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Physical, textural, and sensory evaluation of cakes with carob molasses pulp

Keçiboynuzu pekmez posalı keklerin fiziksel, dokusal ve duyusal değerlendirilmesi

Yüksel Özdemir [1] **Serpil Yalım Kaya** [2*] **Sevcan İlhan** [3]

1 Department of Nutritional and Dietetics, Toros University, Mersin, Turkey
2 Department of Gastronomy and Culinary Arts, Mersin University, Mersin, Turkey
3 Department of Food Engineering, Mersin University, Mersin, Turkey

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Corresponding Author(s):

* Serpil Yalım Kaya, syalim@mersin.edu.tr

Abstract

Carob molasses pulp flour (CMP), rich in fibers, minerals, and polyphenolics that can benefit human health and have a high potential as a dietary source, is a waste or by-product of carob molasses and carob syrup production. In this study, the effect of adding industrial food waste CMP to commonly consumed cake to develop inexpensive food products with increased nutritional value on the textural, physical, and sensory qualities of the cake was investigated. In this study, 5, 10, and 15% CMP were used instead of wheat flour in the cake, and its quality characteristics were investigated. Weight loss was 14.50±0.1% and volume was 101.83±0.7 dm^3 for the control cake, and it was similar in all samples. Although the hardness of the CMP15 cake (480.95±94.5 g) was slightly increased ($p<0.05$), CMP05 and CMP10 had similar textures compared to the control cake (368.75±33.4 g). The highest color values belonged to the control cake (L*=60.68±0.71 and b*=45.79±0.47). The cake colors strongly depended on the CMP. CMP increased cocoa-like color, which was preferred and desired by some consumers. In conclusion, the utilization of CMP did not significantly change the volume, weight loss, texture, and sensorial properties of cake samples according to the control. According to the findings, up to 15% of CMP can be added to the cake recipes with high sensory acceptance, and without any decrease in quality parameters. As a result, CMP, which is thought to be extremely rich in fibers, minerals, and polyphenolics, may be very suitable as a natural additive or substitute material for many foodstuffs, such as functional foods.

Özet

İnsan sağlığına fayda sağlayabilecek lifler, mineraller ve polifenolikler açısından zengin olan ve besin kaynağı olarak yüksek potansiyele sahip olan keçiboynuzu pekmezi posası unu (CMP), keçiboynuzu pekmezi ve keçiboynuzu şurubu üretiminin bir atık veya yan ürünüdür. Bu çalışmada, besin değeri artırılmış ucuz gıda ürünleri geliştirmek amacıyla yaygın olarak tüketilen keklere endüstriyel gıda atığı CMP ilavesinin kekin dokusal, fiziksel ve duyusal niteliklerine etkisi araştırılmıştır. Bu çalışmada kekte buğday unu yerine %5, 10 ve 15 oranında CMP kullanılmış ve kekin kalite özellikleri araştırılmıştır. Kontrol kekinde ağırlık kaybı %14.50±0.1 ve hacim 101.83±0.7 dm3 olup tüm örneklerle benzerdi. Her ne kadar CMP15 kekinin sertliği (480.95±94.5 g) biraz artmış olsa da ($p<0.05$), CMP05 ve CMP10, kontrol kekiyle (368.75±33.4 g) benzer dokulara sahipti. En yüksek renk değerleri kontrol kekindeydi (L^*=60.68±0.71 ve b^*=45.79±0.47). Kek renkleri büyük ölçüde CMP'ye bağlıydı. CMP, bazı tüketiciler tarafından tercih edilen ve istenen kakao benzeri rengi arttırdı. Sonuç olarak, CMP kullanımı kek örneklerinin hacmini, ağırlık kaybını, dokusunu ve duyusal özelliklerini kontrole göre önemli ölçüde değiştirmedi. Elde edilen bulgulara göre, duyusal kabulü yüksek olan ve kalite parametrelerini düşürmeden kek tariflerine %15'e kadar CMP eklenebilmektedir. Sonuç olarak lifler, mineraller ve polifenolikler açısından son derece zengin olduğu düşünülen CMP'nin, fonksiyonel gıdalar gibi birçok gıda maddesi için doğal bir katkı maddesi veya ikame malzemesi olarak çok uygun olabileceği düşünülmektedir.

INTRODUCTION

One of the most consumed foods in the world is bakery products such as cake. Cake is a commonly consumed food because of its pleasant flavor, variety, and airy texture (1). The relationship between food and health has an increasing impact on food consumers due to the importance of a healthy diet on the quality of life (2). Nowadays, some functional and enriched food products such as cakes are found in stores (3). Common cake can be an excellent food type for introducing new healthy eating habits (4). Therefore, functional components coming from a waste of plant sources are good choices for developing new food with special health-enhancing and economic benefits (2). Some studies have been made to enrich cake with fiber and functional compounds like by-products from fruits and cereals (1, 4-7). Replacing a part of wheat flour with functional ingredients to produce enriched products can change properties such as stability, texture, and taste (3). Generally appearance, color, and texture of cake are important for consumers.

Carob bean (*Ceratonia siliqua* L.), which grows widely in the Mediterranean region of the world, consists of 90% pod and 10% seeds. Generally, the carob pod is consumed as fresh or processed into a cocoa-like carob powder, carob syrup, and carob molasses (pekmez in Turkish) (8-10). The carob pods have nutritional components such as minerals (calcium, iron, potassium, etc.), carbohydrates (especially glucose, fructose, and sucrose), and functional components like polyphenolic compounds and dietary fibers with antioxidant activity that can benefit human health (9, 11). Carob products are used in producing a wide range of food and beverage formulations such as bakery, confectionery, cocoa, and chocolate alternatives, infusions, sweets, cereals, snacks, health bars, carob spreads, teas, pasta, etc. (4, 9, 11). Carob molasses pulp (CMP), is a by-product or a waste of carob molasses or carob extract or carob syrup industry, and it represents a cheap and available raw material to produce a value-added product such as bakery products. Unfortunately, CMP contains high amounts of dietary fiber and both insoluble and soluble polyphenols (9,10), but it is not used as food and is generally treated as waste (12). Carob fiber has a very high antioxidative capacity against reactive oxygen species (11). A fiber-rich diet is characterized by biological benefits such as improving colon health, lowering the risk of chronic diseases, and protecting the cells from oxidative damage (3). Unlike carob flour which contains high sugar content (8-10), the CMP can be considered healthier because of its high fiber content and low sugar or sugar-free pulp (9). Minerals, dietary fibers, polyphenolics, and antioxidants are among the phytochemicals found in CMP, so utilization of CMP in recipes can enhance the nutritional value of foods (10). CMP was used to enrich sucuk with fibers (9), and ice cream cones (10). Although the recent literature reports the use of carob flour in cake, bread, and other bakery food recipes (4, 6, 13) no studies could be found about replacing wheat flour with carob molasses pulp in cakes. This study aims to research the effect of adding carob molasses pulp flour at an increasing rate (0-15%) to cake recipes. The weight loss, volume, texture, color, and sensory properties of cakes were measured for quality evaluations.

MATERIALS AND METHODS

Materials

Raw carob molasses pulp was obtained from a carob molasses processing company in Türkiye. All of the chemicals used for the experiments were analytical grades. Wheat flour, milk, sunflower oil, sugar, eggs, baking powder, and vanilla included in the production of cakes were supplied from the local markets and cold-stored until their usage.

Carob molasses pulp flour preparation

The raw carob molasses pulp was dried in an oven (JP, Selecta, Spain) at 50 - 55 °C for 8 hours to less than 10% moisture. Then, the dried pulp was grinded with a laboratory mill (IKA, M20, Labortechnic, Staufen, Germany), and the ground particles were sieved (Model VE 100, Retch, Germany) to adjust the particle size to 100 μm. The prepared flour sample was stored in air-tight plastic bags at 4 °C until further use and called carob molasses pulp flour (CMP) (12).

Cake preparation

The ingredients used in each cake formulation are given in Table 1. The cakes were prepared by replacing wheat flour with 5%, 10%, and 15% CMP on a flour basis. The control sample contained wheat flour, in total, 300.0 g (100% flour basis). 164.0 g sugar, and 180.0 g whole egg were first mixed at the maximum speed of the mixer (KitchenAid Model APM10, St. Joseph, MI, USA) for three minutes until a creamy mixture was formed. Then 182.0 g whole milk and 164.0 g sunflower oil were added and blended for one minute. After that, 300.0 g wheat flour, 10.0 g baking powder, 5.0 g vanilla, and 0 – 45 g CMP (0% CMP for control) were added, and the mixture was stirred up for four minutes. Oil, milk, and eggs were equilibrated at room temperature before use. The cake batter was put in greased aluminum pans and baked at 180 °C for 45 min in a preheated oven (Mayapaz, HCG-6/11 Model, Türkiye). At least three cakes were prepared per recipe. Deionized water was used in all formulations (12). The baked samples were removed from their pans, after cooling to room temperature. All the cakes were analyzed on the day of baking. The weight loss, volume, color, texture (hardness), and sensory analysis were assessed as bread quality characteristics.

Weight loss analysis

The weight loss as an index of moisture loss of cakes was measured three times for the same sample. It was calculated as a percentage of the difference between the weight of the baked sample just after baking and the weight of dough or batter just before it was placed into the oven (13).

Volume analysis

The volume of cake samples was measured by the rapeseed method based on the bread volume determination method (AACC, 1995) (14). The test was applied at room temperature and based on the rapeseed displacement principle. The principle of the experiment; rapeseed is filled into a measuring cylinder to the marked size and afterwards it is emptied back. The cake samples are put into the cylinder and rapeseeds are added again and filled until the level reaches the marked size. The volume of the remaining rapeseed seeds was measured The volume of rapeseed measured is equal to the volume of the cake and is expressed in dm3. The experiment was performed in 3 repetitions and 2 in parallel.

Texture (hardness) analysis

Texture parameters (Fmax, deformation, hardness, firmness) of each cake sample were measured using a texture analyzer (Stable Micro Systems, UK) according to the AACC 74-09 method (AACC, 2000) (14). Test parameters, pretest speed: 1.0 mm/s, test speed: 1.7 mm/s, posttest speed = l0 mm/s, and distance = 10 mm with automatic detection of the force with a 5 kg load cell (trigger force = 5 g force). The maximum force in the force-deformation curve was defined as the hardness of the sample and was measured for textural properties. The maximum peak value was recorded for each analysis, and its average was calculated in force unit (g). The hardness test was applied to both the outer surface and the inner section of the samples, which were kept at 25 ºC after baking for equilibration to room temperature. The experiment was carried out in 3 repetitions and 5 parallels (14).

Color analysis

The color of cake samples was measured by using a Color Quest XE colorimeter (Hunter Lab., Hunter Assoc. Laboratory, Reston, VA, USA). Six samples were analyzed for each cake recipe. The average color method was used to determine average L*, and b* values for each sample. The results were expressed in the CIELAB system as L*, a*, and b* parameters indicating lightness (+) to darkness (−), redness (+) to greenness (−), and yellowness (+) to blueness (−), respectively (14).

Overall acceptability and sensory analysis

Sensory analysis of the samples was carried out with 20 trained panelists (mean age 26, nonsmokers) consisting of Mersin University Food Engineering Department (10). The laboratory was equipped with individual compartments and the tests were performed under white light at room temperature. The cake samples coded with random three-digit numbers were offered to panelists. All samples were analyzed for their appearance, crust and crumb color, structure (porosity and softness), odor, mouthfeel, and overall acceptability. Cake samples for each recipes were offered on white plastic plates together with advice to rinse their palate with water to avoid residual effects and detailed information about the procedure. All the sensory evaluations were carried out using a five-point hedonic scale (1 = 'Strongly disliked'; 2 = 'Slightly disliked'; 3 = 'Indifferent'; 4 = 'Slightly liked'; and 5 = 'Strongly liked'). Statistical analyses were carried out by taking the average of the scores given by each panelist for different cake formulations (6, 10, 15).

Statistical analysis

Statistical analysis of the data was performed using the package program (SPSS version 11.5 (SPSS Inc., Chicago, IL)).In cases where more

Table 1. Formulation for cake preparation

Ingredients	Control	CMP05†	CMP10	CMP15
Wheat flour (g)	300	285	270	255
Carob molasses pulp flour (CMP) (g)	0	15	30	45
Egg (g)	180	180	180	180
Milk (g)	182	182	182	182
Sugar (g)	164	164	164	164
Sunflower oil (g)	164	164	164	164
Baking powder (g)	10	10	10	10
Vanilla (g)	5	5	5	5

† CMP: Carob molasses pulp flour

than two groups should be compared with each other in terms of a variable examined, it was determined whether there was a difference between the means and One-Way ANOVA, then the difference was evaluated with the Duncan test at a 95% confidence interval. All of the applied processes and analyses were carried out repetitively, but the number of parallels (at least two) varied according to the analysis. Statistical analyses were also evaluated according to the number of repetitions and parallels. All the data were reported as means ± SD (standard deviation) (10, 12).

RESULTS AND DISCUSSION

The data on weight loss and volume of control and sample cakes are given in Table 2. The weight loss was 14.50 % and the volume was 101.83 dm3 for the control cake. As seen in Table 2, no significant differences (p>0.05) were found between the weight loss of control cake and cakes with CMP. As known that baking heat causes weight loss and decreasing yield because of the vaporization of moisture from samples (13).

The volume and weight loss of cakes with CMP were not more than the control cake means that CMP did not cause a low yield for different ratios. These study findings were in agreement with previous studies. Aydogdu et al. (2) used pea, oat, lemon, and apple fiber to enrich cakes and stated that as the concentration of fiber increased, the weight loss of cakes did not change except for using lemon fiber. The water-holding capacity of lemon fiber was reported to be the highest among pea, apple, and oat fibers in cakes, and a higher amount of lemon fiber prevented moisture loss in cakes as compared to control cake. Yalım Kaya & Özdemir (8) reported that fiber-rich carob pods had water-holding capacity values between 1.51 and 2.37. Berk et al. (13) reported that higher carob bean flour in cake formulation had not affect the weight loss of cakes. Gums, which have a similar effect on weight loss with fibers, increase moisture retention in baking products, effective for preventing moisture loss because they have higher water binding capacity. The fact that the weight loss and volume values of the samples were not different from the control could be explained as the fibers in the CMP could hold the water and prevent moisture loss due to its water-holding capacity, like the bran in wheat flour, during the baking of the cakes. There was no difference between the volume of cake with CMP and control (P>0.05). However, some studies have reported that it has changed. When cakes were prepared from blends of wheat flour with 5, 10, 15 and 20% fruits (orange waste, carrot pomace), and vegetable wastes (potato peels and green pea peels), the volume of cakes decreased with an increase in fruit and vegetables wastes content from 0 to 20% (5). El-Beltagi et al. (1) reported that 15% of PPPF (prickly pear peel flour) significantly decreased the volume of cake and it exhibited the lowest values for height, volume, and specific volume, according to the 5% PPPF, 10% PPPF, and control cakes. This was likely because as the concentration of wheat flour was reduced in each subsequent sample, the concentration of wheat gluten was also decreased, and as a result, a corresponding decrease in the batter volume

Table 2. Percentage weight loss, volume, texture (hardness), and color of cake samples with and without CMP†

Sample Code	CMP (%, w/w)	Weight Loss‡ (%, w/w)	Volume‡, (dm^3)	Hardness‡ (g)	L*‡	b*‡
Control	0	14.50±0.1^a	101.83±0.7^a	368.75±33.4^b	60.68±0.71^a	45.79±0.47^a
CMP05	5	14.53±0.1^a	102.83±1.2^a	411.65±26.9$^{a.b}$	33.47±1.03^b	14.45±0.95^b
CMP10	10	14.51±0.1^a	102.16±1.2^a	370.65±40.0^b	26.45±0.50^c	10.56±0.63^c
CMP15	15	14.52±0.1^a	102.30±1.2^a	480.95±94.5^a	23.84±0.18^d	9.16±0.59^d

† CMP: Carob molasses pulp flour,

‡ Standard deviation of the mean of at least three replicates. This means that the same column with different superscripts is significantly different (p< 0.05).

was observed. Nakov et al. (16) observed that the addition of grape pomace (GPP) flour to cakes by 4–10% increased nutrients. The cake volume did not change significantly from 0 to 6% GPP but then decreased sharply by 10% GPP. Fidan et al. (6) reported that the specific volume of the control cake was lower than the cake samples that contained carob flour. It has been reported that when the cocoa powder was replaced with carob flour in the cakes, the weight of the cakes with increased substitutes was heavier (17). The effect of the oat, lemon, apple, and pea fiber supplementation on the volume of cakes which depends on the nature and the amount of added fibers, was studied. As reported, there was a significant difference between cakes enriched with different types of fibers, because oats and peas had a higher amount of insoluble fiber than apple and lemon, and lemon fiber resulted in the lowest volume of cakes (2). It was reported that muffins' weight remained constant in all formulations using peach fiber to replace wheat flour (18). Papageorgiou et al. (4) reported that a significant decrease was observed in the cake-specific volume and cake yield with increasing levels of wheat flour substitution with carob flour whereas carob cake batters exhibited similar densities with that of the control at carob flour substitution levels lower than 70% flour basis. In general, carob flour has a high sugar content and lower DF content than CMP. The difference between the content of carob flour and CMP may have caused the difference between the volume value of this study and the studies in which carob flour was added.

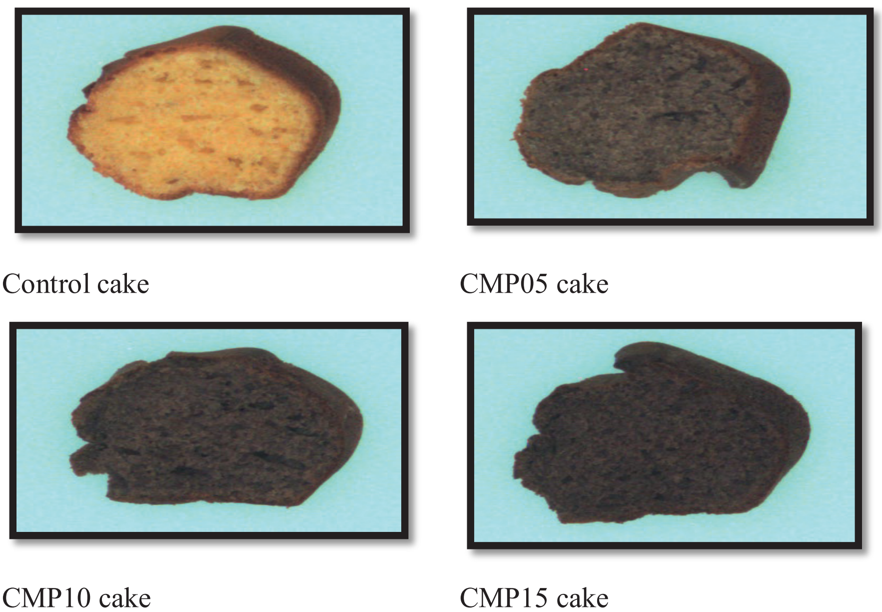
One of the important parameters that influence the cake quality is texture. Thus, hardness values were evaluated in terms of textural properties. Cake quality was adversely connected with an increase in cake hardness (7). The data for the hardness of cakes with and without CMP was given in Table 2. The control cake's hardness was 368.75 g. The hardness of cake values was slightly increased with increasing substitution and the highest value was obtained for CMP15 cake. The chewiness of the product is positively related to the hardness, when the hardness of the cake increases, it causes difficulty chewing cake (7). The texture properties of the cake were affected by replacement levels of fiber sources (5). The addition of grape pomace to the cake had increased hardness and chewiness (16). The hardness value of CMP15 cake (480.95±94.5 g) was significantly higher than the control cake (368.75±33.4 g). However, the hardness difference between the control cake and the cakes of CMP05 and CMP10 was not significant ($P>0.05$). This result agreed with studies by Papageorgiou et al. (4) and Grigelmo-Miquel et al. (18). According to a study, only a higher-level addition of roasted carob flour (50%) caused a significant difference from the control cake. It has been reported that when compared to the control cake, the hardness of the crumb decreased significantly without any significant change in the springiness values of the cake when 10% and 30% (flour basis) carob flour were used (4). The textural properties of the muffin samples with 2, 3, 4, 5, and 10% peach dietary fiber were examined by Grigelmo-Miguel & Martin-Belloso (18), and no statistically significant difference had observed among the samples, but, only one sample with 10% fiber was found to differ from the control sample. It was reported that when peach fiber was used in muffins instead of wheat flour, their density increased and the number of air pockets reduced, thereby increasing the force required (hardness) for compression. However, significant differences had not been found and it did not have much negative effect on its textural properties (18). In a study that was associated with the fiber content, about the effects of replacement of rice flour with carob bean flour at different concentrations (10 to 30%) on cake quality, it was reported that cakes prepared with 20% carob flour had the highest specific gravity and the softest texture value. It has been reported that optimum fiber content improved volume and texture properties, while excess fiber content caused less volume and unacceptable textural properties (13).

Color plays a crucial role in cakes as it, along with texture and aroma, greatly influences consumer preference (7). The change of color parameters of cakes are shown in Table 2 and Figure 1. As seen in Table 2, significant differences between all of the samples for the lightness (L*) and yellowness (b*) values of the crust of the cake were observed.

The L* values of the control, CMP05, CMP10, and CMP15 cake samples were 60.68, 33.47, 26.45, and 23.84 respectively. Also, b* values were 45.79, 14.45, 10.56, and 9.16, respectively. The L* and b* values, the highest in the control sample, decreased gradually due to the increase in the amount of CMP. Because the control cake produced by using only wheat flour was yellow, the lightness and yellowness values were the highest. On the other hand, the CMP has a dark color and it significantly affected the L* and b* values of the samples with CMP. The increased color darkness was thought to be due to the natural color of fruit or oxidation of polyphenols in CMP because the important properties of carob beans are the high amount of dietary fiber and soluble and insoluble polyphenols, in addition to carbohydrates (19). That could be occurred because of both CMP flour's darker color (lower value of L* and b*) compared with wheat flour and also the development of caramelization or Maillard reaction. The Maillard reaction, and caramelization of sugars cause of darkening and the formation of color in bakery products during baking are widely known as browning (20). Browning occurs on account of non-enzymatic chemical reactions that generate colored compounds while baking. Those reactions are the Maillard reaction and caramelization. The Maillard reaction transpires whilst reducing sugars and amino acids, proteins, and/or different nitrogen-containing compounds are subjected to heat together. However, caramelization is a term for describing a complex group of reactions that occur due to direct heating of carbohydrates, in particular, sucrose and reducing sugars (21).

These findings are consistent with those of El-Beltagi et al. (1) who reported that cakes containing different levels of PPPF (5, 10, and 15%) showed a significant decrease in the L* properties of the crumbs. In contrast, the cakes containing 10 and 15% PPPF showed a notable rise in the crust's redness. Compared to the control, the color of cakes made from proso millet had been shown that considerable increases in b*, and a significant decrease in L*, probably due to the color of the proso millet itself (7). The color parameters L*, and b* varied with the addition of grape pomace (GPP). The control cake had the brightest color, followed by the 4%, 6%, and 8% GPP-enriched samples, while the 10% GPP-added cakes had the darkest color because of the darker color of the GPP in comparison to the wheat flour (16). The quality of roasted carob

Figure 1. Effect of carob molasses pulp flour (CMP) on the appearance, color, and structure of cakes



Note: The cakes were prepared by replacing wheat flour with 5% (CMP05 cake), 10% (CMP10 cake), and 15% carob molasses pulp flour (CMP15 cake) on a flour basis.

flour (0–70% flour basis) added to cakes had been studied and carob flour addition of up to 10% flour basis resulted in cakes with lighter crumb color than the control cocoa cake. At cocoa substitution levels higher than 50% carob flour, the final products were resulted as significantly darker cakes ($p< 0.05$). On the other hand, it was reported that the gradual increase in the level of carob flour produced cakes with less yellow and more intense red color compared to the control cocoa cake in this study (4). It was reported that when the cocoa powder was replaced by carob flour in cakes, the color of the cakes was darker than the others, and the cake with 100% carob flour was the darkest (17). Although the color darkness of cakes with the addition of CMP increased, these color results did not negatively affect the sensory acceptability of the cake samples.

Consumers' appreciation of food products is largely based on visual and sensorial impressions. Hence, for new product development, sensory analysis is necessary to test the acceptability of foods (16). Although typical and diverse quality features are related to each product, in most bakery products, surface color together with its texture and flavor are the main features affecting the preferences of consumers (20). Sensory analysis data of control and CMP-added cakes are given in Table 3. The results showed that the sensory properties of the cakes with CMP were not significantly different from the control cake and each other for almost all criteria ($p> 0.05$).

For example, there is no difference between the overall acceptability scores of the CMP05, CMP10, and CMP15 cake samples, and all scores are approximately 4.0 and above (slightly liked), so the cake samples are sensory acceptable. It was observed that the scores of some sensory parameters increased as the amount of CMP in the formulations increased. The CMP10 and the CMP15 cake samples had significantly higher crust color, crumb color, and mouthfeel values than the CMP05 cake (p◎0.05). This is probably because carob pod, which has high coloring substances such as poly-phenolics, gives it color and taste similar to cocoa. These results were agreed with studies about the addition of carob flour in cocoa cake recipes (4, 17). It had been reported that the cake elaborated with 10% PPPF obtained the highest sensory analysis scores for the appearance, flavor, and texture to the 5%, and 15% PPPF (1). Sensory evaluation cake samples containing the same type of fiber source at 5, 10, 15, and 20% fruit and vegetable waste had shown that all high fiber substituted cake samples had significantly lower than control cake. The highest and lowest scores in the same type of fiber source by cake samples at 5 and 20% replacement levels, respectively (5). It has been reported that when the cocoa powder was replaced with carob flour up to 75%, the cakes did not show a significant difference concerning sensory properties, and the produced cakes had higher dietary fiber, lower lipid, lower carbohydrate content, and lower calories (17). In a study, panelists evaluated the crumb and crust color of cakes with 30% and 50% carob flour as similar to control cocoa cake, and all carob flour-containing cakes' scores in overall acceptability were similar to the control cake (4). The findings

Table 3. Overall acceptability and sensory test of control and CMP †-added cakes‡§

Sample Code	CMP (%)	Appearance	Crust color	Crumb color	Softness	Porosity	Odor	Mouthfeel	Overall acceptance
CMP05	5	$3.4±0.96^a$	$2.6±0.69^a$	$2.6±0.69^b$	$3.9±0.73^a$	$4.0±1.05^a$	$3.4±0.69^a$	$3.6±1.07^b$	$4.0±0.66^a$
CMP10	10	$4.0±0.66^a$	$4.2±0.78^b$	$3.9±0.73^a$	$3.5±0.97^a$	$3.7±0.94^a$	$3.6±0.84^a$	$4.4±0.84^a$	$3.9±0.99^a$
CMP15	15	$4.1±0.87^a$	$3.6±0.69^b$	$3.6±7.84^a$	$4.0±0.66^a$	$3.8±0.78^a$	$3.8±0.91^a$	$4.6±0.51^a$	$4.5±0.52^a$

† CMP: Carob molasses pulp flour

‡ : Results presented are the mean ± SD of all replications. This means that different letters in the same columns are significantly different ($p < 0.05$)

§: Five-point hedonic scale with 1, 3, and 5 representing extremely dislike, neither like nor dislike, and extremely like, respectively.

of the sensory analysis showed that CMP05, CMP10, and CMP15 can be used successfully to replace cakes made with wheat flour.

CONCLUSIONS

Carob molasses pulp flour (CMP) which is used as livestock feed or disposed of as waste, is a by-product or waste in carob syrup extraction and carob molasses industries. The CMP contains nutritive compounds that can have beneficial effects on human health, such as a high content of insoluble dietary fiber, antioxidants, and polyphenols. Because of this, it could be used as an food additive. Nowadays, the increase in nutrition-related diseases and awareness of healthy nutrition has increased the demand for bakery products that are healthy, functional, and have good sensory quality characteristics. In this study, 5, 10, and 15% CMP were used instead of wheat flour in the cake. As a result of the research, the addition of CMP did not significantly change the volume, weight, and sensorial properties of cake samples. The hardness of the cake slightly increased, but only the CMP15 cake sample was significantly different ($p<0.05$) from the control. CMP05 and CMP10 cakes showed similar results to the control cake. The colors of the cake are strongly dependent on the CMP amount. The use of CMP in cake formulations caused a strong reduction in lightness and yellowness depending on the substitution level, but it enhanced the desired cacao color, which is preferred by some consumers. Sensory evaluation showed that the addition of CMP had no negative effect on cake quality and overall acceptance. On the other hand, the sensory evaluation scores of all samples are close to or higher than 4 (slightly liked). According to the findings, 5, 10, and 15% of CMP can be added to the cake recipes with high sensory acceptance, and without decreasing any quality parameters. As a result, the CMP can be used in the preparation of many functional foods that are exceptionally rich in fibers, minerals, and polyphenolics.

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