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Effect of substituting of cocoa powder for carob flour in cakes made with soy and banana flours

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Abstract

This study evaluated the effect of replacing cocoa powder by carob flour in gluten-free cakes. Five cake formulations were prepared: standard (100% cocoa powder); T_1 (25% carob flour), T_2 (50% carob flour), T_3 (75% carob flour) and T_4 (100% carob flour). The following were analyzed: moisture, carbohydrates, lipids, proteins, dietary fiber, ash and energy. The physical analysis of height and weight, pre-and post-cooking, and the heat factor were performed. The sensory analysis of color, odor, taste and texture was performed by affective test, and color was assessed using a Minolta colorimeter. The replacement of cocoa powder by carob flour gave the cakes a higher level of dietary fiber (16.42 the 2.89 g%), a lower lipid (6.89 the 5.27 g%) and carbohydrate content (20.65 the 8.42 g%), and lower calorie content (208.89 the 148.07 kcal%). The cake made with 100% carob flour was darker in color than the others. The increasing substitution of cocoa powder by carob flour resulted in decreased cohesiveness (0.51 the 0.46), elasticity (0.95 the 0.79) and resilience in the cakes (0.26 the 0.24). The cakes with greater substitution of cocoa powder were heavier in weight. With respect to sensory attributes, the cakes with replacement of up to 75% of cocoa powder by carob flour showed no significant difference. The results indicate that it is possible to prepare gluten-free cakes from soy and banana flours, using carob flour to replace cocoa powder, which are rich in protein, fiber, low in calories and with pleasant sensory characteristics for people with celiac disease.

Introduction

In the 1960s, the use of mixed flours in baking was introduced to partially substitute wheat flour and to reduce the importation of this cereal. Nowadays, research on mixed flours is designed to improve the nutritional quality of food products and to meet consumer need for diversified products. Several factors must be considered in the use of mixed flours for food production. The characteristics of the surrogate flours should minimize the effects of substitution and result in food that has an acceptable color, a pleasant flavor and good texture (Borges *et al.*, 2006).

Changes in processing and growing consumer demand for foods with sensory and nutritional quality that bring health benefits, has encouraged the study of new ingredients to be used by the food industry. An example of this is the case of people with celiac disease, where the only treatment that currently exists is the total exclusion of gluten from the diet (Moscatto *et al.*, 2004).

Among baked goods, cakes have been gaining increasing importance in relation to consumption and marketing in Brazil. Technological developments have resulted in industrial changes, which have transformed production from small to large scale (Moscatto *et al.*, 2004, Borges *et al.*, 2006). Cakes are a sweet food that are based on flour and are generally cooked in the oven. Cake dough consists of a two-phase system with fat and other ingredients (Esteller *et al.*, 2006). To prepare the dough, various types of flours are available. Soybean flour is considered to be a functional food; it contains no gluten, is high in protein, and its consumption is associated with health benefits by lowering cholesterol and reducing the risk of heart disease (Barbosa *et al.*, 2006). Green banana flour has great potential for use in the food industry, mainly for dietary bakery products, because it is a source of starch and minerals; it does not promoting changes in the taste of the products, it increases the amount of fiber, protein and minerals, and it increases yield as a function of water absorption (Fasolin *et al.*, 2007).

Cocoa has a high fat content (10-25%), high amounts of hydrophobic polysaccharides, and its capillary structure traps air bubbles because it has low solubility (Omobuwajo *et al.*, 2000). Cocoa substitutes are substances which can be used in biscuits, cakes, desserts or chocolate, for the total or

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Table 1. Formulation of cakes made with soy flour and banana flours, containing different proportions of carob flour replacing cocoa powder.

Ingredients	Standard	T1	T2	T3	T4
Margarine (g)	100	100	100	100	100
Milk (mL)	300	300	300	300	300
Eggs (g)	150	150	150	150	150
Sugar (g)	200	200	200	200	200
Yeast (g)	6	6	6	6	6
Soy flour (g)	150	150	150	150	150
Banana flour (g)	150	150	150	150	150
Carob flour (g)	--	25	50	75	100
Cocoa powder (g)	100	75	50	25	--

Standard: 100% cocoa powder; T_1: 25% carob flour; T_2: 50% carob flour; T_3: 75% carob flour, T_4: 100% carob flour

partial replacement of cocoa in order to reduce the fat content, or to provide different characteristics to the final product.

Carob flour is currently used as an alternative to chocolate in many products; while the latter has about 25% fat, carob flour contains around 2.54% fat, as well as being gluten-free. Because carob is a product with a color and flavor similar to chocolate it is used extensively in the food industry as a substitute for cocoa in candies, ice cream, drinks, cakes etc. (Pereira *et al.*, 2011).

This study prepared gluten-free cakes with banana and soy flours and evaluated the effect of replacing cocoa powder with carob flour, in the physical, chemical and sensory characteristics.

Materials and Methods

Raw materials

Carob (Carob House®), soy (i-nutri®) and banana (Slim 30®) flours were acquired in a specialized store in Santa Maria, RS, Brazil; the other ingredients were purchased in a local supermarket. Five cake formulations were prepared: standard (100% cocoa powder); T_1 (25% carob flour), T_2 (50% carob flour), T_3 (75% carob flour) and T_4 (100% carob flour). The formulations of the cakes, according the methodology described by Padilla *et al.* (2010), with flours substitutions, are shown in Table 1.

Processing of the cakes

The cakes were developed in the food processing laboratory of the Technology and Food Science Department of the Federal University of Santa Maria (UFSM). For the preparation of the cake dough, chicken's white eggs, regular margarine salt free, and sugar were transferred to a planetary mixer (ARNO, Deluxe SX80 model) and mixed (15 minutes) to form a homogeneous mixture. The following were then added: milk, soy flour, banana flour, cocoa powder (Nestlé®) or carob flour and baking powder. The cakes were baked in a rectangular mold with dimensions of 24 cm x 35 cm in a Brastemp domestic oven preheated to 200°C for 35 minutes. Once baked, the cakes were cooled to room temperature and wrapped in aluminum foil.

Chemical analyses

The determination of moisture, minerals, protein, ethereal extract and fiber in the cakes followed the methodology described by the AOAC (1995). The samples were pre-dried in a fan oven at 55°C for 36 h and were then ground in a micro-mill. The moisture determination was performed in an oven at 105°C to constant weight. The protein content was assessed by the Kjeldahl method, using a conversion factor of 6.25 for converting nitrogen into protein. The ethereal extract was obtained by extraction with petroleum ether in Soxhlet. The ash was obtained by the complete incineration of the organic compounds in an oven at 550°C. The carbohydrates were assessed by difference from the other fractions. The total, insoluble and soluble dietary fiber fractions were determined by the enzymatic gravimetric method (method 985.28).

Physical analyses

The measurement of weight and the height of the cakes were performed before and after cooking following the methodology described by the AACC (1995). To determine the weight, firstly the mold used for cooking the cakes was weighed. Then the raw cake dough was weighed, with the dough already packed in the mold, using a semi-analytical

Table 2. Chemical composition (g. 100g^{-1}) of cakes made with banana and soy flours, containing different proportions of carob flour replacing cocoa powder.

Formulation	Moisture	Ash	Lipids	Protein	Total fiber	CHO	Calorific value
Standard	36.04^c	3.93^a	6.89^a	16.07^a	16.42^d	20.65	208.89
	± 0.83	± 0.05	±0.01	± 0.59	± 0.01	±0.03	±0.10
T_1	37.94^b	3.82^a	6.24^b	17.18^a	20.22^c	14.60	183.28
	± 0.06	± 0.02	± 0.02	± 0.58	± 0.02	±0.10	±0.11
T_2	37.14^b	3.85^a	5.81^c	16.77^a	19.30^c	17.13	187.89
	± 0.17	± 0.06	± 0.02	± 0.19	± 0.02	±0.08	±0.10
T_3	37.96^b	3.83^a	5.31^d	16.74^a	22.20^b	13.96	170.59
	± 0.04	± 0.05	± 0.01	± 0.30	± 0.03	±0.08	±0.09
T_4	39.83^a	3.85^a	5.27^d	16.74^a	25.89^a	8.42	148.07
	± 0.52	± 0.03	± 0.23	± 0.49	± 0.02	±0.05	±0.09

Different letters in the same column indicate significant difference between treatments at the 5% level by Tukey's test (P <0:05). Standard: 100% cocoa powder; T_1: 25% carob flour; T_2: 50% carob flour; T_3: 75% carob flour; T_4: 100% carob flour.

balance (Quimis) before the weight of the mold was subtracted. The same procedure was performed when the cakes were baked.

For determining the initial height of the cake dough in the mold, three different points were marked with a pen on the mold and afterwards the height of these points was measured with a ruler. The post-cooking height was measured in the same manner, after removing the cake from the oven, using the same points as reference.

Color

Color determination was performed with the CIELAB system using a Minolta CR-300 chroma meter by reading the following parameters L^*(which is the percentage of brightness, where 0% is black and white 100%); a^* (where + a^* is red); and b^* (where $+b^*$ is yellow). The readings were performed at room temperature on the surface of the cakes, with five replicates for each evaluated sample.

Texture

The texture profile analysis (TPA) was performed using a TA.XTplus® texturometer and Exponent Stable Micro Systems software, using the parameters of firmness, cohesiveness, elasticity and resilience. The samples were double compressed by a metal cylinder (probe) with a 36 mm diameter in a room heated to 20°C. The test parameters were: pre-test speed = 5.0 mm s $^{-1}$; post-test speed = 10.0 mm s $^{-1}$; test speed = 2.0 mm s^{-1}; distance 12 mm; and also the second distance 12 mm, with a compression of 20% of the diameter of the cake for 5 seconds and the second compression at the same value as the first.

Sensory analysis

The project was approved by the Ethics Committee in Human Research (CEP - CONEP) of the Federal University of Santa Maria, in accordance with Resolution CNS 196/96 No. CAAE 17416013.8.0000.5346. The sensory evaluation of the cakes was performed at the Laboratory for Sensory Analysis of the Department of Science and Technology of Food. The affective test was used to evaluate the acceptability of the cakes in terms of color, odor, flavor and texture using a 7-point hedonic scale, where the extremes corresponded to: 7 = liked very much, and 1 = disliked very much. The fifty untrained, randomly recruited tasters were offered approximately 6 g of cake, which was coded with three random digits, along with a glass of water to wash the taste buds, as suggested by (Dutcosky, 2006).

Statistical analysis

The statistical analysis of the data was performed by analysis of variance (ANOVA) and Tukey's test with a significance level of 5% using SPSS, version 21.0.

Results and Discussion

Chemical analysis

The chemical composition of the cakes is shown in Table 2. The cakes had high levels of protein and dietary fiber, which stemmed from the soy and banana flours (values not shown). These values were higher than those found by Veit *et al*. (2012) and Miranda *et al.* (2013), which were 10.98g. 100 g^{-1}

Table 3. Physical parameters, before and after cooking, of cakes made with banana and soy flours, with different proportions of carob flour to replace cocoa powder

Physical parameters	Weight pre-cooking (g)	Weight post-cooking (g)	Height pre-cooking (cm)	Height post-cooking (cm)	Yield
Standard	2160.35^c ± 0.01	2012.05^d ± 0.01	1.533^a ± 0.15	3.300^a ± 0.10	0.931
T1	2045.32^e ± 0.01	1910.03^e ± 0.02	1.700^a ± 0.10	2.976^ab ± 0.15	0.933
T2	2237.88^a ±0.01	2096.18^a ± 0.01	1.576^a ± 0.05	3.000^a ± 0.10	0.936
T3	2115.50^d ± 0.02	2019.81^c ± 0.02	1.600^a ± 0.20	2.976^ab ± 0.20	0.954
T4	2215.24^b ± 0.01	2089.88^ab ± 0.01	1.333^a ± 0.15	2.600^b ± 0.10	0.943

Different letters in the same column indicate significant difference between treatments at the 5% level by Tukey's test (P <0:05). Standard: 100% cocoa powder; T_1: 25% carob flour; T_2: 50% carob flour; T_3: 75% carob flour; T_4: 100% carob flour.

protein and 1.86 g. 100 g^{-1} food fiber, respectively, for cakes enriched with tilapia fillets. According to Gutkoski *et al*. (2007), the demand for nutritious and safe products is growing globally and the intake of balanced products helps to prevent treatment for health problems arising from inadequate eating habits. The cakes with partial replacement of cocoa powder by carob flour had higher moisture when compared to the standard. Krauspenhar and Rosa (2012) found that carob has a greater power to retain water because it contains starch and fiber. The formulation with 100% carob flour differed from the others by presenting the highest moisture content, followed by T_1, T_2 and T_3. According to Torbica *et al.* (2010), products with high fiber content have high absorbency of water. Higher moisture contents were found in the cakes with higher levels of dietary fiber, which is explained by the ability of fibers to retain and maintain water in their structure during the cooking process. Values for moisture similar to those found for the cakes analyzed in the present study were cited by (Ferreira *et al*., 2001).

Regarding the ash content, the formulations did not differ significantly from each other, because cocoa powder has on average 5.7g.100 g^{-1} of minerals, a similar value to carob flour (5.67g.100 g^{-1}). The standard cake differed statistically from the others, showing a higher lipid content, which was attributed to the cocoa powder, because the cakes with cocoa powder substituted by carob flour showed a lower lipid content. Medeiros and Lannes (2009) found that cocoa powder contains approximately 14.21g.100 g^{-1} of lipids, while carob flour has only 2.54g.100 g^{-1}.

The cakes did not differ significantly from each other in protein content. The high values found for the protein content were the result of using soy flour, which is an important source of protein and which plays a role in formulations similar to that of gluten. The use of soy flour in the cakes represents significant progress not only for its functional properties, but also because it acts as an emulsifier and a stabilizer, as well as its ability to absorb water and its gelatinization, elasticity, cohesion and aeration properties (Ferreira, 2003).

All the cakes were rich in fiber, which was derived from the soy and banana flours, although the fiber content of the formulations varied significantly between the cakes. The total fiber content of the cake with 100% carob flour (T_4) showed an increase of 63.7% compared with the standard formulation. Ordinance No. 27 (1998) of the National Health Surveillance Agency classifies solid foods according to the fiber content present in 100 g of product as a source (minimum 3 g. 100g^{-1}) and high content (6 g. 100g^{-1}) (BRASIL, 1998). All the formulations had high fiber content because the flours used in the formulations of the cakes are rich in fiber. Similar results were found by Souza *et al.* (2013), who prepared gluten-free cakes using broken rice flour and cassava peel; as the substitution of rice flour by cassava peel flour increased, the fiber content increased. However, the levels were lower than those found for T_3 and T_4 in the present study.

As the level of replacement of cocoa powder by carob flour increased, the calorific value of the cakes decreased. Krauspenhar and Rosa (2012) formulated

Table 4. Texture parameters and color of cakes made with banana and soy flours, with different proportions of carob flour to replace cocoa powder

Physical parameters	Standard	T1	T2	T3	T4
Cohesiveness	0.51^{a}	0.42^{b}	0.48^{b}	0.43^{b}	0.46^{b}
Elasticity	0.95^{a}	0.86^{ab}	0.88^{b}	0.85^{b}	0.79^{c}
Firmness (N)	4.49^{b}	5.75^{a}	5.41^{a}	5.91^{a}	5.97^{a}
Resilience	0.26^{a}	0.20^{b}	0.24^{b}	0.20^{b}	0.24^{b}
L$^{?}$	47.06^{a}	46.85^{b}	44.29^{c}	40.71^{d}	38.58^{e}
a$^{?}$	5.25^{c}	5.30^{c}	6.68^{b}	7.72^{a}	7.90^{a}
b?	15.39^{a}	15.59^{a}	13.31^{b}	11.82^{c}	11.59^{c}
h$^{?}$	63.42^{b}	63.16^{b}	63.40^{b}	65.94^{a}	65.76^{a}

Different letters in the same line indicate significant difference between treatments at the 5% level by Tukey's test (P <0:05). Standard: 100% cocoa powder; T_1: 25% carob flour; T_2: 50% carob flour; T_3: 75% carob flour; T_4: 100% carob flour

cocoa powder cake and carob flour cake and they found that the carob flour cake contained less calories than the cocoa powder cake because cocoa powder has high fat content and low fiber, while carob flour contains little fat and high fiber content. Moscatto *et al*. (2004) used inulin and yacon flour as ingredients for a chocolate cake and found that the cake prepared with 40% yacon flour and 6% inulin had an energy value approximately 24% lower than the standard cake made exclusively with wheat flour. In the present study, there was a 70% reduction in calorific value for the cake made with carob flour (T_4) compared to the standard cocoa powder cake.

Physical analysis

The results obtained for the analysis of height and weight of the cakes before and after cooking, as well as the yield, are shown in Table 3. It can be seen that the pre-cooking weight differed significantly between the cakes and the formulation with 50% carob flour was the heaviest pre-cooking, followed by the standard formulation, the cake with 100% carob flour, and the cake with 75% carob flour. This result may have been due to bad mixing of the ingredients during the preparation of cake dough, which may have resulted in incorrect aeration in the middle of the dough.

Considering the results that were obtained, the T_4 formulation showed the lowest weight loss, with highest yield. This was similar to a study by Miranda *et al.* (2013) of cakes enriched with passion fruit flour, where the greater the replacement of wheat flour by flour passion fruit, the greater the yield of the cake. The same occurred in a study by Borges *et al.* (2006), which found increased yield for cakes with added oat flour and wheat. Silva *et al*. (2010) reported that this occurs because the fibers absorb more water, which leads to an increase in yield in the formulation of baked products.

Regarding the pre-cooking height, the five formulations in the present study did not differ significantly from each other. After cooking, the T_4 formulation differed statistically from the standard, in that it was lower in height, and this result may have been associated with the high fiber content of this formulation. However, Miranda *et al.* (2013) found contrary results using cakes with added passion fruit flour. Hood and Jood (2006) found that cakes made with flour with high fiber levels reduced in volume. Similar results were found by Schmielle *et al.* (2011), when studying English cake with added soy protein isolate, whole oat flour and oat flakes; these researchers detected a reduction in the height of the cakes as the concentration of these flours was increased. These results may be associated with the hydrophilic characteristics of insoluble fibers retaining water in their structures. Padilha *et al.* (2010) reported that fibers adsorb intramolecular water, increasing their weight, but not their height to any great degree.

Color

The colors of the cakes are shown in Table 4. It can be seen that as the cocoa powder was replaced by carob flour the cakes became darker in color, and the formulation with 100% carob flour (T_4) was the darkest. According to Esteller *et al.* (2006), cakes that have high L^* values are lighter in color because they have higher rates of reflectance for light. From the results of all the formulations, it was possible to classify all the samples as dark, in that they all had L^* values of less than 50 ($L^* < 50$), as stated by Cohen

Table 5. Sensory analysis of cakes made with banana and soy flours, with different proportions of carob flour to replace cocoa powder

Treatments	Color	Odor	Flavor	Texture
Standard	5.450^{a} ± 0.90	5.000^{a} ± 1.03	4.675^{a} ± 1.16	4.675^{a} ± 0.99
T1	4.950^{ab} ± 1.08	4.875^{a} ± 0.88	4.525^{a} ± 1.33	4.650^{a} ± 1.35
T2	5.000^{a} ± 0.98	4.700^{a} ± 0.85	4.375^{a} ± 1.07	4.175^{a} ± 1.15
T3	4.300^{b} ± 1.18	4.475^{a} ± 0.90	4.250^{a} ± 1.25	4.625^{a} ± 1.25
T4	3.375^{c} ± 1.29	3.525^{b} ± 1.15	3.350^{b} ± 1.27	3.475^{c} ± 1.13

Different letters in the same column indicate significant difference between treatments at the 5% level by Tukey's test (P <0:05). Standard: 100% cocoa powder; T_1: 25% carob flour; T_2: 50% carob flour; T_3: 75% carob flour; T_4: 100% carob flour.

and Jackix (2005).

Regarding the parameters of chromaticity (a^* and b^*), the chromaticity coordinate a^* increased in line with the increased substitution of cocoa powder, and the chromaticity coordinate b^* decreased in the same manner. According to Esteller *et al*. (2006), high values for the b^* parameter translate into samples as strong yellow/gold staining, which are characteristic of products that have been baked. From the results it can be seen that the formulations with lower levels of substitution of cocoa powder by carob flour (the standard and the cake with 25% carob flour), showed higher b^* values, which characterized the cakes with the typical coloring described above.

According to Esteller *et al.* (2006), high values for the a^* chroma indicate cakes with a dark color. Observing the results, it can be seen that as the replacement of cocoa powder by carob flour increased, the a^* chroma increased, and hence the darkening of the cakes ocurred.

Texture

The results for the texture parameters are shown in Table 4. Cohesiveness is defined as the ratio of the summation of the forces employed in the first and second compression, which represent the internal structure of the product (Szczesniak, 1963). As Esteller *et al.* (2006) have argued, cohesiveness is associated with the molecular interactions of the components of baked products; low values for this parameter characterize products that are difficult to handle and slice. The results showed that the standard cake differed statistically from the others in that it had greater cohesiveness, which was related to its lower fiber content compared to the other formulations because it did not contain carob flour.

According to Szczesniak (2002), elasticity can be physically defined as the rate at which deformed material returns to its original condition. Regarding this parameter, it was observed that as the replacement of cocoa powder by carob flour increased, the elasticity decreased and T_4 differed significantly from the other samples, with less elasticity.

Firmness can be physically defined as the force that is required to achieve a given deformation of a certain product (Szczesniak, 2002). It can be seen that the standard cake showed the lowest firmness (softer). The other treatments showed no significant difference between them, and these characteristics were more pronounced in T_4, which appeared to be drier than the others, with a higher incidence of cracks. Similar results were found by Miranda *et al.* (2013) in relation to cakes developed with increasing percentages of passion fruit flour. Padilha *et al*. (2010) reported that high fiber content absorbs more water, which can lead to a reduction in quality of some of the technological characteristics of products, such as elasticity, cohesiveness, firmness and conformation.

As described by Calabuig (2012), resilience is given by the symmetry of a cake in the first compression, which relates to the degree that a sample recovers after compression, when taking into account the distance to which the sample was compressed and the speed at which this compression occurred. As with elasticity, the standard cake formulation showed the best resilience (0.26), which was associated with the fiber content of the cakes, the greater the percentage of fiber, the lower the resilience (Scaranto, 2010).

Sensory analysis

The results for sensory analysis, regarding color, odor, flavor and texture, are shown in Table 5. In terms of color, the standard formulation and those made with 25 and 50% carob flour had the highest average scores, with no statistically significant difference (P> 0.05) between them. These were classified on the 7-point hedonic scale between 'indifferent' and 'liked moderately'. Regarding color, the formulation with 100% carob flour (T_4) had the lowest acceptability (3.37), a factor that may have been associated with the dark color caused by the carob flour (Silanikove *et al*., 2006).

Regarding odor, the results obtained in the sensory analysis showed that, in general, all the formulations received scores between 4.47 and 5.00 and did not differ significantly from each other; with the exception of the formulation with 100% carob flour (T_4), which received a score of 3.52 that classified it between 'disliked' and 'indifferent'.

In terms of flavor, the T_4 formulation differed significantly from the others, presenting a score of 3.35, which classified it between 'disliked' and 'indifferent', in the same way that this formulation was evaluated for the attribute of odor. According to Silva (2011), when wishing to fully replace cocoa powder by carob flour, as was the case of this formulation, it is possible to use cocoa flavoring to improve the taste of the product. According to Silanikove *et al.* (2006), carob is rich in condensed tannins, which, when used in excess, tends to give an astringent aftertaste to products.

Regarding texture, the formulations received scores from 4.1 to 4.6. As for the other attributes, the T4 formulation differed from the others, being the least preferred. All the cakes containing up to 75% carob flour showed no significant difference between each other (indicating the possibility of substituting carob flour for cocoa powder up to this level), with scores between 4 and 5, i.e. 'indifferent' and 'moderately liked'. Souza *et al.* (2013) developed gluten-free cakes with broken rice and cassava peel flours and also found good acceptance in all the formulations independent of the amount of cassava flour that was added. However, when Fasolin *et al.* (2007) incorporated green banana flour into cookies they noted a reduction in tester acceptance in line with an increase in the percentage of green banana flour in the product, similar to the results in the present study found for the T_4 formulation.

Conclusion

The results of this study showed that it is possible to develop cakes with banana and soy flours with high protein and dietary fiber and that the replacement of cocoa powder with carob flour is possible. The chemical composition of the cakes with carob flour replacing cocoa powder showed higher dietary fiber content and lower levels of lipid content, carbohydrates and calories. The physical analyses showed that as the replacement of cocoa powder by carob flour increased, the yield increased. The texture analysis showed that the partial or total replacement of cocoa powder by carob flour decreased elasticity, resilience and cohesiveness. The cakes with up to 75% replacement of cocoa powder by carob flour showed no difference in terms of flavor, odor and texture, demonstrating that replacement up to this level did not influence sensory attributes.

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