Development of a cake rich in resistant starch with good sensory acceptance

Desenvolvimento de bolo rico em amido resistente e com boa aceitação sensorial

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Highlights

The incorporation of GBF increased the resistant starch content of the cake.
Cakes with 14% and 18% GBF had better flavor, softness, and overall acceptance.
Cakes with GBF showed high sensory acceptance and purchase intent.

Abstract

The objective of this study was to develop a cake rich in resistant starch, with green banana flour (GBF), of good sensory acceptance. In step 1, four cake formulations were prepared with increasing concentrations of GBF and evaluated for acceptability and purchase intention. In step 2, four new formulations were made by modifying the most accepted formulation in step 1, in addition to the formulation without GBF (control). The resistant starch content, proximate composition, total calorific value, and sensory acceptance data were obtained. The formulation with cocoa powder and dried banana (E1F4) achieved 97.78% overall acceptance and higher purchase intent. In step 2, the formulations with 14% and 18% GBF were the most accepted for flavor, texture/softness, and overall acceptance. Adding the categories of "would certainly buy" and "would probably buy", 53.33% of consumers would buy the cake with 14% GBF and 48.89% would buy the cake containing 18% GBF. The incorporation of GBF increased the resistant starch contents of the formulations as compared with the control. Ash content was highest in the formulation with 26% GBF (2.22%) and lipid content in the control formulation (11.58%). The treatments did not differ in terms of moisture content. Protein content decreased as the GBF content in the formulations was increased. The total dietary fiber content of the formulations was 9.30%. Carbohydrate content and calorific value also did not vary. The mean values of L*, a*, b*, C*, and h* showed that the cakes had an intense dark brown color. In conclusion, the addition of 14% and 18% GBF to the cake resulted in a product of high sensory acceptance, with high purchase intent, a resistant starch content 7.21 and 8.34 times higher than those in the control cake.
Key words: Functional food. Bakery. Green banana flour.

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Resumo

O objetivo desse estudo foi desenvolver uma formulação de bolo com farinha de banana verde (FBV), rica em amido resistente e com boa aceitação sensorial. Na etapa 1, foram elaboradas quatro formulações de bolo, com concentrações crescentes de FBV, as quais foram avaliadas quanto à aceitação sensorial e intenção de compra. Na etapa 2 foram feitas quatro novas formulações, modificando-se a formulação mais aceita na etapa 1, e um controle, sem farinha de banana verde. Quantificou-se o teor de amido resistente, estudou-se a composição centesimal, calculou-se o valor calórico total e avaliou-se a aceitação sensorial. A formulação com cacau em pó e banana passa (E1F4) apresentou aceitação global igual a 97,78% e maior intenção de compra. Na etapa 2, as formulações com 14% e 18% de farinha de banana verde foram as mais aceitas para o sabor, textura/maciez e aceitação global. Somando-se as categorias "certamente compraria" e "provavelmente compraria", 53,33% dos consumidores comprariam o bolo com 14% de farinha de banana verde e 48,89% o com 18%. A incorporação de concentrações crescentes de FBV proporcionou aumento nos teores de amido resistente das formulações em relação ao controle. O teor de cinzas foi maior na formulação com 26% de farinha de banana verde (2,22%) e o de lipídeos na formulação controle (11,58%). Os tratamentos não diferiram quanto ao teor de umidade. O teor de proteína reduziu, à medida em que o teor de farinha de banana verde foi incrementado nas formulações. O teor de fibra alimentar total das formulações foi igual a 9,30%. O teor de carboidratos e valor calórico também não variaram. Os valores médios das variáveis L*, a*, b*, C* e h* demonstraram que os bolos apresentaram coloração marrom escura intensa. Conclui-se que a adição de 14% e 18% de farinha de banana verde no bolo resultou em um produto com elevada aceitação sensorial, elevada intenção de compra e com teor de amido resistente 7,21 e 8,34 vezes superior ao bolo controle.

Palavras-chave: Alimento funcional. Panificação. Farinha de banana verde.

Introduction

In the green maturation stage, bananas do not have marked sensory characteristics due to physiological immaturity. However, they have aroused the interest of the food industry and producers for being available throughout the year, minimizing post-harvest losses, and being easy to transport and store, as well as for the possibility of adding value to their cultivation (Pires, Silva, & Souza, 2014; Campuzano, Rosell, & Cornejo., 2018).

With the growing and rapid access to information and market trends in the food sector, consumers have increasingly sought healthier products that offer nutritional benefits (Ferronatto, Rossi, & Cappellari, 2020). Food rich in fiber and resistant starch (RS) fall into this group (Freitas, Silveira, Veras, & Santos, 2017), which takes the green banana to a prominent position for being a good source of RS (Reis, Viana, Assis, Sena, Souza, & Amorim, 2019; Campuzano et al., 2018). Additionally, its consumption in the recommended amount directly contributes to the proper functioning of the immune system and intestinal function (Öztürk & Mutlu, 2019).

Nonetheless, green banana is not consumed in its natural state, mainly due to its typical hardness and high astringency caused by the presence of soluble phenolic compounds (tannins). Consequently, flour production is the main alternative to ensure the use of green fruit by the food industry

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(Sarawong, Schoenlechner, Sekiguchi, Berghofer, & Ng., 2014).

Green banana flour (GBF), a product obtained from the natural or artificial drying of banana, has considerable levels of protein, mineral salts, and dietary fiber (Carmo, 2015; Reis et al., 2019). It has been widely used in the preparation of functional foods by the industry, especially in the production of bakery and dietetic products, making it a known source of RS and mineral salts (Vernaza, Gularte, & Chang, 2011; Campuzano et al., 2018). The consumption of high fiber foods is associated with prevention of diseases such as cancer, diabetes, and cardiovascular disease, as well as lowering LDL cholesterol levels (Veronese et al., 2018).

According to the Brazilian Association of Industrialized Biscuits, Pasta, Bread & Cakes, cake sales have steadily grown each year. In 2020, Brazil occupied the 12th position globally and sold 205,000 t of cakes (Associação Brasileira de Massas Alimentícias, Pães e Bolos Industrializados [ABIMAPI], 2021).

Due to the great popularity of cakes, several studies have been conducted aiming at their nutritional enrichment (Bitencourt, Dutra, Pinto, Helbig, & Borges, 2014; Urrutia et al., 2019; Eggea et al., 2020; Gouvea, Maciel, Carvalho, Boas, & Nachtigall, 2020). The consumption of these fortified foods can contribute important nutrients to the population's diet, such as fiber, vitamins, and minerals. In the case of enrichment with RS, studies associate its consumption with benefits related to reducing the risk of cardiovascular diseases and contributing to the modulation of cholesterol, especially LDL, and triglycerides, as it is a carbohydrate that is not digested by the digestive process that also has functional properties similar to those performed by fibers (Ranieri & Delani, 2014; Öztürk & Mutlu, 2019).

This study developed a cake formulation containing GBF rich in resistant starch and good sensory acceptance.

Materials and Methods

Green banana flour production

Cultivar BRS SCS Belluna was used to obtain the GBF used in the present study. The flour was prepared according to Reis et al. (2019), at the Food Science and Technology Laboratory at Embrapa Cassava & Fruits, located in Cruz das Almas - Bahia, Brazil.

Step 1: Development and selection of a formulation

Cake processing

Four cake formulations were elaborated (Table 1), and the most sensory accepted one was used as a starting point for developing new formulations in step 2.

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Table 1
Cake formulations developed in step 1 of the study

Ingredient (%)	E1F1	E1F2	E1F3	E1F4
GBF*	17.57	16.05	16.46	15.12
Oat flour	20.27	18.52	18.99	17.44
Eggs	29.46	26.91	27.59	25.35
Raw sugar	10.81	9.88	10.13	9.30
Baking powder	1.08	0.99	1.01	0.93
Coconut milk	20.27	18.52	18.99	17.44
Cinnamon powder	0.54	0.49	0.51	0.47
50% cocoa powder	---	---	6.33	5.81
Dried banana	---	8.64	---	8.14

*GBF - green banana flour; E1F1 - control (no dried banana or 50% cocoa powder); E1F2 - formulation with dried banana; E1F3 - formulation with 50% cocoa powder; E1F4 - formulation with 50% cocoa powder and dried banana.

The ingredients were weighed individually and homogenized until a homogeneous dough was obtained, which was later baked in a rectangular pan at 200 ºC for 25 min.

Sensory evaluation

The study was approved by the Research Ethics Committee (authorization registered under the number CAAE: 17106213.1.0000.0053).

The sensory evaluation of the cake was performed by 47 untrained assesors. The tests were conducted in individual booths, on the same day the cakes were produced. Samples were served in pieces of 4 × 4 cm, inside a paper liner for mini-cakes that was encoded with three-digit random numbers. Acceptability was evaluated regarding color, aroma, flavor, texture/softness attributes, and overall acceptance, using a nine-point hedonic scale ranging from "I extremely dislike" to "I extremely like", according to Stone and Sidel (2010). Approval percentages for sensory attributes were calculated based on the sum of scores equal to or greater than six. The purchase intention was evaluated using a five-point scale anchored from "would certainly buy" (5) to "would certainly not buy" (1). The five-point ideal scale was also applied to evaluate the sweetness and texture/softness attributes, as described by V. L. P. Ferreira et al. (2000) and Berilli et al. (2011).

Stage 2: Development and evaluation of new formulations with different GBF contents

Cake processing

The E1F4 formulation, which contained 15.43% GBF was used as a starting point for the proposal of four new formulations, aiming to increase the RS content of the product, as shown in Table 2. The GBF contents of the new formulations maintained the approximate proportions of 14, 18, 22, and 26% GBF. A cake without GBF (control) was also prepared to compare its composition with the other formulations.

Table 2
Formulations of cakes with different GBF contents developed in step 2 of the study

Ingredient (%)	Control	E2F1	E2F2	E2F3	E2F4
Oat flour	28.67	14.95	11.06	6.55	2.25
GBF*	-	13.72	17.61	22.12	26.42
Eggs	22.32	22.32	22.32	22.32	22.32
Raw sugar	8.19	8.19	8.19	8.19	8.19
Baking powder	0.82	0.82	0.82	0.82	0.82
Coconut milk	27.30	27.30	27.30	27.30	27.30
Cinnamon powder	0.41	0.41	0.41	0.41	0.41
50% cocoa powder	5.12	5.12	5.12	5.12	5.12
Dried banana	7.17	7.17	7.17	7.17	7.17

*GBF - green banana flour; Control - without GBF; E2F1 - 14% GBF; E2F2 - 18% GBF; E2F3 - 22% GBF; E2F4 - 26% GBF.

Physicochemical evaluation and proximate composition

These analyses were conducted only for the cake formulations developed in the second step of the study.

The cakes were subjected to color analysis using the Konica Minolta® colorimeter and the CIELAB color system. The device was calibrated with a white ceramic plate, using the D65 illuminant (z = 93.6; x = 0.3133; y = 0.3195). The parameters of L* (lightness), C* (chroma), h* (hue), a* (green/red component) and b* (blue/yellow component) were evaluated.

Moisture, ash, and protein contents were also determined according to Instituto Adolfo Lutz [IAL] (2008).

Lipids were quantified following the method proposed by Bligh and Dyer (1959). Total carbohydrates were estimated as the difference between 100 and the sum (in percentage terms) of moisture, ash, lipid, protein, and fiber values. The total calorific value was calculated from the proximate composition data, using the conversion factors of 4 kcal for carbohydrates and protein and 9 kcal for lipids (Araújo & Menezes, 2005).

The RS content was obtained as proposed by Goñi, Garcia-Diz, Eva and Calixto (1996); the main steps of analysis consisted of the removal of proteins and digestible starch as well as enzymatic solubilization and hydrolysis of the RS, for its subsequent quantification as released glucose.

The total dietary fiber content was determined by the AOAC 985.29 enzymatic-gravimetric method (Prosky, Asp, Devries, Schweizer & Harland, 1985).

Three experimental replicates were conducted, and each analysis was performed in triplicate.

Sensory evaluation

In step 2, the sensory acceptance test was performed, on a laboratory scale, by 45 untrained assessors. The test was conducted

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in a randomized-block design in which the same evaluations described in item 2.3 were performed. In this step, the four formulations containing GBF were served to the assessors.

Statistical analysis

Three experimental replicates were carried out in a completely randomized design to produce the cakes, and the physicochemical evaluation data were subjected to analysis of variance. In the case of a significant F (p<0.05), means were compared by Tukey's test at 5% probability, using SISVAR software version 5.3 (D. F. Ferreira, 2010).

For the sensory evaluation, a randomized-block design was followed, where each assessor represented an experimental replicate.

Results and Discussion

Step 1 - Development and selection of a formulation

Sensory evaluation of the cake

Table 3 shows the results of the sensory acceptance test and the approval percentages (scores from 6 to 9) of the cakes made with GBF. There were differences between the formulations for the five attributes evaluated.

In terms of color, the assessors preferred formulations E1F3 and E1F4, which included 50% cocoa powder in common, which shows that consumers prefer the dark brown color of the cake. Fasolin, Almeida, Castanho and Netto Oliveira (2007) developed cookies with GBF and reported a similar consumer behavior, with a preference for the darker cookies.

Table 3
Average hedonic values and approval percentage of cakes with GBF

Formulation	Color		Aroma		Flavor		Texture/softness		Overall acceptance	
	Avg.[1]	Apv.[2]	Avg.[1]	Apv.[2]	Avg.[1]	Apv.[2]	Avg.[1]	Apv.[2]	Avg.[1]	Apv.[2]
E1F1	5.71[b]	66.67	6.06[c]	64.44	5.68[c]	57.78	5.56[c]	62.22	5.57[c]	59.09
E1F2	6.00[b]	71.11	6.68[b]	82.22	6.73[bc]	84.44	6.33[bc]	73.33	6.62[b]	86.67
E1F3	7.77[a]	97.78	6.70[b]	80.00	6.40[ab]	80.00	5.96[ab]	68.89	6.55[b]	82.22
E1F4	7.90[a]	100	7.24[a]	86.67	7.40[a]	95.45	6.90[a]	82.22	7.50[a]	97.78

E1F1 - control (without the addition of dried banana or 50% cocoa powder); E1F2 - formulation with dried banana; E1F3 - formulation with 50% cocoa powder; E1F4 - formulation with dried banana and 50% cocoa powder; (1) Average of hedonic scores (n = 47) on a nine-point scale; (2) Approved; results expressed as a percentage of scores ≥ 6. Means followed by common letters in the column do not differ at 5% by Tukey's test.

Formulation E1F4 showed greater acceptance in terms of aroma, differing statistically from the others, with an average score of 7.24 and an approval percentage of 86.67%. Indeed, the combination of dried banana with 50% cocoa powder provided an aroma that pleased the cake consumers.

The consumers noticed a significant difference in flavor between formulations E1F1 and E1F4, with a higher percentage of

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approval for the E1F4 (95.45%). This result indicates that the addition of 50% cocoa powder and bananas contributed positively to improving the flavor of the formulations, and the association of the two ingredients provided the best result for this attribute. The same observation can be made for texture/softness and overall acceptance, as the approval percentages increased due to the addition of dried banana and 50% cocoa powder. Formulation E1F4 presented the highest score for overall acceptance, indicating the preference of the assessors for this formulation. In general, formulation E1F1 had a lower acceptance percentage (above 57%) for all evaluated attributes. The results indicate that the use of GBF in cake formulations is promising from a sensory point of view, especially when associated with 50% cocoa powder and dried banana.

Regarding the ideal scale, most consumers considered the sweetness of formulations E1F2 and E1F4 to be ideal (Figure 1A). Considering dried banana as the common ingredient in these two formulations is, it can be concluded that this ingredient positively interfered with the acceptance of the product's sweetness. Texture/softness was considered not very soft in formulations E1F1, E1F2 and E1F3; however, formulation E1F4 stood out in this attribute, with most assessors classifying it as ideal (Figure 1B).

Figure 2 illustrates the results of the purchase intention of the cakes. Adding the "would certainly buy" and "would probably buy" categories, the highest purchase intent is seen for formulation E1F4 (75.55%) and the lowest for formulation E1F1 (22.22%), corroborating the acceptance test (Table 3).

Formulation E1F4 was the most accepted for all evaluated attributes and showed ideal sweetness and texture/softness as well as high purchase intent. Therefore, it was chosen as the starting point for developing four different new formulations, which contained the same ingredients, in step 2.
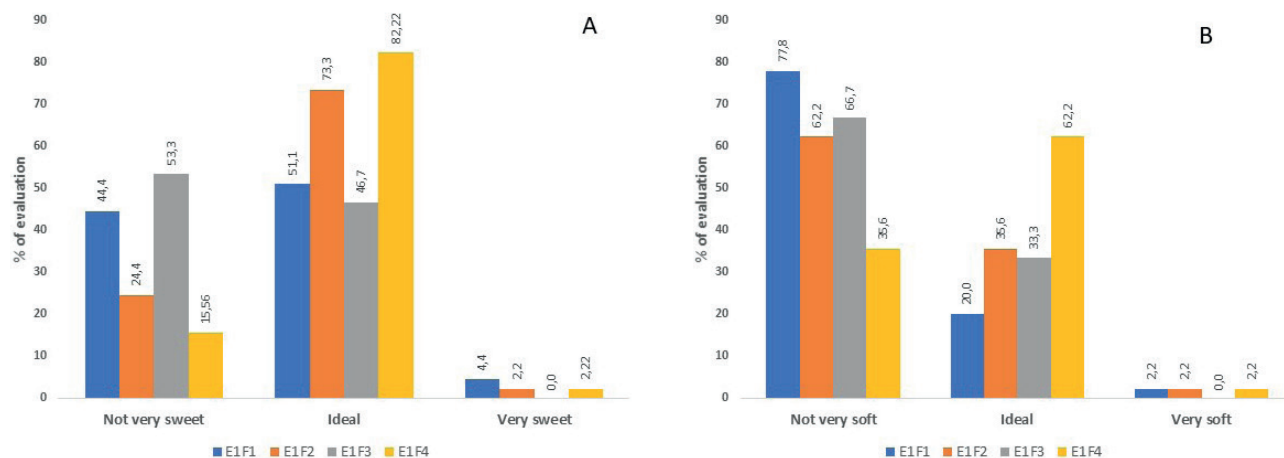

Figure 1. Evaluation of sweetness (A) and texture/softness (B) of cakes made with GBF by assessors*, according to the ideal scale.
E1F1 - control (without the addition of dried banana or 50% cocoa powder); E1F2 - formulation with dried banana; E1F3 - formulation with 50% cocoa powder; E1F4 - formulation with dried banana and 50% cocoa powder; Percentage of scores *n=47.
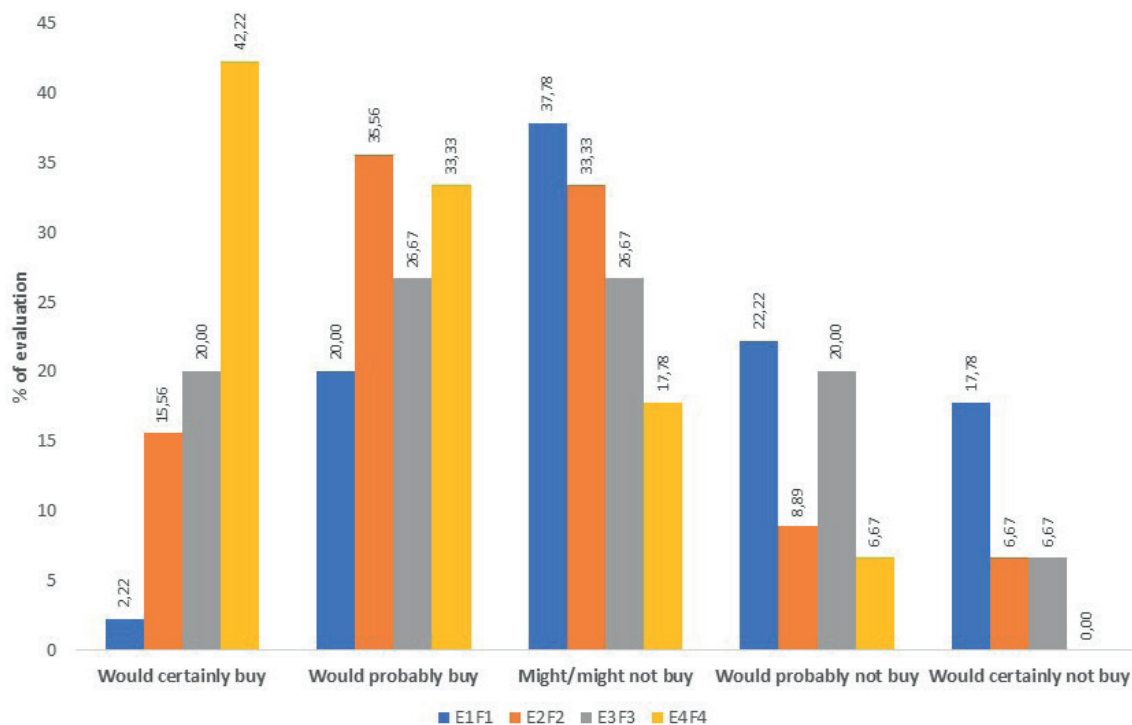
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Figure 2. Purchase intent for cakes made with GBF by assessors*.
E1F1 - control (without the addition of dried banana or 50% cocoa powder); E1F2 - formulation with dried banana; E1F3 - formulation with 50% cocoa powder; E1F4 - formulation with dried banana and 50% cocoa powder; Percentage of scores *n=47.

Stage 2- Development and evaluation of new formulations with different GBF contents

Physicochemical characterization and proximate composition of the cakes

The addition of GBF to the cake formulations increased the RS content (Table 4). The observed increase was of the orders of 7.2, 8.3, 14.9, and 17.9 times, respectively, in formulations E2F1, E2F2, E2F3 and E2F4, relative to the control. Andrade, Perius, Mattos, Luvielmo and Mellado (2018) used GBF associated with whole wheat flour to prepare whole wheat bread and reported that the formulations with higher GBF contents (15%

and 20%) had significantly higher RS contents when compared with the control formulation.

A higher ash value was detected in formulation E2F4 compared with E2F1 and E2F2, suggesting that this formulation is the richest in minerals. Borges, Pereira and Lucena (2009) reported that GBF has a high mineral content when compared with other types of flours on the market, which may explain the increase in ash content as the concentration of GBF in the cakes was increased. In contrast, Viana, Souza, Reis and Oliveira (2018) found no difference in ash content after using different concentrations of GBF (15%, 20%, and 25%) in the partial replacement of wheat flour in sliced bread.

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Table 4
Physicochemical characteristics of cakes made with GBF

Evaluated trait	E2F1	E2F2	E2F3	E2F4	Control	Mean
Resistant starch (%)	2.31^c	2.67^c	4.77^b	5.73^a	0.32^d	3.16*
Ash (%)	1.96^b	1.96^b	2.11^{ab}	2.22^a	2.08^{ab}	2.07*
Lipids (%)	10.48^{ab}	8.78^{ab}	9.74^{ab}	8.49^b	11.58^a	9.81*
Moisture (%)	32.23	32.76	34.17	33.12	34.01	33.26^{ns}
Protein (%)	8.07b	7.34c	6.84^{cd}	6.63^d	9.48^a	7.67*
Total dietary fiber (%)	9.85	10.80	8.90	9.85	7.10	9.30^{ns}
Carbohydrates (%)	36.50	37.40	36.41	39.04	35.74	37.02^{ns}
Total calorific value (kcal 100 g^{-1})	272.76	252.50	264.84	259.75	284.41	266.85^{ns}
L*	31.66	32.53	30.41	31.5	30.44	31.37^{ns}
a*	9.45	10.35	9.6	9.4	9.35	9.65^{ns}
b*	10.88	13.11	10.99	11.31	10.37	11.4010^{ns}
C*	14.42	16.71	14.48	14.66	13.97	14.91^{ns}
h*	48.79	51.7	48.75	49.96	47.96	49.54^{ns}

E2F1 - 14% GBF; E2F2 - 18% GBF; E2F3 - 22% GBF; E2F4 - 26% GBF; Control - without GBF.
n. s. = not significant at 5% by Tukey's test; *= significant at 5% by Tukey's test. Means followed by common letters in the rows do not differ at 5% by Tukey's test.

There was also a significant difference in the lipids and protein contents of the formulations (Table 4). Lipids were highest in the control formulation (11.58%) and lowest in formulation E2F4 (8.49%). Protein results were similar, with the highest content occurring in the control formulation (9.48%), which decreased as the GBF content in the formulations was increased. This result can be explained by the fact that the formulation of control treatment includes a greater amount of oat, an ingredient with a higher lipid and protein content relative to GBF. According to Sandrin (2013), oat is a cereal whose structure is different from the others, and in addition to having a high lipid content distributed throughout the entire grain, it is also rich in protein. Unlike the present study, Freitas et al. (2017) did not observe significant differences in the lipid and proteins levels in honey breads made with 30% cooked GBF (banana varieties Prata and Grande Naine) partially replacing wheat flour.

The mean values of L*, a*, b*, C*, and h* showed that the cake had an intense dark brown color. There was no significant difference between the formulations for these variables (Table 4) since 50% cocoa powder the main ingredient responsible for the color was used in the same proportion in all formulations.

The use of different concentrations of GBF in the formulations did not interfere with moisture, which averaged 33.26% (Table 4). This value was close to the 35.5% found by Galeano and Rezende (2013), who developed a cake formulation with 15% passion fruit peel flour. The moisture content found by Chiareli, Silva, Marchiori and Mello (2017), who

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developed a cake formulation containing oat flour and chia grains, was 33.49%, a value also similar to that found in the present study. It is important to emphasize that products with high moisture favor the development of deteriorating microorganisms, directly influencing the product's shelf life.

There was no variation in the content of total dietary fiber (mean value of 9.30%) or carbohydrates (mean value of 37.02%) (Table 4). In the study by Chiareli et al. (2017), who developed a cake based on oat flour and chia, the results for dietary fiber and carbohydrates were 8.59% and 31.03%, respectively. These values were relatively close to those found in the present study.

In Brazil, the Ministry of Health allows the designation of "fiber source" for industrialized products that contain at least 2.5 g of fiber per serving (ANVISA, 2012). Considering that the portion of cake in Brazil is 60 g (ANVISA, 2003), it can be considered that the consumption of a portion of the food prepared in this study will bring benefits to health, as it would contribute 5.58 g of fiber to the diet.

The caloric values of the four formulations did not differ, either, with a mean value of 266.85 kcal 100 g^{-1} (Table 4). In the study by Carneiro (2015) to evaluate a cake formulation based on oat, quinoa, and flaxseed flour, the authors found 321.58 kcal 100 g^{-1}, an energy value higher than that obtained in this study.

Based on the presented results, the addition of GBF to the cake did not change its physicochemical traits or proximate composition, but considerably increased its RS content, suggesting that it is a functional ingredient that can be added to increase the nutritional value of the product.

Sensory evaluation

Sensory evaluation was carried out only with formulations that included GBF in their composition. There was no significant difference between the cakes for the attributes of color or aroma, and approval percentages were above 77% for all formulations, indicating high acceptance of these attributes (Table 5).

Table 5
Average hedonic values of cakes prepared with different GBF concentrations

Formulation	Color		Aroma		Flavor		Texture/ softness		Overall acceptance	
	Avg.[1]	Apv.[2]	Avg.[1]	Apv.[2]	Avg.[1]	Apv.[2]	Avg.[1]	Apv.[2]	Avg.[1]	Apv.[2]
E2F1	7.64	97.78	6.80	82.22	6.80a	84.44	6.36a	75.56	6.73a	82.22
E2F2	7.60	97.78	6.93	84.44	6.73a	80.00	6.00a	62.22	6.62a	80.00
E2F3	7.62	100.00	6.87	82.22	6.16b	71.11	5.51b	60.00	6.20b	77.78
E2F4	7.51	100.00	6.69	77.78	5.62b	60.00	4.93b	51.11	5.84b	68.89
Mean	7.59[n.s.]	-	6.82[n.s.]	-	6.33*	-	5.70*	-	6.35*	-
CV (%)	0.007	-	0.015	-	0.087	-	0.108	-	0.064	-

E2F1 - 14% GBF; E2F2 - 18% GBF; E2F3 - 22% GBF; E2F4 - 26% GBF.
n.s. = not significant at 5% probability by the F test; * = significant at 5% probability by Tukey's test; ([1]) Average of hedonic scores (n = 45) on a nine-point scale; (2) Approved; percentage of scores ≥ 6. Means (n = 45) followed by common letters in the column do not differ at 5% by Tukey's test.

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In terms of flavor, there was a preference for the formulations with lower levels of GBF (E2F1 and E2F2), whose approval percentages were both higher than 80%. For the texture/softness attribute, formulations E2F1 and E2F2 were also highlighted, achieving greater acceptance (greater than 62%). Finally, the overall acceptance item confirms the preference for these formulations, with over 80% of approval (Table 5).

Because the four formulations only differed in the GBF and oat contents, the addition of GBF above 18% was found to reduce the acceptance of the attributes of taste and texture/softness, as well as overall acceptance (Table 5). Loong and Woong (2018) also observed less texture acceptance in steamed Chinese breads after incorporating 15% GBF in the formulations, with mean values between 5.2 and 6.71.

C. K. O. Andrade (2013) found a similar result after preparing cookies enriched with GBF at the concentrations of 10%, 20%, and 30%. The author described greater acceptance for those with 10% GBF and a reduction in acceptance in those with 30% of the ingredient, demonstrating that the assessors preferred cookies with lower levels of GBF, probably because they resemble other cookies usually consumed.

Although the raw sugar content in the four formulations was the same, most assessors considered the sweetness of the formulations with 14% (E2F1) and 18% (E2F2) GBF to be ideal, with acceptance values of 66.7% and 55.6% (Figure 3A), respectively, whereas the formulations with 22% GBF (E2F3) and 26% GBF (E2F4) were considered as having ideal sweetness by 46.7% and 47.7% of assessors, respectively.
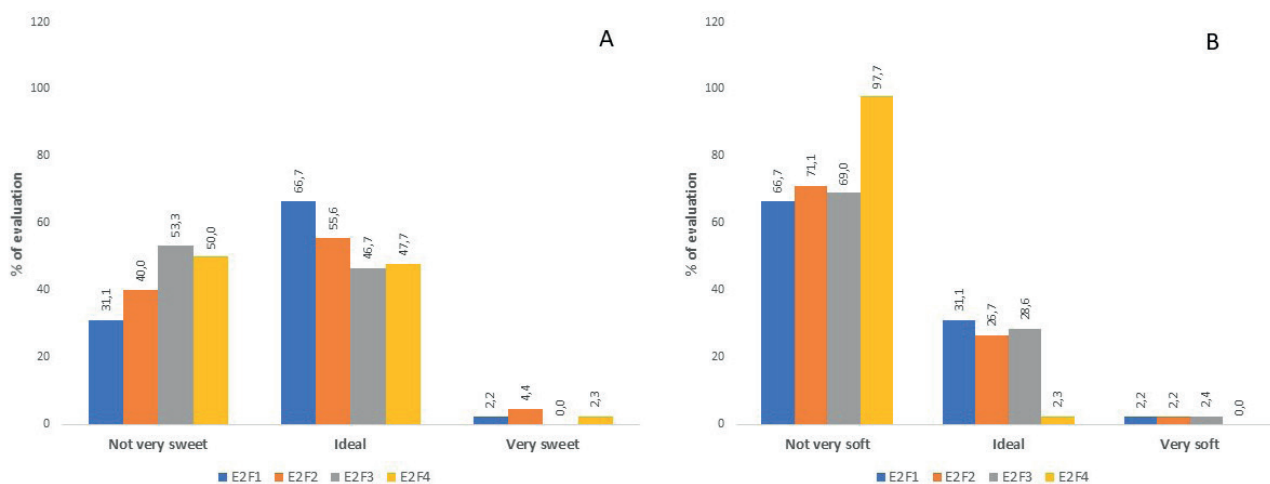

Figure 3. Evaluation of sweetness (A) and texture/softness (B) of cakes made with different concentrations of GBF by assessors*, according to the ideal scale
GBF: green banana flour; E2F1 - 14% GBF; E2F2 - 18% GBF; E2F3 - 22% GBF; E2F4 - 26% GBF; *n=45

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As for the ideal scale, regarding the texture/softness attribute, all formulations were considered not very soft (Figure 3B), and the formulation with the highest GBF content (E2F4) was considered the least soft by 97.7% of assessors.

This result occurred because products without wheat flour tend to be harder than products made with common wheat flour.

In this respect, Vieira, Freitas, Silva and Barbosa (2015) conducted a study on the effect of replacing wheat flour in the preparation of gluten-free cookies with cassava starch, soy flour, quinoa, and amaranth flour. Sensory analysis revealed, regarding the texture attribute, a higher preference for the control cookie (based on wheat flour), which allows us to conclude that the other flours used in the study also changed the texture characteristics of the cookies, reducing their acceptance by consumers.

Figure 4 shows the results of the purchase intention test of the cake formulations. Adding the scores of "would certainly buy" and "would probably buy" categories, a reduction is observed in purchase intent as the GBF content in the product is increased, with 53.33% of consumers stating they would buy the cake containing 14% GBF, while only 24.24% would buy the cake containing 26% GBF.
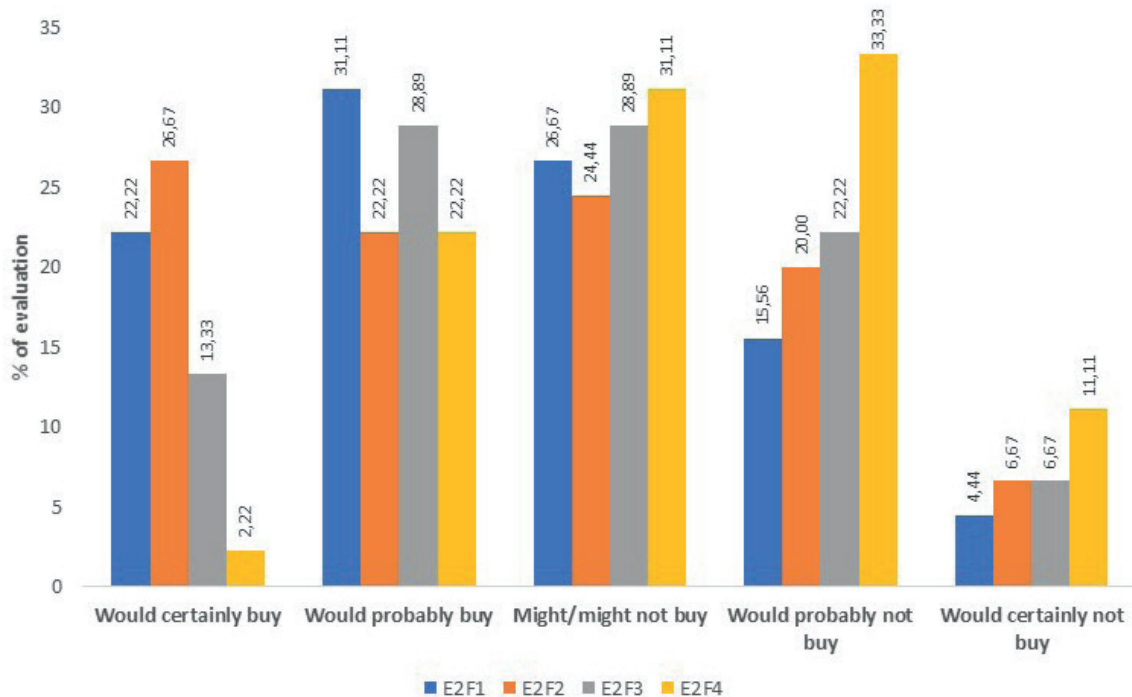

Figure 4. Purchase intent for cakes made with different concentrations of GBF by assessors. E2F1 - 14% GBF; E2F2 - 18% GBF; E2F3 - 22% GBF; E2F4 - 26% GBF; *n=45

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Conclusions

The addition of 14 and 18% green banana flour to the formulations contributed to the development of products of high sensory acceptance, high purchase intent, and resistant starch contents 7.2 and 8.3 times higher, respectively, than those in the cake without the addition of green banana flour.

Acknowledgments

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