23^{a}	71.31 ± 4.28^{a}	72.35 ± 4.34^{a}
	a*-value	9.35 ± 0.93^{ab}	7.45 ± 0.75^{a}	7.67 ± 0.77^{a}	8.49 ± 0.85^{ab}	9.29 ± 0.93^{ab}	10.33 ± 1.03^{b}
	b*-value	37.56 ± 2.25^{a}	35.77 ± 2.15^{a}	36.15 ± 2.17^{a}	37.09 ± 2.23^{a}	37.61 ± 2.26^{a}	38.11 ± 2.29^{a}

Mean values of replication (n = 3) within rows are significantly ($p \leq 0.05$) different; NFE, nitrogen free extract; AKF, apricot kernel flour; T_0, 100% shortening : 0% AKF; T_1, 80% shortening : 20% AKF; T_2, 60% shortening : 40% AKF, T_3, 40% shortening : 60% AKF; T_4, 20% shortening : 80% AKF; T_5, 0% shortening : 100% AKF.

The current findings are in harmony with the conclusions of Pasha et al. (2002), who studied the impact of sweeteners on cookies and reported a non-significant variation in protein contents among treated biscuits. Similar trend was found by Mushtaq et al. (2010), who reported negligible changes in protein contents during study of xylitol replacement effect on cookies.

3.9. Nitrogen free extracts (NFE)

Nitrogen free extracts of apricot kernel flour supplemented cookies are expressed in Table 1. Within treatments, significant increase in nitrogen free extract (NFE) was recorded by increasing AKF supplementation. Significant increase in nitrogen-free extract (NFE) by increasing apricot kernel flour concentration for cookies preparation might be due to increase in carbohydrates in form of fiber. Amongst the treatments, the increase in T_4 (80% AKF supplemented cookies) and T_3 (60% AKF supplemented cookies) was examined respectively. Minimum value of trait was recorded in T_0 (control). Qaisrani et al. (2014) reported same trend of increase in nitrogen free extracts (69.91 ± 0.01 to 70.61 ± 0.17%) by increasing the concentration of psyllium husk from 5% to 25% for the preparation of dietetic cookies.

3.10. Color

CIELAB color system is used to perform color measurement and its attributes are L*, a* and b* values, where L* is the indicator of lightness to darkness, a* indicates greenish to reddish tonality and b* represents bluish to yellowish tonality.

3.10.1. L, a and b* value*

Means regarding L, a* and b* values of AKF supplemented cookies are illustrated in Table 1. It is obvious from mean vales that treatments owned non-significant effect on L, b* attributes, however treatments significantly affect a* values of AKF supplemented cookies. Treatments vary non-significantly with regards to L value of the cookies, whereas significant increase in a* value and steady increase in b* value took place in all treatments. The maximum value for the traits (L, a* and b*) was observed in T_5 (100% AKF supplemented cookies). However, least value for the trait was observed in T_1 (20% AKF supplemented cookies). L, a* and b* values were significantly ($p<0.01$) correlated with ash content of cookies as demonstrated in Table 3.

Sudha et al. (2007) reported that color of biscuit becomes darker with the increase bran concentration. Similar trend in color change was observed by Ashoush & Gadallah (2011), who supplemented the biscuits with mango peel powder and mango kernel powder. Moreover, it was reported that color of biscuit becomes darker with the increase bran concentration (Fradinho & Nunes, 2015). The findings of the instant research work are quite in harmony with the earlier investigation on properties of kernel flour supplemented cookies (Seker et al. 2010).

3.11. Energy value

Energy values of AKF supplemented cookie are elaborated in Table 2. Treatments had significant effect on energy value of cookies. Highest value were recorded in T_0 (control) followed by T_1 (20% AKF supplemented cookies) and T_2 (40% AKF supplemented cookies) respectively. However, minimum value were observed in T_5 (100% AKF supplemented cookies) as fat content reduced by increasing fiber percentage.

The results of the present investigation closely related with the previous findings. Filipcev et al. (2016) reported that calorie of biscuits reduced from 14.51-16.23% by replacing the fat with fine ground wheat bran at the level of 30, 40 and 50%.

3.12. Total dietary fiber

Total dietary fiber in AKF supplemented cookie is elaborated in Table 2. Treatments had significant effect on total dietary fiber of cookies. Maximum value were recorded in T_5 (100% AKF supplemented cookies) followed by T_4 (80% AKF supplemented cookies) and T_3 (60% AKF supplemented cookies). However, minimum value was observed in T_0 (control).

The results of the present investigation closely related with the findings of Seker et al. (2010), who reported that increasing the level of apricot kernel flour in cookies progressively increased the total dietary fiber content of cookies ranging from 03.24-12.86%.

3.13. Spread factor

The spread factor values of AKF supplemented cookies are presented in Table 2. Results indicate that treatments exhibit highly significant effect on spread factor AKF supplemented cookies. Lowest spread factor was observed in T_5 (100% AKF supplemented cookies) followed by T_4 (80% AKF supplemented cookies) and T_3 (60% AKF supplemented cookies). Whereas, maximum value was found in T_0 (control) followed by T_1 (20% AKF supplemented cookies) and T_2 (40% AKF supplemented cookies) respectively. It was observed that the spread factor decrease gradually as the supplementation level was increased. Spread value reflected significant ($p<0.01$) positive correlation with fat content and significant ($p<0.01$) negative correlation with all other parameters like ash, fiber, and protein, total dietary fiber, nitrogen free extract and water activity of AKF supplemented cookies as shown in Table 3.

The current results are in harmony with the past research findings. Hallen et al. (2004) reported that decrease in spread factor was due to the competing effect among the hydrophilic. Similar results were evaluated by Abu-Salem & Abou-Arab (2011), who recorded that substitution of bambara flour decreased the spread factor.

Table 2. Energy value, total dietary fiber, texture, spread value and water activity of AKF supplemented cookies.

Treatments	T_0	T_1	T_2	T_3	T_4	T_5
Energy value (cal/g)	503.72±0.71^{a}	474.55±0.11^{b}	438.98±0.55^{c}	409.52±1.13^{d}	384.82±1.65^{e}	369.26±2.01^{f}
Total dietary fiber (%)	2.63±0.09^{a}	9.34±0.33^{s}	15.86±0.55^{c}	20.69±0.72^{d}	26.69±0.93^{e}	31.82±1.11^{f}
Spread value (mm)	23.21±0.81^{d}	20.96±0.73^{c}	19.67±0.68^{bc}	19.32±0.68^{bc}	18.06±0.63^{ab}	16.87±0.59^{a}
Texture (N/kg)	3.27±0.11^{a}	3.70±0.13^{b}	3.83±0.13^{b}	4.27±0.15^{c}	5.13±0.18^{d}	6.02±0.21^{e}
Water activity (ERH)	0.48±0.09^{a}	0.58±0.08^{ab}	0.69±0.04^{b}	0.77±0.09^{bc}	0.9±0.04^{c}	0.93±0.05^{c}

Mean values of replication (n = 3) within rows are significantly ($p \leq 0.05$) different; AKF, apricot kernel flour; T_0, 100% shortening : 0% AKF; T_1, 80% shortening : 20% AKF; T_2, 60% shortening : 40% AKF, T_3, 40% shortening : 60% AKF; T_4, 20% shortening : 80% AKF; T_5, 0% shortening : 100% AKF.

3.14. Texture

Texture is an important factor for the consumer acceptance of cookies. Textural measurements were also conducted to study the effect of fat reduction at selected supplementation levels. Texture of AKF supplemented cookies is expressed in Table 2. Treatments owned significant effect on AKF supplemented cookies and behaved differently with regards to texture. Minimum value was observed in T_0 (control) followed by T_1 (20% AKF supplemented cookies) and T_2 (40% AKF supplemented cookies) respectively. However, maximum value for the trait was observed in T_5 (100% AKF supplemented cookies). Texture demonstrated significant ($p<0.01$) negative correlation with fat content and significant ($p<0.01$) positive correlation with all other parameters like ash, fiber, protein, total dietary fiber, nitrogen free extract and water activity of AKF supplemented cookies as shown in Table 3.

Present findings are according to earlier research presented by Srivastava et al. (2012), who reported that hardness and brittleness of the cookies generally increased with fat mimetic such as polydextrose or maltodextrin. Tian et al. (2011) demonstrated that hygroscopic ingredients contribute to decrease in hardness as the moisture contents increased by hygroscopic nature of flour.

Table 3. Correlation coefficient (r) between sensory characterstics, textural attributes and physicochemical properties of flour/AKF supplemented cookies.

	Color			SV (mm)	Tex (N/Kg)	Sensory Properties				
	L-value	a*-value	b*-value			Color	Flavor	Taste	Text	OA
MC (%)	0.24	0.49*	0.31	-0.91**	0.96**	-0.59*	-0.79**	-0.59**	-0.57*	-0.61**
Ash (%)	0.59**	0.65**	0.63**	-0.65**	0.86**	-0.48*	-0.64**	-0.48*	-0.46	-0.49*
Fat (%)	-0.12	-0.39	-0.19	0.95**	-0.92**	0.54*	0.76**	0.54*	0.51*	0.55*
Fib (%)	0.26	0.47*	0.33	-0.90**	0.94**	-0.55*	-0.76**	-0.54*	-0.52*	-0.56*
PC (%)	0.18	0.48*	0.26	-0.93**	0.97**	-0.63**	-0.81**	-0.63**	-0.61**	-0.65**
NFE (%)	0.05	-0.15	-0.01	-0.69**	0.52*	-0.17	-0.29	-0.11	-0.09	-0.13
EV (cal/g)	-0.12	-0.38	-0.19	0.95**	-0.92**	0.53*	0.76**	0.53*	0.50*	0.55*
TDF (%)	0.19	0.44	0.26	-0.94**	0.95**	-0.59**	-0.79**	-0.59*	-0.56*	-0.61**
WA (ERH)	0.43	0.56*	0.48*	-0.80**	0.94**	-0.53*	-0.74**	-0.53*	-0.50*	-0.54*

*, $p<0.05$; **, $p<0.01$; MC, moisture content; Fib, fiber; PC, protein content; NFE, nitrogen free extract; EV, energy value; TDF, total dietary fiber; WA, water activity; L*, lightness; a*, red to green; b*, from yellow to blue; OA, overall acceptability.

3.15. Water activity

Water activity of AKF supplemented cookies is presented in Table 2. Treatments had significant effect on water activity of AKF supplemented cookies. Maximum value of water activity was recorded in T_5 (100% AKF supplemented cookies) followed by T_4 (80% AKF supplemented cookies) and T_3 (60% AKF supplemented cookies) respectively. The minimum value was evaluated in T_0 (control) followed by T_1 (20% AKF supplemented cookies) and T_2 (40% AKF supplemented cookies) correspondingly.

Results of this research are justified from findings of Zoulias et al. (2002), who evaluated that cookies prepared with the fat mimetic at 35% fat replacement demonstrated significantly higher water activity than the control cookies ranging from 0.08 to 0.21.

3.16. Sensory response of AKF supplemented cookies

Color is the basic criteria which gives the perception about food acceptance. AKF supplemented cookies were evaluated for color, flavor, taste, texture and overall acceptability. T_0 (control) was used as reference sample. Significant difference was recorded in sensory attributes of treatments. Treatment, T_3 (60% AKF supplemented cookies) was rated higher scores for color, flavor, taste, texture and overall acceptability followed by T_2 (40% AKF supplemented cookies). Maximum score was received by T_5 (100% AKF supplemented cookies) followed by T_4 (80% AKF supplemented cookies). T_3 (60% AKF supplemented cookies) was recommended best treatment as compared to all other treatments and control sample due to improved sensory properties as shown in Fig. 1. Color, taste, flavor, texture and overall acceptability reflected significant ($p<0.01$; $p<0.05$) positive correlation with fat content of AKF supplemented cookies as shown in Table 3.

Similar results were recorded by Zoulias et al. (2000), who studied improvement in sensory characteristics of biscuits supplemented with citrus peel and pulp at various levels (0, 5, 15 and 25%). Aggarwal et al. (2016) evaluated that flavor, taste and texture were score high by addition of mango peel powder at different levels for biscuits making. Manohar & Rao (2002) reported that maximum texture score is related to improved eating quality of biscuits. The results for overall acceptability are in line with the research findings of Fradinho & Nunes, (2015), who reported that cookies containing 20% wheat bran and 30% barley bran were highly acceptable.

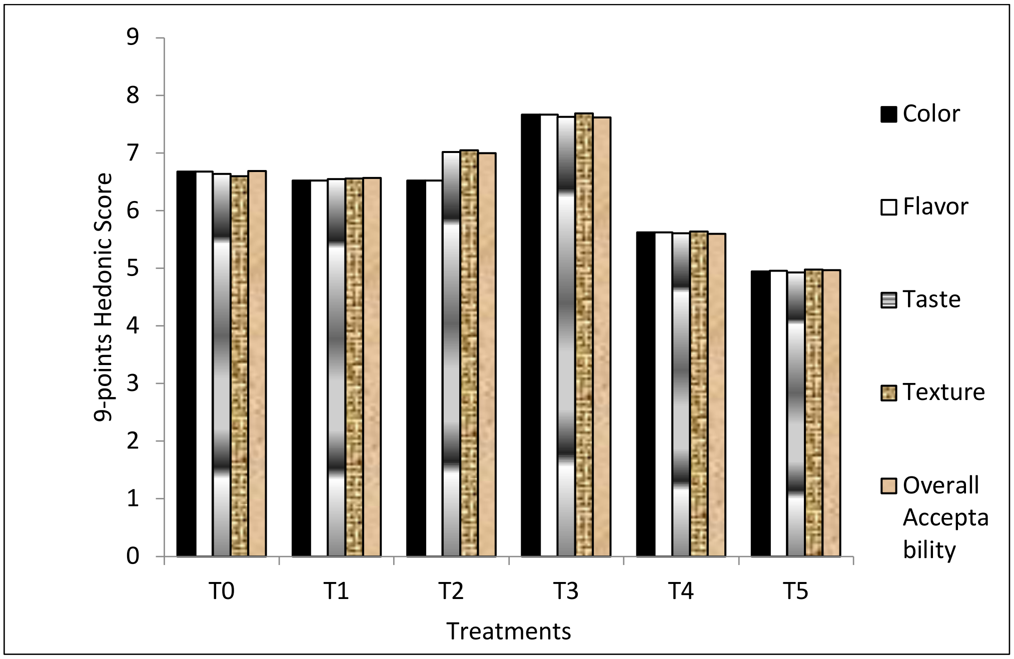

Figure 1. Sensory properties (color, flavor, taste, texture and overall acceptability) of AKF supplemented cookies.

AKF, apricot kernel flour; T_0, 100% shortening : 0% AKF; T_1, 80% shortening : 20% AKF; T_2, 60% shortening : 40% AKF, T_3, 40% shortening : 60% AKF; T_4, 20% shortening : 80% AKF; T_5, 0% shortening : 100% AKF.

4. Conclusions

This study revealed that AKF supplemented cookies are good source of fiber, partially reduced fat and protein. Sensory properties of the AKF supplemented cookies were affected in positive way like color, flavor, taste and texture, leading to softer eating quality which is required in cookies. Cookies containing 40% and 60% AKF were recommended on the basis of different parameters including energy value, texture and organoleptic properties.

5. References

Abu-Salem, F.M, Abou-Arab, A.A., (2011). Effect of supplementation of Bambara groundnut (*Vigna subterranean* L.) flour on the quality of biscuits. *African Journal of Food Science,* 5, 376-383.

Adeola, A.A., Ohizua, E.R., (2018). Physical, chemical, and sensory properties of biscuits prepared from flour blends of unripe cooking banana, pigeon pea, and sweet potato. *Food Science & Nutrition,* 6 (3), 532-540.

Ackbaralil, A.S., Maharaj, R., (2014). Sensory evaluation as a tool in determining acceptability of innovative products developed. *Journal of Curriculum and Teaching,* 3 (1), 10-27.

Alpaslan, M., Hayta., (2006). Apricot kernel: physical and chemical properties. *Journal of the American Oil Chemists,* 83(5), 469-471.

Ajila, C.M., Leelavathi, K., Rao, U.J.S.P., (2008). Improvement of dietary fiber content and antioxidant properties in soft dough biscuits with the incorporation of mango peel powder. *Journal Cereal Science*, 48 (2), 319-326.

Aggarwal, D., Sabikhi, L., Kumar, M.H.S., (2016). Formulation of reduced-calorie biscuits using artificial sweeteners and fat replacer withdairy–multigrain approach. *NFS Journal,* 2, 1-7.

Ashoush, I.S., Gadallah, M.G.E., (2011). Utilization of mango peels and seed kernels powders as sources of phytochemicals in biscuit. *World Journal of Dairy Food Science,* 6, 35-42.

AACC. (2000). Approved methods of the AACC (methods 44-15A, 30-25, 08-01, 32-10, 10-53 32-05, 32-07, 32-20, 10-53) (10th ed.) St. Paul, MN: American Association of Cereal Chemists.

AOAC. (2000). Approved methods of the AOAC (methods 10-54, 985.26) (17th ed.) West Lafayette, IN, USA: Association of Official Analytical Chemists.

Chandi, G.K., Sogi, D.S., (2007). Funtional properties of rice bran concentrates. *Journal of Food Engineering,* 79 (2), 592-597.

Das, L., Bhaumik, E., Raychudhari, U., Chakraborty, R., (2011). Role of nutraceutical in human health. *Journal of Food Science and Technology*, 49 (2), 173-183.

Filipcev, B., Nedeljkovic, N., Simurina, O., Sakac, M., Pestoric, M., Jambrec, D., Saric, B., Jovanov, P., (2016). Partial replacement of fat with wheat bran in formulation of biscuits enriched with herbal blend. *Hemijska Industrija,* 71, 1-28.

Fradinho, P., Nunes, M.C., (2015). Developing consumer acceptable biscuits enriched with Psyllium fibre. *Journal of Food Science and Technology,* 52 (8), 4830-4840.

Gul, R., Jan, S.U., Faridullah, S., Sherani, S., Jahan, N., (2017). Preliminary phytochemical screening, quantitative analysis of alkaloids, and antioxidant activity of crude plant extracts from *Ephedra intermedia* indigenous to Balochistan. *Hindawi.* 17, 1-7.

Gezer, I., Dikilitas, S., (2002). The study of work process and determination of working parameters in an apricot pit processing plant in Turkey. *Journal of Food Engineering,* 53 (2), 111-114.

Gezer, I., Gumer, M., Dursun. E., (2000). Determination of physicomechanics properties of some fruits. *Ekin Journal of Turkish Cooperation,* 13, 70-75.

Gupta, S., Prakash, J., (2009). Studies on Indian green leafy vegetables for their antioxidant activity. *Plant Foods for Human Nutrition*, 64 (1), 39-45.

Hallen, E., Ibsnoglu, S., Anisworth, P., (2004). Effect of fermented germinated cowpea flour addition on the rheological and baking properties of wheat flour. *Food Engineering,* 63, 177-184.

Ikuomola, D.S., Otutu, O.L., Oluniran, D.D., (2017). Quality assessment of cookies produced from wheat flour and malted barley (Hordeum vulgare) bran blends. *Cogent Food & Agriculture,* 3 (1), 1-12.

Korekar, G.T., Stobdan, R.., Arora, A.Y., Singh, B., (2011). Antioxidant capacity and phenolics content of apricot (*Prunus armeniaca L.)* kernel as a function of genotype. *Plant Foods for Human Nutrition,* 66, 376-383.

Kamiloglu, S., Pasli, A.A., Ozcelik, B., Capanoglu, E., (2014). Evaluating the in vitro bioaccessibility of phenolics and antioxidant activity during consumption of dried fruits with nuts. *LWT-Food Science and Technology,* 56, 284-289.

Kyungwon, O., Frank, B.H., Manson, J.E., Stampfer, M.H., Willett, W.C., (2015). Dietary fat intake and risk of coronary heart disease in women: 20 years of follow-up of the nurses' health study. *American Journal of Epidemiology,* 161 (7), 672–679.

Lim, J., Ko, S., Lee, S., (2014). Use of Yuja (Citrus junos) pectin as a fat replacer in baked foods. *Food Science and Biotechnology,* 23 (6), 1837-1841.

Manohar, R.S., Rao, P.H., (2002). Interrelationship between rheological characteristics of dough and quality of biscuits; use of elastic recovery of dough to predict biscuit quality. *Food Research International,* 35, 807-813

Mahloko, L.M., Silungwe, H., Mashau, M.E., Kgatla, T.E., (2019). Bioactive compounds, antioxidant activity and physical characteristics of wheat-prickly pear and banana biscuits. *Heliyon,* 5, 1-9.

Manzoor, M., Anwar, F., Ashraf, M,, Alkharfy, K.M., (2012). Physico-chemical characteristics of seed oils extracted from different apricot (*Prunus armeniaca* L.) varieties from Pakistan. *Grasas Y Aceites*, 63 (2), 193-201.

Mori, S.T., Sawada, T., Okada, T., Adachi. O.M., Keiichi, K., (2007). New anti-proliferative agent, MK615, from Japanese apricot (*Prunus mume)* induces striking autophagy in colon cancer cells in vitro. *World Journal of Gastroenterology,* 13, 6512-6517.

Mushtaq, Z., Zahoor, T., Rehman, S., Jamil, A., (2010). Impact of xylitol replacement on physicochemical, sensory and microbial quality of cookies. *Pakkistan Journal of Nutriition,* 9, 605-610.

Nuttall, J.G., Learya, O., Panozzoa, J.F., Walker, C.K., Barlowb, K.M., Fitzgerald, G.J., (2017). Models of grain quality in wheat-a review. *Field Crops Research,* 202, 136-145.

Ozbas, O.O., Seker, I.T., Gokbulut, I., (2010). Effects of resistant starch, apricot kernel flour, and fiber-rich fruit powders on low-fat cookie quality. *Food Science and Biotechnology,* 19 (4), 979-986.

Ozcan, M., (2000). Composition of some apricot (*Prunus armeniaca* L.) kernels grown in Turkey. *Acta Alimentaria,* 29 (3), 289-294.

Qaisrani, T.B., Butt, M.S., Hussain, S., Ibrahim, M., (2014). Characterization and utilization of psyllium husk for the preparation of dietetic cookies. *International Journal of Modern Agriculture,* 3(3), 81-91.

Pasha, I., Butt, M.S., Anjum, F.M., Shehzadi, N., (2002). Effect of dietetic sweeteners on the quality of cookies. *International Journal of Agriculture and Biology,* 4, 245-248.

Srivastava, S., Genitha, T.R., Yadav, V., (2012). Preparation and quality evaluation of flour and biscuit from sweet potato. *Food Processing and Technology,* 3 (12), 1-5.

Sharma, R., Gupta, A., Abrol, G.S., Joshi, V.K., (2014). Value addition of wild apricot fruits grown in North–West Himalayan regions-a review. *Journal of Food Science and Technology,* 51 (11), 2917-2924.

Seker, I.T., Ozbas, O.O., Gokbulut, I., Ozturk, S., Koksel, H., (2010). Utilization of apricot kernel flour as fat replacer in cookies. *Journal of Food Processing and Preservation,* 34 (1), 15–26.

Shar, G.Q., Kazi, T.G., Jakhrani, M.A., Sahito, S.R., (2002). Determination of iron, zinc and manganese in nine varieties of wheat (*Triticum aestivum* L.) and wheat flour by using atomic absorption spectrophotometer. *Asian Journal of Plant Sciences,* 1 (2), 208-209.

Sudha, M.L., Vetrimani, R., Leelavathi, K., (2007). Influence of fiber from different cereal on the rheological characteristics of wheat flour dough and on biscuit quality. *Food Chem*istry, 100, 1365-1370.

Tian, H., Zhang, H., Zhan, P., Tian, F., (2011). Composition and antioxidant and antimicrobial activities of white apricot almond (*Amygdalus communis* L.) oil. *European Journal of Lipid Science and Technology,* 113 (9), 1138-1144.

Yildirim, F.A., Yıldırım, A.N., Şan, B., Aşkın, M.A., Polat. M., (2010). Variability of phenolics and mineral composition in kernels of several bitter and sweet apricot (*Prunus armeniaca*) cultivars. *Journal of Food, Agriculture and Environment,* 8, 179-184.

Zoulias, E.I., Oreopoulou, V., Tzia, C., (2002). Textural properties of low-fat cookies containing carbohydrate-or protein-based fat replacers. *Journal of Food Engineering,* 55 (4), 337-342.

Zoulias, E.I., Oreopoulou, V., Tzia, C., (2000). Effect of fat mimetic on physical, textural and sensory properties of cookies. *International Journal of Food Properties,* 3 (3), 385-397.

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