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Research Article

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Effects of Apricot Kernel Flour and Fiber-Rich Apple Powder on Low-Fat Cookie Quality

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Abstract In this study, utilization of apricot kernel flour (AKF) as fat replacer in cookies was examined and shortening content in a wire-cut cookie formulation was reduced at 30% and replaced with AKF. Also, the effects of apple powder (APL-P) at the levels of 10, 20, 30 and 40% (w/w) on the quality of low-fat cookies were investigated. As a by-product, apricot kernel offers an exciting new potential as a food ingredient especially in cereal. A new form of apple (*Malus domestica*) as freeze-dried powder retaining all important nutrients such as dietary fiber and flavor of fresh apple might be promising alternative for the utilization of apple. Results showed that there were no significant differences between spread ratio values of the cookies supplemented with different levels of APL-P and control and they were all acceptable ($p<0.01$). The hardness values of the cookies increased significantly ($p<0.01$) with APL-P level up to 20% and the hardness values for the 30 and 40% addition levels were not detected. Overall sensory scores of the cookies supplemented with APL-P were not significantly different from those of the control until 30% addition level. Total dietary fiber contents of the cookies increased with increasing APL-P supplementation (from 12.24% to 23.68%). Although the lightness (L*) of the cookies supplemented with APL-P decreased significantly ($p<0.01$), cookies supplemented with APL-P generally gave higher a* and b* values at all levels. With the production of high-fiber and low-fat cookies by the usage of AKF and APL-P especially in cereal products are offered.

Keywords Apricot kernel flour, apple powder, cookie quality, dietary fiber

Introduction

Dietary fat intake has been implicated in the causation of major diseases including coronary heart disease and cancer. Hence, current recommendations to improve health emphasize the reduction of fat intake. Health specialists recommend that it should not exceed 30% of the total calories in a diet [1]. Texture, flavor and appearance are the main quality attributes of cookies. Fat is a very important ingredient of cookies because it contributes texture and pleasing mouthfeel and positively impacts flavor intensity and perception [2]. Fat mimetics are substances of carbohydrate or protein origin which can be used in some foods to imitate the functional and sensorial properties of fat, but provide considerably less calories. Several research studies were conducted for the usages of fat replacers in bakery products [2-9].

Dietary fiber intake provides many health benefits. Hence, inadequate fiber intake has been found to be associated with diseases like diverticulosis, atherosclerosis, colonic cancer and appendicitis [10-12]. An increase in level of dietary fiber in the daily diet has been recommended (25-30 g/day) [13]. Apricot (*Prunus armeniaca* L.) is one of the most popular stone fruits grown in some regions of Turkey which is the biggest apricot producer (795,768 metric tons/yr) [14]. The chemical and nutritional properties of apricot kernel were studied by various investigators [15-21]. Apricot kernels are rich in lipid and protein [18, 21]. Durmaz and Alpaslan

[22] mentioned that the apricot kernel is added to bakery products and also consumed as appetizers. Apple (*Malus domestica*) is usually consumed in fresh form. It is also well known that apples are good sources of fiber [23]. Fresh apples are very convenient for storage, transportation and consumption. However, there is a demand for new apple products such as freeze-dried apple powder which retains all nutrients (dietary fiber, antioxidants etc.) and flavor of fresh apple.

The objective of this paper was to study the effects of APL-P addition on the low-fat cookie quality. To determine the effects of fiber-rich fruit powder on cookie quality and total dietary fiber content of the cookies, APL-P was used to replace wheat flour in the formulation of cookies at the levels of 10, 20, 30 and 40% (w/w) with 30% AKF to replace shortening.

Materials and Methods

Materials

The commercial soft wheat flour (Örnek Flour Inc., Nevşehir, Turkey) used in this study consisted of 9.8% protein (Nx5.7), 0.65% ash (d.b.), 28% wet gluten and, 1.6% total dietary fiber. Apricot kernels (cv: Hacıhaliloğlu) and Golden delicious type apples were purchased from local markets in Malatya (Turkey). Only reagent-grade chemicals were used.

Preparation of Apricot Kernel Flour and Fiber-Rich Apple Powder

Apricot kernel flour (AKF) was produced from apricot *(Prunus armenica* L.) according to Şeker *et al.* [24]. Fiber-rich apple powder (APL-P) was produced according to Şeker *et al.* [25].

Analytical Methods

Apricot kernel flour was analyzed for moisture, protein (Nx6.25), ash and lipid contents [26]. Soft wheat flour was analyzed for moisture, protein, ash and wet gluten contents according to standard method [27]. APL-P was analyzed for moisture, protein (Nx6.25, d.b.) and ash contents by using AOAC methods [26], and for water-holding capacity [28] and bulk density [29]. Antioxidant properties of APL-P was evaluated by determining total phenolic content, assessed by Folin method [22]. Total dietary fiber (TDF) contents of soft wheat flour, AKF, APL-P and cookies were determined by using AACC Method [27].

Cookie Formulation and Evaluation

The cookie qualities of AKF including and APL-P supplemented flours were determined by AACC Method No: 10.54; Baking Quality of Cookie Flour-Micro Wire-Cut Formulation [27]. The formulation of the cookies are shown in Table 1 (control) and Table 2.

AKF was used to partially replace shortening at the level of 30 (w/w) in the formulation. A control sample including 30% AKF was also prepared. APL-P was used to replace wheat flour in the formulation of cookies at the levels of 10, 20, 30 and 40% (w/w) with 30% AKF to replace shortening. Four cookies were prepared per bake. The baked cookies were cooled at room temperature (30 min) and then they were wrapped in aluminum foil and allowed to stand at room temperature until analysis. The quality parameters of the cookies were evaluated in terms of width (W), thickness (T), spread ratio (W/T), color and texture values. After cooling of the cookies for 30 min, width and thickness measurements of the cookie samples were taken using a caliper.

Table 1: Formulation of cookies

Ingredients[a]	Weight (g)
Sucrose (fine granulating)	25.6
Brownulated granulated sucrose	8.0
Nonfat dry milk	0.8
Salt	1.0
Sodium bicarbonate	0.8
All-purpose shortening (fat)	32.0
High-fructose corn syrup	1.2

Ammonium bicarbonate	0.4
Deionized water	variable
Flour[b]	80.0

[a] Ingredients at 21±1 °C

[b] 13% moisture basis

CIE color values (L*, a* and b*) were measured with a Minolta Spectrophotometer CM-3600d (Japan). The L* value indicates the lightness, 0-100 representing dark to light. The a* value gives the degree of the red-green colour. The b* value indicates the degree of the yellow-blue colour. A texture analyzer (TA Plus, Lloyd Instruments, UK) equipped with a three-point bending jig was used for texture analysis and the maximum force (Newtons) required to break the cookie sample was determined 24 h after baking. The span between the supports was 40 mm. A load cell of 1,000 N was used. The sensory characteristics of the cookies were screened by a six-member panel that was well aware of the purpose of the investigation. The panel members individually evaluated appearance and taste of the cookies by giving scores ranging between 1 to 5, 5 being the most desirable. Then, the overall sensory scores were calculated as the mean of the appearance and taste scores for each bake [30]. Data were analyzed for variance using the MSTAT statistical package [31]. When significant differences were found, the LSD (Least Significant Difference) test was used to determine the differences among means.

Table 2: Addition levels of AKF and APL-P in cookie formula

AKF (30%) with APL-P Formula [a]	
APL-P/ F	**AKF/S**
0/100	30/70
10/90	30/70
20/80	30/70
30/70	30/70
40/60	30/70

[a] F, flour; S, shortening,

APL-P: Apple powder

AKF: Apricot kernel flour

Results and Discussion

Properties of Apricot Kernel Flour and Apple Powder

The results of various properties of AKF and APL-P were given in our previously published paper in detail [24, 32]. The protein and lipid contents of the AKF were found to be 21.8% and 40.2%, respectively. The protein content reported in this study generally agreed with the previously published data [15, 16, 18, 19]. The lipid content of the apricot kernel sample generally agreed with the previously published data [33]. The ash content of the AKF was found to be 2.71%, which is slightly higher than the one determined by Femenia *et al*. [18], and almost equal to the one reported by Özcan [19]. The TDF content of AKF used in this study was found to be 35.8%.

The protein and ash contents of APL-P were found to be 3.4% and 3.08%, respevtively. The water holding capacity (WHC) and bulk density values of APL-P were found to be 6.6 g/g and 355 mg/cm^3, respectively. The TDF content of APL-P was found to be 22.8%, which is higher than the value reported by Li and Cardozo [34], and within the range of the one reported by Lentowicz *et al*. [35]. Total phenolic contents of APL-P was found to be 1.327 µg GAE/g db. Total phenolic content of whole apple was reported to be 1.2 mg/100 g fresh fruit by Gorinstein *et al*. [23]. The data revealed that APL-P sample is both rich in terms of total dietary fiber content and antioxidant power.

Effects of Apple Powder on the Quality of Low-Fat Cookies:

In order to investigate the effects of fruit powder addition on the low-fat cookie quality, APL-P was used to replace wheat flour in the formulation of cookies at the levels of 10, 20, 30 and 40% (w/w) with 30% AKF to

replace shortening. Spread ratio and hardness values, sensory properties and TDF contents of the APL-P supplemented low-fat cookies are presented in Table 3.

Table 3: Effects of APL-P on spread ratio, hardness value, overall sensory score and TDF contents of the low-fat cookies.

APL-P level (%)	Spread Ratio	Hardness (N)	Overall Sensory Score	TDF (%)
0	7.10a	47.12b	3.82a	1.86a
10	6.53b	119.62a	3.65a	12.24b
20	6.40b	131.30a	3.28ab	17.33c
30	6.63b	-	2.66bc	20.49d
40	6.64b	-	2.21c	23.68e
LSD	0.33	43.26	1.00	0.11

Means followed by the different letter are significantly different using the LSD test ($p<0.01$)
TDF: Total dietary fiber; APL-P: Apple powder

Results indicated that there were no significant differences between spread ratio values of the cookies supplemented with different levels of APL-P and control and they were all acceptable ($p<0.01$). Increasing fiber addition generally reduces the spread ratio values of the high-fiber cookies [36] and similar results were also obtained in cookies supplemented with brewer's spent grain and sugar beet fiber [30, 37]. Chen *et al.* [38] investigated effects of spray-dried apple fiber compared to wheat and oat brans in cookies and demonstrated that as the concentration of apple fiber increased, the diameter of cookies decreased, and their thickness increased. On the contrary, the diameters of oat bran supplemented cookies did not change significantly as the addition level increased.

The hardness values of the cookies increased significantly ($p<0.01$) with APL-P level up to 20%. Similar results for hardness values were also reported by Zoulias *et al*. [6]. The hardness values for the 30 and 40% addition levels were not detected.

Overall sensory scores of the cookies supplemented with APL-P were not significantly different from those of the control until 30% of addition level. The effect of incorporation of high-fiber fruit powder on TDF content of low-fat cookies was investigated for the first time. TDF contents of the cookies supplemented with APL-P increased significantly ($p<0.01$) as the addition level increased (from 12.24% to 23.68%).

CIE color values (L*, a*, and b*) of APL-P supplemented low-fat cookies are presented in Table 4. The color of the cookies is one of the characteristics which are firstly perceived by the consumer and affect the acceptability of the product.

Table 4: Effects of APL-P on color values of the low-fat cookies

APL-P level (%)	L*	a*	b*
0	70.39a	8.36d	36.10d
10	62.70b	12.77c	40.74c
20	55.74c	15.72b	43.84bc
30	57.05c	15.39b	45.80ab
40	52.11d	17.64a	49.10a
LSD	3.27	1.61	3.89

Means followed by the different letter are significantly different using the LSD test ($p<0.01$)
L*: Lightness; a*: Redness; b*: Yellowness; APL-P: Apple powder

Although the lightness (L*) of the cookies supplemented with APL-P decreased significantly ($p<0.01$), cookies supplemented with APL-P generally gave higher a* and b* values at all levels. Similar results for color values were also reported by Özboy and Köksel [36], Köksel and Özboy [30] and Öztürk *et al.* [37].

Conclusion

One of the purposes of this study was to investigate the effects of AKF on the quality of low fat cookies. AKF is rich in terms of dietary fiber (35.8%). Thus, it can be used to supplement cereal based foods such as cookies and cakes. Another objective of this study was to determine the effects of fiber-rich apple powder on the quality of low-fat cookies produced by replacing the fat with AKF (30%). The data revealed that APL-P is both rich in terms of TDF content and antioxidant power thus; they can be used to supplement cereal based foods such as cookies. Overall sensory scores of the cookies supplemented with APL-P were not different from those of the control until 30% addition level. TDF contents of the cookies increased with increasing APL-P supplementation level. As a result, the replacement of flour by APL-P in wire-cut cookie formulation showed that the physical characteristics, TDF contents and textural properties of the cookies were significantly affected ($p<0.01$) and that APL-P appeared to be a suitable replacer up to 30% level.

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