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Research Article

Physicochemical and Sensory Evaluation of Sandwich Cookies Made with Carob Powder

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Abstract: This study aimed to investigate the viability of replacing cocoa by carob powder in the development of sandwich cookies and to evaluate their physicochemical and sensory characteristics. Three formulations were tested: carob sandwich cookies, carob and Textured Soy Protein (TSP) sandwich cookies and cocoa sandwich cookies. Some physical analysis was taken such as: weight and diameter, before and after baking. It was also evaluated protein, fatty-acids, fiber, ashes, moisture, carbohydrates and calories. Forty eight judges analyzed the cookies acceptability and purchase intention of the cookies. In physical analyses, a significant difference was observed in weight after baking between the carob cookies and cocoa cookies. Moisture, ash, protein, lipids, calories per portion showed similar chemical characteristics for all the samples. Cocoa cookies presented the highest content of crude fiber. Carob cookies presented highest content of carbohydrate; however Carob and TSP cookies showed the highest content of proteins and the lower content of lipids. The attributes appearance, texture, flavor and global acceptability showed similar characteristics for all the samples. The attributed color showed higher acceptability in Cocoa cookies, nevertheless the purchase intention was similar for all the samples.

Keywords: Carob, *Ceratonia silique*, cocoa, cookies, TSP

INTRODUCTION

Carob (*Ceratonia siliqua*) belongs to the subfamily Caesalpinioideae of the Leguminosae family, it is a typical tree of the semiarid environments in the Mediterranean area (Batlle and Tous, 1997; Biner *et al*., 2007). The fruit of carob tree is composed by pod (90%) and seeds (10%) (Tous *et al*., 1995), which has a high content of insoluble fiber and polyphenols (tannins), with supposed beneficial effects for human health (Zunft *et al*., 2001). In rodents studies, carob powder preparations demonstrated a cholesterol-lowering effect and an increase excretion of cholesterol and bile acids (Pérez-Olleros *et al*., 1999a, b) and in humans, the supplementary intake of carob fiber shows beneficial effects on total and LDL cholesterol levels (Zunft *et al*., 2003).

Carob seeds are mostly used in food industry for production of gum due to high levels of galactomannans, used as thickening agent in food preparations (Batlle and Tous, 1997; Santos *et al*., 2005). The carob powder is composed only of its pod, which is rich in sugars (48-56%), but it also contains a large amount of condensed tannins (16-20%). In addition, it contains about 18% cellulose and hemicelluloses, 3-4% protein and 0.4-0.8% lipids (Bravo *et al*., 1994; Yousif and Alghzawi, 2000).

The carob pulp is roasted and milled to produce carob powder and it is sold as a substitute for cocoa. Its flavor and appearance is similar to cocoa. In terms of nutrition, carob powder has a high sugar content, moderate protein content and low fat content compared to cocoa powder. Additionally, it is well established that carob powder is free of the two anti-nutrients found in cocoa: cafeine and theobromine (Craig and Nguyen, 1984; Yousif and Alghzawi, 2000) and contain nutritionally important amino acids (aspartic and glutamic acids, alanine, valine) and minerals (K and Ca) (Ayaz *et al*., 2007). Therefore, carob powder has been used in the production of cookies, cakes and beverages containing milk "chocolate" (Arrighi *et al*., 1997). Thus, it's an alternative for people with cocoa allergy. Sole *et al*. (2007) observed that Brazilian pediatrician attributed to chocolate (6.7%) as being the starter food allergy.

The cookies are made mainly with wheat flour, fat and sugar (Manohar and Rao, 1997) and they are as part of the group of non-essentials food are classified as

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Table 1: Ingredients of sandwich cookies formulations

Ingredients	CC	CSC	CoC
Cookies			
Refined sugar (g)	64	64	64
Corn starch (g)	30	30	30
Cocoa powder (g)	-	-	20
Carob powder (g)	20	20	-
White wheat flour (g)	40	40	40
Whole wheat flour (g)	64	64	64
Butter (g)	30	30	30
Egg (g)	46	46	46
Textured soy protein (g)	-	8	-
Filling			
Refined sugar (g)	105	105	105
Boiling water (mL)	80	80	80
Cocoa powder (g)	-	-	10
Carob powder (g)	10	10	-
Milk powder (g)	90	90	90
Butter (g)	10	10	10

CC: Sandwich cookies only with carob powder; CSC: Sandwich cookies with carob powder with textured soy protein; CoC: Sandwich cookies only with cocoa powder

snack food (Brown *et al*., 1998), generally are very much appreciated specially by kids and adolescent. These products are usually eaten to satisfy sensory expectation instead of nutritional needs, besides the sensory quality is the main factor in determining the acceptance and consumer preference for these kinds of products (Ormenese *et al*., 2001).

This study aimed to investigate the viability of replacing cocoa by carob powder in the development of sandwich cookies and to evaluate their physicochemical and sensory characteristics.

MATERIALS AND METHODS

The physical and sensory analysis was conducted at the Dietetic Laboratory of the Nutrition course at the Medicine School (FAMED) of Federal University of Rio Grande do Sul (UFRGS).

Source of materials: The carob powder was supplied by Carob House Company and the other ingredients were acquired in a local market in Porto Alegre-RS, Brazil.

Preparation of sandwich cookies: The sandwich cookies were elaborated with cocoa powder being replaced by carob powder, resulting in three different formulations. Some changes had to be made to the original formulation in order to adapt the recipes to that carob powder during the tests. The ingredients used can be found in Table 1.

All ingredients were weighted using a Plenna® precision scale (graduation 0.1 g). For all treatments, the cookies were prepared as follows: the butter was heated in a Brastemp® microwave oven for 30 sec, after that it was homogenized manually with the egg. Furthermore, refined sugar was manually added in order to make a uniform batter. Latter, in this batter was slowly added whole wheat flour, white wheat flour and corn starch until making it homogeneous. Then, for each formulation added the ingredient such as: for sandwich Cookie of Carob powder (CC) only carob powder; for sandwich cookie of Carob powder and textured Soy protein (CSC) carob powder and textured soy protein; and for sandwich Cookie of Cocoa powder (CoC) only cocoa powder was added.

Once ready, the batter standed by for 20 min in ambient temperature, after that it was stretched out with a roll of Polyvinyl Chloride (PVC) to achieve a thickness of 0.5 cm and it was cut in 4 cm of diameter. The cookies were baked in the preheating Dako® oven, Luna model in an aluminum baking pan greased with butter, for 10 min at 180°C and cooled at room temperature for 10 min in a stainless steel pholate.

To prepare the filling of CC and CSC, it was added in a blender, boiling water, refined sugar, milk powder and carob powder to obtain a totally homogenous filling. Later, that filling was cooked on low flame, into a stainless pan, with the butter until reaching non sticking point. For the filling of CoC, the carob powder was replaced by cocoa powder. The sandwich cookies were finished with one tablespoon of filling (5 g) between two cookies.

Physical analyses: The physical analyses carried out were: weight and diameter of cookies before and after baking. Three cookies from different batches were chosen to analyses. They were also weighted in Plenna® precision balance (graduation 0.1 g) and measured of diameter with Vernier® caliper rule (150×0.5 mm). In addition, the yield for each treatment was quantified with three batches.

Chemical analyses: The chemical analyses were conducted at the Animal Nutrition Laboratory of the Animal Science Department of UFRGS, in quadruplicate. Moisture, ash, lipids, proteins and crude fiber analyses were performed following AOAC (1996), while carbohydrate was determined by difference (Ihekoronye and Ngoddy, 1985). The calories were obtained by the values stipulated by RDC n° 360/2003, 4.0 kcal for 1 g carbohydrate, 4.0 kcal for 1 g protein and 9.0 kcal for 1 g lipid. These values were multiplied by each macronutrient and finally were summed to obtain the total caloric value.

Sensory analysis: Forty eight non-trained judges performed the sensory analysis after signing the Informed Consent Form. The judges were students and teachers from the university. The three sandwich cookies samples were evaluated in terms of global acceptance, texture, color, flavor and appearance. The sensory analysis was conducted isolated with each judge, at ambient temperature, using white plastic dishes, numbered with three random digits, which corresponded to each sample. The judges received water to drink before evaluating each sample. A 9-points hedonic scale of was used, each point meaning:

- Dislike extremely
- Dislike very much
- Dislike moderately
- Dislike slightly
- Neither like nor dislike
- Like slightly
- Like moderately
- Like very much
- Like extremely

It was also evaluated the purchase intention, using the following scale:

- Would certainly not buy it
- Would probably not buy it
- Not sure if would buy it
- Would probably buy it
- Would certainly buy it

This study was approved by the Ethics Committee of UFRGS, process number 150.778.

Statistical analysis: The statistical analysis was made using the program ESTAT®, version 2.0, with the Tukey's test, considering a 5% error probability. The results were given as means plus standard deviation. There were considered as being statistically significant the results that showed differences with $p<0.05$.

RESULTS AND DISCUSSION

Physicals analyses: As shown in Table 2, there was no statistically significant difference ($p>0.05$) in relation to weight before baking, diameter before and after baking and yield among samples. Only weight after baking showed statistically significant difference ($p<0.05$) between CoC and CC and that the CoC was the heaviest. This difference can also have influenced on yield although statistically significant difference was not observed, because the CC had the highest yield. This change may have been influenced the texture batter of cookies, showing different stretch.

According to Fasolin *et al*. (2007), cookies elaborated with green banana flour, also haven't statistically significant differences between the samples for weight and diameter before baking, whereas weight and diameter after baking showed statistically significant difference ($p<0.05$) between samples.

From Larrea *et al*. (2005), the study with cookies supplemented with different percentages of extruded orange pulp not showed statistically significant difference ($p<0.05$) for weight before and after baking between the samples.

Chemicals analyses: Table 3 presents the results of chemical characteristics of all sandwich cookies evaluated. Thus, it is possible to observe that there was no statistically significant difference ($p>0.05$) among samples for moisture, ash, protein, lipids and calories per portion. However, for crude fiber it was observed statistically significant differences ($p<0.05$) which CoC had the highest amount of fiber between CC and CSC. Carbohydrates also presented statistically significant differences ($p<0.05$) among all the samples. CC presented, CSC and CoC had the lowest amount.

Yousif and Alghzawi (2000) founded that the fat, ash and protein values of carob powder (0.74, 2.48 and 5.82%, respectively) was lower than those of cocoa powder (22.88, 6.40 and 22.9%, respectively) and that the sugar were higher in carob powder (38.7%) than those of cocoa powder (2.16%). The study according to Youssef *et al*. (2009). Whereas Ayaz *et al*. (2007) observed the lowest value of protein in carob powder (4.45%).

Table 2: Physicals characteristics of the cookies formulations before and after baking

Characteristics	CC	CSC	CoC
Weight before baking (g)	9.57 ± 0.75^{a}	10.51 ± 0.87^{a}	10.77 ± 1.00^{a}
Weight after baking (g)	9.11 ± 0.00^{b}	$10.11\pm1.00^{a\ b}$	11.22 ± 1.00^{a}
Diameter before baking (cm)	4.32 ± 0.10^{a}	4.58 ± 0.12^{a}	4.47 ± 0.12^{a}
Diameter after baking (cm)	4.71 ± 0.10^{a}	4.60 ± 0.12^{a}	4.56 ± 0.15^{a}
Yield (units)	28.00 ± 2.65^{a}	27.00 ± 1.73^{a}	26.00 ± 1.15^{a}

Values with different superscripts within the same row are significantly different ($p\leq0.05$); CC: Cookies only with carob powder; CSC: Cookies with carob powder with textured soy protein; CoC: Cookies only with cocoa powder

Table 3: Chemical parameters of the sandwich cookies formulations

Parameters	CC	CSC	CoC
Moisture (%)	2.70 ± 0.15^{a}	3.27 ± 0.67^{a}	2.68 ± 0.50^{a}
Ash (%)	1.55 ± 0.07^{a}	1.73 ± 0.08^{a}	1.73 ± 0.11^{a}
Protein (%)	9.65 ± 0.82^{a}	10.64 ± 0.47^{a}	10.03 ± 0.49^{a}
Lipids (%)	12.15 ± 1.28^{a}	11.90 ± 1.16^{a}	13.04 ± 1.17^{a}
Crude fiber (%)	1.30 ± 0.10^{b}	1.33 ± 0.05^{b}	1.85 ± 0.17^{a}
Carbohydrate (%)	75.35 ± 0.43^{a}	74.41 ± 0.13^{b}	73.36 ± 0.53^{c}
Calories per portion of 25 g (kcal)	112.32 ± 1.65^{a}	111.81 ± 2.24^{a}	112.71 ± 1.69^{a}

Values with different superscripts within the same row are significantly different ($p\leq0.05$); CC: Sandwich cookies only with carob powder; CSC: Sandwich cookies with carob powder with textured soy protein; CoC: Sandwich cookies only with cocoa powder; 25 g is the weight of two cookies plus filling

Table 4: Properties sensory of the sandwich cookies formulations

Attributes	CC	CSC	CoC
Appearance	6.92±1.51[a]	6.79±1.33[a]	7.21±1.47[a]
Color	6.71±1.53[b]	6.58±1.65[b]	7.48±1.18[a]
Texture	6.60±1.67[a]	6.75±1.79[a]	7.08±1.65[a]
Flavor	6.85±1.50[a]	6.75±1.74[a]	7.31±1.68[a]
Global acceptability	6.87±1.36[a]	6.81±1.41[a]	7.25±1.49[a]

Values with different superscripts within the same row are significantly different ($p \leq 0.05$); CC: Sandwich cookies only with carob powder; CSC: Sandwich cookies with carob powder with textured soy protein; CoC: Sandwich cookies only with cocoa powder

Table 5: Evaluator's purchase intention of the sandwich cookies formulations

	CC	CSC	CoC
Purchase intention	3.54±1.03[a]	3.44±1.20[a]	3.94±1.12[a]

Values with different superscripts within the same row are significantly different ($p \leq 0.05$); CC: Sandwich cookies only with carob powder; CSC: Sandwich cookies with carob powder with textured soy protein; CoC: Sandwich cookies only with cocoa powder

In accordance with Rababah *et al*. (2013), in carob powder were found to contain high concentrations of carbohydrate (71.4 g/100 g), moderate amounts of protein and fiber (5.9 and 8.2 g/100 g, respectively) and low amounts of fat and ash (1.2 and 2.7 g/100 g, respectively).

Lar *et al*. (2012) used carob powder as substitute of wheat flour in tarhana formulation, which is an Asian traditional fermented cereal food. The carob powder showed a high ash, Ca and K contents when compared with wheat flour.

Salem and Fahad (2012) prepared the milk chocolate substituting the cocoa for carob powder (25, 50, 75 and 100%, respectively). This study showed highly significant differences in fiber contents among milk chocolate samples contained 25, 50, 75 and 100%, respectively carob powder of their weights than the control (free carob-powder) sample. Wherein, there was a progressive increment as a result of increase the carob powder amount. The same model was also achieved in case of ash contents of the milk chocolate samples provided by carob powder. Already, the fat and carbohydrates were low whereas increased the carob powder amount, which contradicts the earlier studies cited than showed the high level carbohydrates in carob powder.

Salem and Fahad (2012) showed that the control sample of the milk chocolate (carob free) possessed the highest amount of caffeine (2720.26 mg/100 kg). Addition of the carob powder (25, 50 and 75%, respectively) gradually significantly lowered the milk chocolate contents of caffeine (to be 22382.44, 1059.16 and 740.678 mg/100 kg, respectively). The milk chocolate sample by 100% carob pod powder was caffeine free. Medeiros and Lannes (2009) showed methylxanthines (caffeine and teobromine) levels highest in cocoa powder (1.09%) when compared to carob powder (0.24-0.41%).

Properties sensory: In sensory analysis of the sandwich cookies samples, the attributes appearance, texture, flavor and global acceptability did not show statistically significant difference ($p>0.05$) among all samples (Table 4), although the CC and CSC samples presented lower rates when compared to CoC sample.

The attribute color showed statistically significant difference ($p<0.05$) between samples CoC (like moderately) and CC and CSC (like slightly).

Table 5 presents the evaluator's purchase intention test, which indicated no statistically significant difference ($p>0.05$) among the samples. That's indicates a good acceptability and similar sensory quality of CC and CSC when compared a CoC.

Fernandes (2007) mentioned the texture soy protein such as improving texture in the formulations. The sandwich cookies made with carob powder and texture soy protein showed this result when compared to sandwich cookies made with only carob powder, but did not show this result when compared to sandwich cookies made with only cocoa powder.

Youssef *et al*. (2009) prepared hot drinks and cakes with carob powder, utilizing different times and temperatures for roast, to compare the ones made with cocoa powder. The hot drinks were prepared with roasted carob powder for 30 min at 160ºC had a rate of same overall acceptability, texture similar, odor, taste and color major when compared to the hot drink made with cocoa powder. The cakes were made with roasted carob powder showed the same results with the roast for 30 min at 160ºC.

According to Atasoy (2009), the sensory analysis of the yoghurts made with carob juice concentrate (10 mL) had taste and flavor rate major than those the standard, while texture and appearance had a similar rate in comparison to the standard.

Lar *et al*. (2012) founded that addition of 3% of carob powder in tarhana as substitute of wheat flour showed a major rate to taste and color attributes and equal grittiness and overall acceptability when compared to control.

Salem and Fahad (2012) showed that in milk chocolates with carob powder there was a significant difference in general appearance attribute between the control sample and the other samples. It was also found that there were significant differences among the carob powder samples as a result of increasing the carob amounts.

Sabatini *et al*. (2011) prepared the ice cream with carob powder and submitted to sensory analysis. The attributes appearance, flavor and global acceptability showed approximated average 8 ("like very much"). Regarding the purchase intention, 54% said "Certainly I would buy", 39% "Probably I would buy", 6% "Maybe I would buy" and 2% "Probably I would not buy". With these results, it is observed that 93% of the tasters would buy the ice cream prepared in the study.

CONCLUSION

Carob cookies and Carob and texturized soy protein cookies showed similar physicochemical and sensory characteristics when compared to Cocoa cookies.

In terms of physical characteristics, the weight before baking, diameter before and after baking and yield showed similar characteristics for all the samples. Cocoa cookies were the heaviest one.

Moisture, ash, protein, lipids, calories per portion showed similar chemical characteristics for all the samples. Cocoa cookies presented the highest content of crude fiber.

Carob cookies presented highest content of carbohydrate, however Carob and soy cookies showed the highest content of proteins and the lower content of lipids.

The attributes appearance, texture, flavor and global acceptability showed similar characteristics for all the samples. The attributed color showed higher acceptability in Cocoa cookies, nevertheless the purchase intention was similar for all the samples.

Thus, the carob powder is a good alternative as substitute for cocoa in elaborating sandwich cookies. Therefore, the sandwich cookies elaborated in this study were made with whole wheat flour and they are fatty-acids-trans free, which is generally found in commercial sandwich cookies.

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