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*Research* / Araştırma

# PINE CONE AS AN ALTERNATIVE DIETARY FIBER SOURCE AND ITS EFFECT ON CAKE AND COOKIE QUALITY

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**Abstract**

In this study, production and characterization of pine cone powder (PCP) and its utilization as alternative dietary fiber source in cake and cookie formulations at 10, 20, and 30% levels were investigated. Total dietary fiber (TDF) content of PCP was found as 62.0%. TDF contents of fiber-rich PCP supplemented products increased with increasing addition levels and reached to 8.3% in cake and 11.8% in cookie by 30% addition. PCP addition did not cause deterioration on physical properties of cakes. Cookies had better (10% PCP) or same (20% PCP) spread ratio values as compared to control one. The hardness of the products increased by 30% PCP addition. The PCP supplemented products had darker but acceptable color. According to sensory score, the PCP added products were accepted up to 20% addition level. The pine cone has potential using as a source of dietary fiber for bakery products.

**Key Words:** Pine cone, dietary fibers, cake quality, cookie quality

# ALTERNATİF BİR BESİNSEL LİF KAYNAĞI OLARAK ÇAM KOZALAĞININ KEK VE BİSKÜVİ KALİTESİNE ETKİSİ

**Özet**

Bu çalışmada, çam kozalağı tozu (ÇKT) üretimi ve karakterizasyonu ile alternatif bir lif kaynağı olarak kek ve bisküvi formülasyonunda %10, 20 ve 30 oranlarında kullanımı araştırılmıştır. ÇKT'nin toplam besinsel lif (TBL) içeriği %62.0 olarak bulunmuştur. Lifçe zengin ÇKT ilaveli ürünlerde, artan ilave oranıyla TBL miktarı artmış ve %30 ilave ile kekte %8.3, bisküvide ise %11.8 değerlerine ulaşılmıştır. ÇKT ilavesi keklerin fiziksel özelliklerini bozmamıştır. Bisküvilerin yayılma oranı değerleri kontrole göre daha iyi (%10 ÇKT) ya da aynı (%20 ÇKT) bulunmuştur. Ürünlerin sertliği, %30 ÇKT ilavesi ile artmıştır. ÇKT ilaveli ürünler daha koyu ancak kabul edilebilir renklere sahiptir. Duyusal analiz sonucuna göre, ÇKT ilaveli ürünler %20 ilave oranına kadar kabul edilebilir bulunmuştur. Çam kozalağı, fırıncılık ürünlerinde besinsel lif olarak kullanılma potansiyeline sahiptir.

**Anahtar kelimeler:** Çam kozalağı, besinsel lifler, kek kalitesi, bisküvi kalitesi

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## INTRODUCTION

Dietary fiber (DF) is the edible parts of plants or analogous carbohydrates that are resistant to digestion and absorption in the human small intestine with complete or partial fermentation in the large intestine. DF includes polysaccharides, oligosaccharides, lignin, and associated plants substances (1, 2). The health benefits of DF were generally reported by many researchers. It has been supposed to have a role in prevention of certain diseases such as diverticulitis, colon cancer, hemorrhoids, arteriosclerosis, varicose veins, and appendicitis (1, 3-6). An increase in level (25-30 g/day) of DF in the daily diet has been recommended by World Health Organization.

Different plant fibers are added to various baked food products in order to increase their fiber content. Whole grains, cereal bran, legumes (soy) and fruit fibers (apple, apricot), sugar beet fiber and brewer's spent grain are common some used for fiber supplementation of foods (7-13). Although, increasing DF content in food products confers health benefits, the sensory and textural properties generally deteriorate (14, 15). In the last decades, there is a trend to find new sources of DF. Dietary fibers from different sources such as pea, mango, hazelnut, banana and cocoa have been used to replace wheat flour in bakery products (16-20).

In East-Asian countries various parts of pine trees, including pine needles, cones, cortices and pollen, are widely consumed as food or dietary supplements to promote health. Consumption of pine tree parts is supposed to affect gastrointestinal diseases and neuronal problems beneficially, and believed to prevent chronic diseases such as hypertension, atherosclerosis, and diabetes (21). Extracts from pine cones have been reported to be effective scavengers of reactive oxygen and lowering serum lipids. Anti-mutagenicity and anti-influenza virus activity of substances of pine cone extract were also determined (21-26). It was shown that a natural product extracted from pine cones inhibited the replication of human immunodeficiency virus (HIV) type 1 (27).

Cakes and cookies are highly consumed bakery products. The qualities of these products are affected by the quality and level of ingredients used (28). Generally dietary fiber sources cause deteriorations in quality properties, especially in volume and texture. Fiber content of pine cone is also high and therefore appears as an alternative dietary fiber source. To the authors' knowledge, there is no published research investigating the possible use of pine cone as a fiber source in foods. Thus, the current work investigated the production and characterization of fiber-rich pine cone powder (PCP) and evaluated the effects of PCP addition into cake and cookie formulations.

## MATERIALS and METHODS

### Materials

Commercial soft wheat flour was used in cake and cookie production. All of the other ingredients were supplied from a local market. Pine cone samples were obtained from Kastamonu, Turkey. The wheat flour used in the study contained 13.4% moisture, 8.4% protein, 22.1% wet gluten, 0.65% ash and 1.1 % total dietary fiber with 1.0% insoluble and 0.1% soluble forms.

### Preparation and properties of pine cone powder

Pine cones were collected as immature forms (green, young buds) with a length of 20-25 mm. They were cut into two parts and dried in oven at 50°C until reaching moisture content below 10%. The dried samples were ground and sieved (425 μm) to obtain pine cone powder (PCP). The dried PCP was kept in glass jar and stored at 4°C until used.

The PCP sample was analyzed for moisture and ash by using AACC Approved Methods No. 44-15A and No. 08-01, respectively (29). Soluble (SDF), insoluble (IDF) and total dietary fiber (TDF) contents of PCP sample were determined according to AACC Approved Method No.32-07 (29). The bulk density value of PCP sample was determined (30). Solubility (%), water binding capacity (%), swelling power (g water/g sample) and fat binding capacity (mL oil/100 g sample) values of the PCP sample were determined as functional properties (31-33).

### Cake and cookie production

Cakes and cookies were prepared according to AACC Approved Methods No.10-90 and No.10-54,

respectively (29). The PCP was added into formulations at 10, 20, and 30% (in flour basis). Control cake and cookie were also produced without PCP. In preliminary studies, it was observed that the PCP addition caused very low batter consistency. Therefore, in cake formulation water was added at 90, 80, and 70% for 10, 20, and 30% PCP levels, respectively. Four cookies and two cakes were baked at a time and baking was done in duplicate.

### Evaluation of cakes and cookie quality

Soluble, insoluble and total dietary fiber contents of cake and cookie samples were determined by using AACC Approved Method No.32-07 (29).

Weight loss (%) values of cakes were determined after cooling of 2 hours. Volume, symmetry and uniformity index values of cakes were calculated (29). After cooling of the cookies, diameter (D) and thickness (T) were measured and spread ratio values (D/T) were calculated. Color values (L*, a*, and b*) of the products were examined by using Lovibond RT300 (UK). Texture analyzer (Brookfield CT3, USA) was used for determination of the hardness of products. The maximum force (N) required to compress the cake samples by 25% of its initial height and the maximum force required breaking cookie sample with a three-point bending jig were determined.

The sensory characteristics (appearance, texture and taste) of the products were screened by panel members by giving the scores ranging between 1 and 5; 5 being the most desirable.

### Statistical analysis

The tests were performed in duplicate and mean values were reported. Data were analyzed for variance using the one-way analysis of variance (ANOVA). When significant ($P$<0.05) differences were found, Duncan's test was used to determine the differences among means.

## RESULTS and DISCUSSION

### Properties of pine cone powder

The moisture and ash contents of the PCP sample were found as 8.8% and 3.45%, respectively. Total dietary fiber content of PCP sample was determined as 62.0% (in dry basis), which was mostly insoluble dietary fiber (61.6%, db). Dietary fiber contents varied between 35-60% in apple, 35-74% in orange, 35-87% in pea, 70-73% in sugar beet, 30-36% in peach and 6-64% in nuts (34). The data in the present study revealed that the PCP sample was rich in dietary fiber and could be used to supplement cereal based foods.

Bulk density of PCP was found as 0.5 g/mL. Solubility, water binding capacity, swelling power and fat binding capacity values of PCP sample were measured as 17%, 335%, 4.5 g/g and 15 mL oil/100 g sample, respectively.

### Dietary fiber contents of cakes and cookies

Soluble (SDF), insoluble (IDF) and total (TDF) dietary fiber contents of cakes and cookies are presented in Table 1. Control samples did not have IDF and had very low TDF contents.

Insoluble dietary fiber of wheat flour was higher than SDF. However, control cookie and cake samples did not have IDF and had low SDF contents. Baking of the products caused changes in fiber structures and also increases in resistant starch by heating. Resistant starch is indigestible form of starch which is considered as soluble dietary fiber (35). Therefore, formation of resistant starches in products could be the reason of higher SDF than IDF values.

Table 1. Dietary fiber contents of cakes and cookies

| | Cakes | | | Cookies | | |
|---|---|---|---|---|---|---|
| PCP level (%) | SDF (%) | IDF (%) | TDF (%) | SDF (%) | IDF (%) | TDF (%) |
| 0 | 0.6$^{a}$ | 0.0$^{d}$ | 0.6$^{d}$ | 0.7$^{a}$ | 0.0$^{d}$ | 0.7$^{d}$ |
| 10 | 0.3$^{a}$ | 3.5$^{c}$ | 3.8$^{c}$ | 0.2$^{a}$ | 4.1$^{c}$ | 4.3$^{c}$ |
| 20 | 0.6$^{a}$ | 5.7$^{b}$ | 6.3$^{b}$ | 0.3$^{a}$ | 8.4$^{b}$ | 8.7$^{b}$ |
| 30 | 0.6$^{a}$ | 7.7$^{a}$ | 8.3$^{a}$ | 0.3$^{a}$ | 11.5$^{a}$ | 11.8$^{a}$ |

Means with different letters within each column are significantly different ($P$<0.05)
PCP: Pine cone powder, SDF: Soluble dietary fiber, IDF: Insoluble dietary fiber, TDF: Total dietary fiber

IDF and TDF contents of the products increased significantly ($P$<0.05) as the PCP level increased. TDF content reached up to 8.3% in cake and 11.8% in cookie by replacing 30% of flour with pine cone powder. SDF content of pine cone powder was very low (0.4%), therefore SDF contents of the products were also found as low levels and there was no statistically difference in SDF values with PCP levels.

In the related literature, similar results were obtained for fiber enriched bakery products. It was reported that the TDF content of cookies reached to 11.74% and 12.55% by replacing 25% of flour with brewer's spent grain (12) or sugar beet fiber (36) and increased to 11.3% and 10.6% with 40% addition of apple and apricot powder, respectively (13). The cakes prepared with 25% of apple pomace had a dietary fiber content of 14.2% (37).

**Quality parameters of cakes and cookies**

Volume and symmetry index values of the cake samples were in the range of 75-79 and 10.0-11.3, respectively (Table 2). The PCP addition had negative effect on uniformity index of the cakes. Weight loss of the cakes decreased with increasing PCP level (Table 2) which was probably caused by high water binding capacity of the PCP. The hardness values of the 10% and 20% PCP supplemented cakes were lower than control sample while the differences were not significant. Low water content in formula could be the reason of the higher cake hardness with higher level (30%) of PCP addition. During baking, PCP can absorb more water by increasing of temperature. At 10 and 20% PCP addition levels in cake, water content was adequate for all components and also PCP could hold more water to maintain soft products. At higher PCP level in cake, water content in formula was not sufficient for hydration of gluten and starch that could be the reason of hard texture after baking. Therefore, this level might possibly be limited level for the PCP sample produced in this study to obtain good texture in cake.

Spread ratio (SR) value of 10% PCP supplemented cookie increased as compared to control (Table 2). However, at high addition level (30%) SR value decreased. The hardness values of cookies increased with increasing PCP levels and the increases were significant ($P$<0.05) at 20% and 30% addition levels (Table 2).

The color of the food product is one of the characteristics which are firstly perceived by the consumer and affect the acceptability. The PCP sample had color of 44.5 L*, 9.4 a* and 33.2 b* values. Changes in color values were caused by natural dark color of the PCP sample (Table 3). The crumb L* values decreased while a* and b* values increased by adding PCP into cakes. The surface L* values of the PCP added cookies decreased significantly ($P$<0.05) with increasing level. Cookies supplemented with PCP gave higher a* and lower b* values as compared to control sample, especially for higher PCP addition levels.

In related literature, negative effects have been reported for bakery products when flour was substituted with various fiber sources. Addition of fibers has been shown to reduce loaf volume and generate harder and darker crumb in cakes (37, 38). Similarly, increased hardness, loss of crispness and reduced spread ratio were observed in cookies (34). Studies have shown that baked products with high level of fiber were not well accepted. Acceptable levels of fiber inclusion varied between 5 and 15% (12, 17, 18, 39). It was compatible with the findings of this study.

Sensory properties of the PCP supplemented products are presented in Figure 1. General appearances of the PCP supplemented cakes were

Table 2. Physical properties and hardness values of cakes and cookies

| PCP level (%) | Volume index | Symmetry index | Uniformity index | Weight loss (%) | Cake hardness (N) | Spread ratio | Cookie hardness (N) |
|---|---|---|---|---|---|---|---|
| 0 | 75$^{a}$ | 10.3$^{a}$ | 1.0$^{c}$ | 19.0$^{a}$ | 2.35$^{b}$ | 9.5$^{ab}$ | 55.1$^{b}$ |
| 10 | 78$^{a}$ | 10.8$^{a}$ | 2.6$^{b}$ | 17.2$^{c}$ | 1.63$^{b}$ | 10.3$^{a}$ | 60.6$^{b}$ |
| 20 | 79$^{a}$ | 11.3$^{a}$ | 2.6$^{b}$ | 17.8$^{bc}$ | 1.75$^{b}$ | 9.2$^{ab}$ | 97.4$^{a}$ |
| 30 | 78$^{a}$ | 10.0$^{a}$ | 4.4$^{a}$ | 18.1$^{b}$ | 3.48$^{a}$ | 7.5$^{b}$ | 97.5$^{a}$ |

Means with different letters within each column are significantly different ($P$<0.05)
PCP: Pine cone powder, N: Newton

Table 3. Color values of the cakes and cookies

| PCP level (%) | Cake color values | | | Cookie color values | | |
|---|---|---|---|---|---|---|
| | L* | a* | b* | L* | a* | b* |
| 0 | 73.9[a] | 0.8[c] | 29.8[b] | 70.5[a] | 8.5[b] | 44.5[a] |
| 10 | 54.9[b] | 7.9[b] | 31.9[b] | 54.7[b] | 10.9[ab] | 36.3[b] |
| 20 | 54.3[b] | 11.1[a] | 35.4[a] | 49.9[bc] | 11.6[a] | 34.0[c] |
| 30 | 54.4[b] | 11.4[a] | 35.8[a] | 45.7[c] | 12.1[a] | 32.0[c] |

Means with different letters within each column are significantly different ($P$<0.05)
PCP: Pine cone powder; L*: Lightness; a*: Redness; b*: Yellowness

higher than that of control cake. The softness of the PCP supplemented cakes were not significantly ($P$>0.05) different from that of control sample up to 30% addition level. However, the cookies supplemented with PCP were accepted by the panelists up to 20% level. Crispness of cookies decreased significantly by adding PCP. Above 20% addition level, sensory scores deteriorated significantly ($P$<0.05), especially for taste. Above 20% level, bitter taste was detected in cakes and cookies.

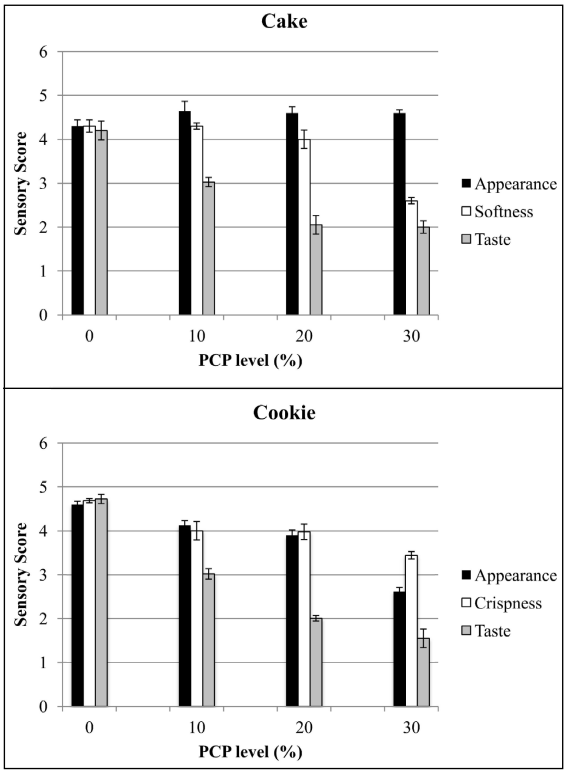


Figure 1. Sensory scores of the cakes and cookies
PCP: Pine cone powder

Figure 2 shows the photos of the cakes and cookies supplemented with different levels of PCP. Addition of PCP did not have substantial deteriorative effect on external appearance of the products. The PCP included cakes and cookies had darker color because of the natural dark color of PCP, but they were found as acceptable.

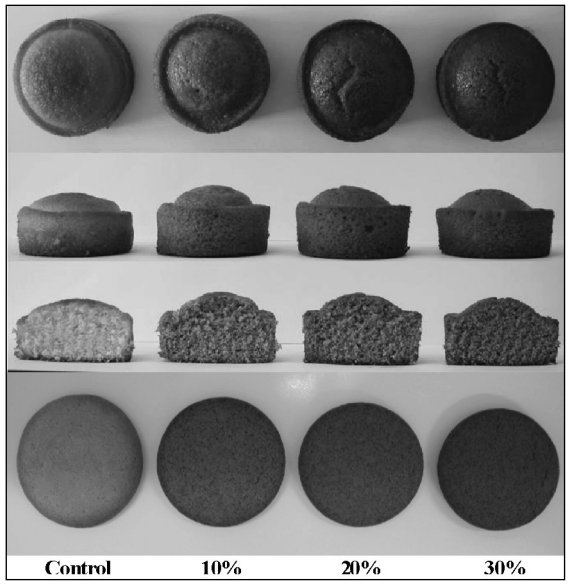


Figure 2. Cakes and cookies supplemented with pine cone powder (PCP)
Control: not supplemented with PCP; 10, 20 and 30%: PCP levels

## CONCLUSION

The importance of dietary fibers in human diet is well-understood and accepted by many researchers. Extensive studies have been carried out regarding to the fortification of food products with different fibers. Enrichment of bakery products with new sources of fiber other than common ones (whole grains, wheat bran, oat, barley, etc.) has been interested nowadays. The current work investigated, the first time, the production and characterization of pine cone powder (PCP) and evaluated the effects of fiber-rich PCP incorporation on cake and cookie quality.

Total dietary fiber (TDF) content of PCP was found as 62.0%, which was very high level as

compared to fiber sources commonly used. TDF contents of the PCP supplemented products increased with increasing addition levels and reached up to 8.30% in cake and 11.80% in cookie with 30% addition. The PCP did not have substantial deteriorative effect on external appearance of cakes and cookies. Generally dietary fiber sources caused lower volume and harder texture in cakes. In the present study, 10 and 20% PCP addition gave softer cake than control sample without decreasing volume of the products. Also spread ratio, the most important physical parameter of cookies, was not negatively affected by adding PCP up to 30% level, moreover improved by 10% addition.

The color of the food product is one of the characteristics which affect the consumer acceptability. The PCP included products had darker color, but the changes in color were not substantial to make the products unacceptable according to sensory evaluation. Acceptable PCP addition level was found as 20% according to taste of the cakes and cookies. Above the level, bitter taste was detected in products. However, there was no flavoring agent in formulations of products to observe the effect of PCP better. Bitter taste caused by high level of PCP addition could be enhanced by adding flavoring such as vanilla or the formulation could be fortified with fruit fibers such as apple pomace or orange peels that have rich fine flavor. Therefore, pine cone powder sample produced in this study has great potential in baking industry and can be used as an alternative dietary fiber source in cake and cookie formulations.

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