Revista Ciência Agronômica, v. 53, e20207297, 2022
Centro de Ciências Agrárias - Universidade Federal do Ceará, Fortaleza, CE
www.ccarevista.ufc.br

Scientific Article
ISSN 1806-6690

Technological applicability of mama-cadela (*Brosimium gaudichaudii* Trecúl) seed flour in gingerbread[1]

Aplicabilidade tecnológica da farinha de sementes de mama-cadela (*Brosimum gaudichaudii* Trecúl) em pão de Mel

Vânia Maria Alves[2], Eduardo Ramirez Asquieri[3], Clarissa Damiani[3]

ABSTRACT - The objective of this paper was the partial addition of mama-cadela seed flour in the production of gingerbread with chocolate coating for a partial substitution of wheat flour (15 percent and 25 percent relative to flour), in order to verify its contributions to the chemical, physical properties of the product developed. After the analyses, again observed that the mama-cadela seed flour had an improvement regarding a few chemical parameters, such as an increase; in the amount of ashes in the gingerbread with chocolate coating with 15 percent mama-cadela seed flour and 25 percent mama-cadela seed flour, respectively (1.20 percent, 1.37 percent); the gingerbread with 25 percent of mama-cadela seed flour showed lower water activity, favoring the product life; texture proved softer and more pleasant for the gingerbread with coating. Therefore, we conclude that the substitution of wheat flour with mama-cadela seed flour it is a viable and nutritious option, not only prevents seed waste, but has a positive effect on the physical, chemical characteristics of the gingerbread.

Key words: Exploitation of coproducts. Baked goods. Flavoring. Nutritional enrichment.

RESUMO - Objetivou-se com o presente trabalho adicionar, parcialmente, a farinha de semente de mama-cadela (FSMC) em pão de Mel com cobertura de chocolate em substituição parcial de farinha de trigo, verificando as contribuições da mesma sobre as propriedades químicas e físicas do produto desenvolvido. Foram realizadas análises de umidade, atividade de água e granulometria na FSMC e analisou-se composição proximal, pH, acidez total titulável, sólidos solúveis, potencial antioxidante, diâmetro da base, superfície e altura, volume especifico, cor, textura e microscopia eletrônica de varredura (MEV) no pão de mel. Após as análises, notou-se que a FSMC agregou melhoria em alguns parâmetros químicos como; aumento da quantidade de cinzas no pão de mel com cobertura de chocolate com 15% FSMC e 25% FSMC, respectivamente (1,20%, 1,37%), e a textura mostrou-se mais leve e agradável ao paladar no pão de mel com cobertura. Conclui-se, portanto, que a substituição de farinha de trigo por FSMC, além de evitar o desperdício da semente, afetou de maneira positiva, as características físicas e químicas do pão de mel.

Palavras-chave: Aproveitamento de coprodutos. Panificados. Especiarias. Enriquecimento nutricional.

DOI: 10.5935/1806-6690.20220001
Editor-in-Article: Prof. Alek Sandro Dutra - alekdutra@ufc.br
*Author for correspondence
Received for publication on 13/04/2020; approved on 17/08/2021
[1]Artigo proveniente do Trabalho de Conclusão de Curso do primeiro autor e financiado pelo Programa de Iniciação cientifica, Universidade Federal de Goiás
[2]Programa de Pós Graduação em Ciência e Tecnologia de Alimentos, Universidade Federal do Tocantins, Tocantins-TO, Brasil, vanialvees@gmail.com (ORCID ID 0000-0003-3949-6691)
[3]Faculdade de Farmácia e Escola de Agronomia, Universidade Federal de Goiás, Goiânia-GO, Brasil, asquieri@gmail.com (ORCID ID 0000-0003-3312-8003), damianiclarissa@hotmail.com (ORCID ID 0000-0001-8507-0320)

INTRODUCTION

Many fruit species in Brazil are unknown, and therefore, relatively few fruit species are commercially available (MATTIETTO; LOPES; MENEZES, 2010). Cerrado, is a Brazilian biome that have a large number of underexploited native and exotic fruit species, which is of potential interest to agroindustry and a possible future source of income for the local population (ALMEIDA *et al*., 2011).

The *Brosimium gaudichaudii* Trecúl, also known as *mama-cadela*, *mamica-de-cadela*, *mamica-de-porco*, *mamica-de-cachorra*, has an edible part fleshy and the wood of its tree is commonly used in the manufacture of furniture. Other parts of mama-cadela (peels, roots and leaves) are also used in medicine, especially in the treatment of vitiligo, whose active principles are fucoumarins, bergapten and psoralen (SILVA *et al*., 2011). On the other hand, mama-cadela is also important to feed the population of Cerrado, being mixed with cassava flour, forming a paste consumed as a food supplement. In addition, mama-cadela also has a sweet taste and texture similar to chewing gum, and is highly appreciated by children (JACOMASSI; MOSCHETA; MACHADO, 2010).

Considering its integral exploitation and the current changes in the habits of consumers seeking more natural products to provide health benefits, the use of mama-cadela seed as a co-product in the development of bakery products can be an alternative to the integral exploitation of the fruit. Therefore, find another destination for waste other than disposal, you have as a focus of study for many researchers, using as a main alternative preparation of fruit and vegetable flours and application in food products of different areas, mainly in the bakery industry, always touching or enriching nutritional value of commercial food formulations. These alternative formulations have been assessments regarding their nutritional quality and sensory acceptance (ADE; LAL; RATHID, 2014; KAROVICOVÁ; MAGALA, 2013; MENON; MAJUMDAR; RAVI, 2014).

Gingerbread is a popular product of great acceptance and many different preparation processes; it is considered by many as a cookie or even biscuit (POSSAMAI; WASZCZYNSKYJ; POSSAMAI, 2009). The cake is a product made of flour, sugar, fat, baking powder and egg, which after being baked is baked and sweet (EKE; ACHINEWHU; SANI, 2008).

Considering the current changes in food habits, especially regarding the addition of integral products, the objective of this study is the technological application of *Brosimum gaudichaudii* Trecúl (mama-cadela) seed flour as partial substitution of wheat flour in the production of gingerbread with chocolate coating or icing, as well as the assessment of the physical, chemical characteristics of the product.

MATERIAL AND METHODS

The seeds of mama-cadela (SMC) were purchased at the *Fábrica Frutos do Brasil*, in Goiânia-Go. The SMC were selected considering the evidence of defects, plagues, rot, and dirt, and subsequently washed under running water, sanitized with sodium hypochlorite solution (concentration of 200 ppm) for 20 minutes, and followed to water draining.

Again inserted the SMC in a forced-air circulation oven, at the temperature of 60 ºC ± 3 ºC, until obtaining a ten percent moisture. After the drying process, the seeds were milled in an industrial blender (Siemsen Imago) for the production of flour. Subsequently, the flour was distributed in stainless steel containers and subjected to electric-furnace roasting (LAYR/LUXO 2.4) at the temperature of 130 ºC for ten minutes. After this procedure, the roasted flour was stored in high-density plastic bags covered with aluminum foil and kept in a freezer (ELETROLUX-F25) at -18 °C until the development of the products and the physical, chemical analyses.

The production of gingerbread involved the use of wheat flour, refined sugar, milk, honey, cinnamon, ground clove, sodium bicarbonate, and chocolate bar purchased at the local commerce of Goiânia- Go.

Production of gingerbread

Chance to developed two formulations with different concentrations of mama-cadela seed flour (MCSF) (15 percent and 25 percent) with chocolate coating from a standard formulation of gingerbread. Table 1 presents the different formulations used in the production of gingerbread. The formulation was previously tested without MCSF addition for standardization.

Again proceeded with the ingredients mixture using two stages: the preparation of a cream with honey, sugar, and margarine in a domestic blender with the mixture (PHILIPS, R2008) inserted in a plastic bowl added with the remaining ingredients, cinnamon and ground clove, ground bicarbonate, followed by wheat flour and MCSF, and milk. Finally, we inserted the mass in a furnace (LAYR/LUXO 2.4) at 180 °C for 25 minutes to be subsequently bathed in melted chocolate.

Chemical physical characterization

Granulometry, water of activity, and moisture were established in the MCSF, while the analyses of proximal composition, color, texture, pH, soluble solids, water activity, total titratable acidity, specific volume, scanning electron microscopy, base dimension, surface and height, and antioxidant activity were established for the gingerbread produced. All of the analyses were conducted in five repetitions.

Table 1 - Ingredients for the production of gingerbread with the application of MCSF as partial substitution of wheat flour

Ingredients	Treatments		
	Control	15% MCSF	25% MCSF
Wheat flour [g]	264	224	200
MCSF* [g]	-	40	64
Refined sugar [g]	132	132	132
Milk [mL]	160	160	160
Unsalted margarine [g]	40	40	40
Honey [mL]	70	70	70
Cinnamon [g]	2	2	2
Ground clove [g]	1	1	1
Sodium bicarbonate [g]	10	10	10

*MCSF (mama-cadela seed flour)

Proximal composition and caloric value

Again established the proximal composition using the analyses of moisture according to a technique described by the Association of Official Analytical Chemists (2012); total nitrogen according to the micro-Kjeldahl method (ASSOCIATION OF OFFICIAL ANALYTICAL CHEMISTS, 2012); total lipids by Bligh and Dyer (1959); and fixed mineral residue (ASSOCIATION OF OFFICIAL ANALYTICAL CHEMISTS, 2012). The content of carbohydrates was calculated using the difference method subtracting a hundred from the values of moisture, ashes, proteins, and lipids. The energy values were estimated through the ATWATER coefficients (carbohydrates = 4.0 kcal g^{-1}; lipids = 9.0 kcal g^{-1}; proteins = 4.0 kcal g^{-1}) (MERRIL; WATT, 1973). Again used a digital potentiometer (MICRONAL-B474) to establish pH, the titration of the sample with NaOH 0.1N for the total titratable acidity, and a digital refractometer (REICHET AR200) for the content of total soluble solids using the Brix concentration reading of the sample at 20 °C (ASSOCIATION OF OFFICIAL ANALYTICAL CHEMISTS, 2012).

Antioxidant activity

Again used the DPPH method (2.2 diphenyl-1-picrilhydrazyl) to establish the antioxidant potential according to Brand-Williams, Cuvelier and Berset (1995), with modifications by Borguini and Torres (2009). The degree of discoloration of the DPPH radical at 517 nm by the action of antioxidants was measured spectrophotometrically (BIOSPECTRO SP-220) in the ether, ethanol, and aqueous extracts, with results expressed in discoloration percentage. The absorbance readings of the samples were conducted after a two-minute reaction.

Granulometry and activity of water (aw)

The granulometry analysis was carried out in vibration platform (sieve shaker, Bertel), with sieves distributed according to the mesh aperture (the smallest aperture below and the biggest above) during ten minutes through the determination of the amount of the sample retained in each sieve (ASSOCIATION OF OFFICIAL ANALYTICAL CHEMISTS, 2012). Again established the water of activity using the Aqualab (Aqualab CX–2) equipment with direct reading of the sample.

Specific volume, base and surface diameters and height

Again established the specific volume according to a methodology described by Camargo *et al.* (2008) using the millet displacement method. Again used a digital pachymeter (VERNIER CALIPER IVE0-150MM) to obtain the base and the surface diameters as well as height, expressed in mm.

Color

Color was established through the reading of the defined parameters using the CIELAB system. Parameters a^* and b^* were provided by the colorimeter (Hunterlab, ColorQuest II) with a^* and b^* defining chromaticity ($+a^*$ red and $-a^*$ green, $+b^*$yellow and $-b^*$ blue), and the chrome was estimated using equation one.

$$Chrome = \sqrt{\alpha^{*2} + b^{*2}} \quad (1)$$

Texture

Again established the analysis of the texture profile using a texturometer (TextureAnalyser, TA-XT Plus, Surrey, England) through the direct reading of the sample, with parameters established using a probe compression on the sample, with pre-test, test, and post-test velocities of 1.0 mm/s, 1.7 mm/s, and 10 mm/s, respectively, and deformation rate of 40 percent using a probe 100 mm. Shear analysis was carried out through a section in the sample, with pre-test, test, and post-test velocities of 1.0 mm/s, 1.7 mm/s, and 10 mm/s, respectively, and deformation rate of 150 percent.

Scanning electron microscopy (SEM)

The samples of gingerbread were degreased through lipid extraction, dried out at 60 °C, and subsequently dried at CO_2 critical point including a sample holder of four cavities and coating with conductor material (gold) through sputtering. The capture of the images was carried out using a Scanning Electronic Microscope (SEM), Jeol, JSM – 6610, equipped with EDS, Thermos scientific NSS Spectral Imaging.

Statistical analysis

A simple completely randomized design (DIC) was performed, with 3 treatments, in triplicate with five replications. After the analysis of variance, we proceeded with the selection base on the significance of the Tukey test, with a five-percent probability, for each model tested, as well as the determination coefficient using the software SISVAR (FERREIRA, 2014).

RESULTS AND DISCUSSION

Chemical results

The values observed in the mama-cadela seed flour were 0.087 ± 0.006 for water of activity and 10 ± 2 percent for moisture, below the maximum limit of 15 percent for moisture, preconized for flours according to the Resolution RDC 263 (BRASIL, 2005). Through the granulometry analysis, again obtained the index of uniformity for mama-cadela seed flour with the values of three for coarse particles, four for medium particles, and two for fine particles, with a predominance of medium particles.

Table 2 expresses the results of the chemical composition of the gingerbread with chocolate coating or icing and application of MCSF as partial substitution of wheat flour.

According to Brazilian legislation, cookies must contain maximum 14% water content, so the honey breads formulated independently of the treatment, are consistent within standards (BRASIL, 2005). Small letters on a single line and capital letters on a single column have no statistical difference among each other at five percent according to Tukey test. The higher contents of ashes were found in the treatment with 25 percent MCSF; in contrast, the control treatment was similar to the treatment with 15 percent MCSF, indicating that the 15 percent MCSF were not sufficient to alter the amount of minerals in the gingerbread. The replacement of wheat flour with bark flour or fruit seeds in food formulations aims to increase the nutritional value of the product without interfering positively in protein content (CARVALHO *et al*., 2012; SANTOS; STORCK; FOGAÇA, 2014), a fact observed in this study, since the treatments did not differ statistically at ($p \leq 0.05$). Again also observed that the MCSF addition had no effect on lipids, carbohydrates, and caloric value.

The content of total soluble solids decreased according to the addition of MCSF, probably because

Table 2 - Chemical composition of the gingerbread chocolate coating including MCSF as partial substitution of wheat flour

Analysis	Treatments		
	Control	15% MCSF*	25% MCSF*
Moisture [%]	11.24 a ± 2.73	12.06 a ± 3.28	13.35 a ± 1.93
Ashes [%]	1.20 b ± 0.00	1.20 b ± 0.07	1.37 a ± 0.14
Proteins [%]	4.90 a ± 0.30	5.35 a ± 0.48	5.50 a ± 0.24
Lipids [%]	19.66 a ± 0.80	18.58 a ± 1.14	16.58 a ± 1.16
Carbohydrates [%]	74.29 a ± 1.07	74.48 a ± 1.50	76.74 a ± 1.09
Caloric value [kcal]	493.57 a ± 4.21	488.23 a ± 5.93	477. 49 a ± 6.34
pH	8.35 a ± 0.20	7.83 b ± 0.020	7.68 c ± 0.05
Total titratable acidity [%]	0.0022 a ± 0.00	0.0028 a ± 0.00	0.0028 a ± 000
Total soluble solid [°Brix]	49 a ± 2.24	33 b ± 2.74	30 b ± 0.00
P.A Ether extract [%]	18.39 Ab ± 4.99	23.13 Aa ± 3.59	20.15 ABb ± 5.17
P. A Ethanol extract [%]	14.80 Aa ± 3.35	22.26 Ba ± 1.91	18.88 ABa ± 3.25
P. A Aqueous extract [%]	16.31 Aa ± 5.85	20.15 Ba ± 4.97	22.36 Aa ± 5.97

*MCSF = mama-cadela seed flour. Averages ± standard deviation. P.A= antioxidant potential of the decrease in acidity since total soluble solids are constituted of sugars and acids. By analyzing the antioxidant potential in the gingerbread with chocolate coating or icing and the application of MCSF as partial substitution of wheat flour, again assessed both the formulation with higher antioxidant potential in each extract and the most satisfactory extract for each formulation.

The assessment of the antioxidant potential of each extract revealed that for the ether extract, the treatment with 15 percent MCSF presented the highest percentage of discoloration, while both the ethanol and the aqueous extracts presented no difference ($p > 0.05$) for the different formulations. Regarding the efficiency of the extracts (ether, ethanol, and aqueous) in each formulation, again observed that in the control treatment as well as in the treatment with 25 percent MCSF, the different extracts presented no significant difference ($p > 0.05$), while the ether extract in the gingerbread with 15 percent MCSF had the highest antioxidant potential.

Therefore, for the gingerbread with chocolate coating or icing with the application of MCSF as partial substitution of wheat flour, the most satisfactory chemical results were found in the treatment with 25 percent MCSF; however, the treatment with 15 percent MCSF presented better antioxidant capacity with no variation for the remaining parameters analyzed.

Physical results

Table 3 shows the results of the physical analyses of gingerbread with the application of MCSF as partial substitution of wheat flour with chocolate coating or icing.

The water of activity (aw) in the gingerbread added with MCSF was low, according to the expectation for bakery products, not favoring microbiological development and allowing greater storage time. Shibao and Bastos (2011), among the following existing darkening variations, is highlighted in the reactions de Maillard, qualifies for a wide variety of foods to occur, significantly altering the color, flavor, nutritional value, antioxidant properties and texture of the food. Are factors determinants for the course of reaction to the processing of temperatures above 40 °C, or pH between 6 and 8 and activity of water from 0.4 to 0.7. therefore, in both the control treatment and the 15 percent MCSF treatment, it may have occurred a degrading decrease of the Maillard reaction, and the treatment with 25 percent MCSF may have favored this reaction, which can be corroborated through the analysis of color.

Gluten, responsible for extensibility, elasticity, viscosity and gas retention properties of the mass, contributes to the appearance and structure of the bread crumb. The gluten network is formed in bread of wheat flour due to the presence of two proteins, gliadins and glutenins, which, when combined with water and mixed together, they form a network capable of retaining fermentation, giving the dough elasticity (resistance to extension) and extensibility (CAPRILES; ARÊAS, 2011). Again observed that the addition of 25 percent MCSF had no influence on the formation of gluten structure, which is very beneficial, resulting in an attractive, pleasant gingerbread. Regarding the treatment with 15 percent MCSF, again observed a statistical difference in relation to the control, which, in this case, is not convenient, since the MCSF had direct

Table 3 - Physical characteristics of the gingerbread with chocolate coating or icing with the application of MCSF as partial substitution of wheat flour

Analysis	Treatments		
	Control	15% MCSF*	25% MCSF*
Water of water	0.8002 a ± 0.01	0.800 a ± 0.01	0.7704 b ± 0.00
Specific volume [cm^3g^{-1}]	4.90 a ± 0.32	4.20 a ± 0.41	4.52 ab ± 0.23
Base diameter [mm]	43.05 a ± 2.52	43.98 a ± 2.88	42.81 a ± 1.96
Surface diameter [mm]	59.10 a ± 4.55	57.90 a ± 6.41	56.48 a ± 3.94
Height [mm]	28.73 a ± 1.39	28.42 a ± 2.45	28.17 a ± 0.95
Mass [g]	4.20 b ± 2.79	4.52 a ± 3.73	4.90 a ± 2.45
b* [S]	4.77 ab ± 2.09	6.75 a ± 1.43	3.98 b ± 0.71
b*[M]	9.67 a ± 2.10	11.29 a ± 3.81	9.10 a ± 1.62
C* [S]	6.74 ab ± 2.41	9.05 a ± 1.84	5.31 b ± 0.50
C* [M]	12.05 a ± 2.35	13.54 a ± 4.18	11.44 a ± 1.66

C* – chromaticity, (S) =surface of gingerbread, (M) = bread crumb of the gingerbread. Equal letters on a single line have no statistical difference among each other according to Tukey test at five percent effect on the formation of gluten structure. Again verified that the increase in the content of MCSF led to an increase in the mass; the remaining parameters had no influence of the MCSF.

As shows in Table 3, a significant difference occurred ($p < 0.05$) for parameters b* and C* only regarding the surface of the product. The difference in parameter b* can be explained by the Maillard reaction, catalyzed by presence of heat and water available for the reaction, resulting in a tendency to yellow (SHIBAO; BASTOS, 2011). In contrast, the difference in parameter C* had direct influence of parameter b*. Therefore, it is valid to state that the treatment with 25 percent MCSF presented better results for specific volume and color.

The texture of a bread is measured through several factors, including hardness, adhesiveness, elasticity, cohesivity, gomosity, masticability, and resilience. Table 4 presents the characteristics of texture in the gingerbread with the application of MCSF as partial substitution of wheat flour with chocolate coating.

The gingerbread presented fracturability, which, according to Carneiro *et al.* (2011), can be defined as the strength in a sample when crumbling or breaking into pieces. The treatment with 15 percent MCSF presented differences in relation to the remaining ones.

Adhesiveness revealed high values in the treatment with 15 percent MCSF, with probable effect of the factors inherent to the gingerbread, such as the amount of MCSF. The remaining parameters had no influence of the partial MCSF addition in the gingerbread. No differences were indicated for the shearing force among the treatments, leading us to believe that the shearing force had direct influence of the chocolate coating or icing considering that the three treatments used the same chocolate.

For the gingerbread with the application of MCSF and chocolate coating, again observed that the presence of chocolate generated a harder structure, increasing the time spent to disintegrate the gingerbread, which, in this case, demonstrates that the treatments have no differences for most of the parameters, only for resilience and fracturability; therefore, in this analysis, the control treatment presented more satisfactory characteristics than the remaining treatments.

Figures 1 and 2 present the micrographs of the wheat flour and the MCSF used in the production of the gingerbreads.

Table 4 - Mean values of the texture analysis of the gingerbread with chocolate coating or icing with the application of mama-cadela seed flour as partial substitution of wheat flour

Parameters	Treatments		
	Control	15% MCSF*	25% MCSF*
Hardness [N]	6402.06 a ± 9.20	5305.80 a ± 12.73	5099.76 a ± 8.13
Fracturability [N]	1123.4 b ± 6.99	2033.60 a ± 3.95	2058.32 a ± 11.38
Adhesiveness	3.84 c ± 3.74	154.07 a ± 4.49	85.73 b ± 5.28
Elasticity	0.71 a ± 0.08	2.50 a ± 0.091	0.82 a ± 0.06
Cohesivity	0.43 a ± 0.03	0.33 a ± 0.02	0.37ab ± 0.05
Gomosity	2762.93 a ± 5.42	1719.66 a ± 4.49	1917.62 a ± 5.28
Masticability [N]	1983.3 a ± 5.38	1195.49 a ± 3.39	1610.50 a ± 5.38
Resilience	0.15 a ± 0.01	0.11 b ± 0.09	0.096 b ± 0.013
shearing [N]	35.89 a ± 10.60	24.03 a ± 8.82	35.82 a ± 6.67

*MCSF = mama-cadela seed flour. Averages ± standard deviation. Equal letters on a single line have no

Figure 1 - Micrographs observed through the SEM of wheat flour (a), wheat granule (b) (Extracted from Vieira et al. (2010), Yonemoto *et al.* (2007), and MCSF (c) with increase of 1000x

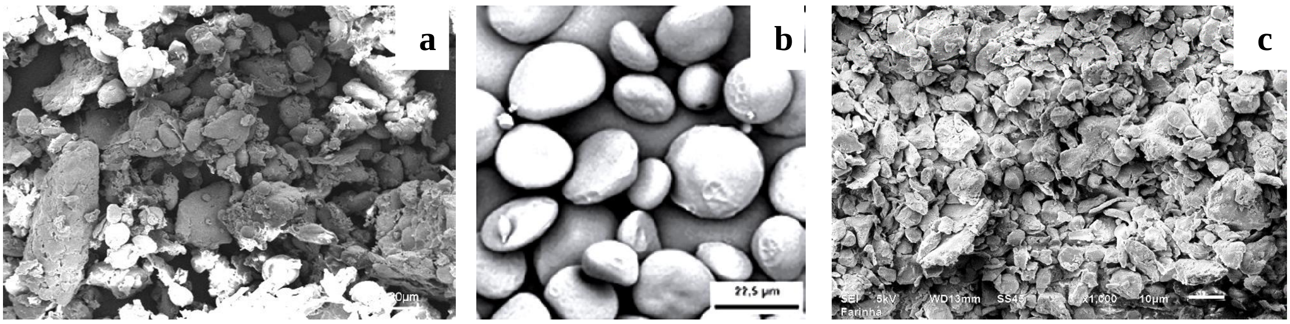
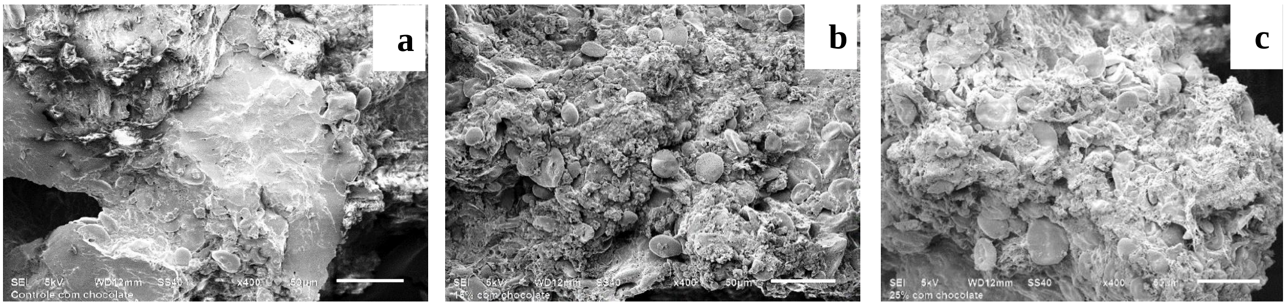


Figure 2 - Micrograph observed in the gingerbread with icing with the application of mama-cadela seed flour as partial substitution of wheat flour: control (a), 15 percent of MCSF (b), and 25 percent of MCSF (c) (increase of 400x)



FSMC has a more defined structure, with granules that are flatter and smaller than wheat flour. Leonel *et al*. (2007) claim that small starch granules can be used as lipid substitutes. Regarding the structure seen in figure 2 (b and c), they present a more porous structure when compared to the control (a). It is quite beneficial, considering that the porous aspect of honey bread can be associated with the soft product. As illustrate in figure 2, only the control treatment appears to be harder and more compact opposite to the treatments with 15 percent and 25 percent MCSF, which presented soft texture.

CONCLUSION

The substitution of wheat flour with mama-cadela seed flour to obtain gingerbreads proved very satisfactory for both the treatment with 15 percent and the treatment with 25 percent substitution. Thus, we recommend the substitution of up to 25 percent MCSF in gingerbreads adding nutritional value from mama-cadela and reducing waste disposal by the industry with a sustainable alternative, which contributes to the conservation and protection of the environment.

ACKNOWLEDGMENT

The authors gratefully acknowledge financial aid from the CNPq.

REFERENCES

ADE, K. D.; LAL, E. A.; RATHID, A. S. Development and quality evaluation of pineapple pomace and wheat bran fortified biscuits. **International Journal of Research in Engineering & Advanced Technology**, v. 2, n. 3, 2014.

ALMEIDA, M. M. B. *et al*. Bioactive compounds and antioxidant activity of fresh exotic fruits from northeastern Brazil. **Food Research International**, v. 44, p. 2155-2159, 2011.

ASSOCIATION OF OFFICIAL ANALYTICAL CHEMISTS. **Official methods of analysis of international**. 19 th ed. Gaithersburg, 2012. 300 p.

BLIGH, E. G.; DYER, W. J. A rapid method of total lipid extraction and purification. **Canadian Journal of Biochemistry and Physiology**, v. 37, p. 911-917, 1959.

BORGUINI, R. G.; TORRES, E. F. S. Tomatoes and tomato products as dietary sources of antioxidants. **Food Reviews International**, v. 25, p. 313-325, 2009.

BRAND-WILLIAMS, W.; CUVELIER, M. E.; BERSET, C. Use of a free radical method to evaluate antioxidant activity. **LWT – Food Science and Technology**, v. 28, p. 25-30, 1995.

BRASIL. Ministério da Saúde. Agência Nacional de Vigilância Sanitária. Resolução n° 263, de 22 de setembro de 2005. Aprova o regulamento técnico para produtos de cereais, amidos, farinhas e farelos. **Diário Oficial da União**, 22 set. 2005.

CAMARGO, K. F de *et al.* Production of extruded biscuits from sour starch with fibers: effect of operational parameters on physical properties. **Food Science and Technology**, v. 28, n. 3, p. 586-591, 2008.

CAPRILES, V. D.; ARÊAS, J. A. G. Advances in the production of gluten-free breads: technological and nutritional aspects. **Boletim CEPPA**, v. 29, n. 1, p. 129-136, 2011.

CARNEIRO, A. P. G. *et al.* Texture parameters of milk chocolate bars. **Alimentos e Nutrição**, v. 22, n. 2, p. 259-264, 2011.

CARVALHO, K. H. *et al*. Development of cupcake with banana peel flour: sensory and chemical characteristics. **Alimentos e Nutrição**, v. 23, n. 3, p. 475-481, 2012.

EKE, J.; ACHINEWHU, S. C.; SANI, L. Nutritional and sensory qualities of some Nigerian cakes. **Nigerian Food Journal**, v. 26, n. 2, p. 12-17, 2008.

FERREIRA, D. F. Sisvar: a guide for its Bootstrap procedures in multiple comparisons. **Ciência e Agrotecnologia**, v. 38, p. 109-112, 2014.

JACOMASSI, E.; MOSCHETA, I. S.; MACHADO, S. R. Morphology and histochemistry of reproductive organs from *Brosimum gaudichaudii* (Moraceae). **Revista Brasileira de Botânica**, v. 33, n. 1, p. 115-129, 2010.

LEONEL, M. *et al*. Effects of extrusion parameters on physical properties of expanded yam products. **Food Science and Technology**, v. 26, n. 2, p. 459-464, 2006.

KAROVICOVÁ, Z. J.; MAGALA, M. Rheological and qualitative characteristics of pea flour incorporated cracker biscuits. **Croatian Journal of Food Science and Technology**, v. 5, p. 11-17, 2013.

MATTIETTO, R. A.; LOPES, A. S.; MENEZES, H. C. Physical and physicochemical characterization of the fruits of the cajazeira (*Spondias mombin* L.) and two pulps obtained by two types of extractor. **Brazilian Journal of Food Tchnolology**, v. 13, p. 156-164, 2010.

MENON, L.; MAJUMDAR, S. D.; RAVI, U. Mango (*Mangifera indica* L.) kernel flour as a potential ingredient in the development of composite flour bread. **Indian Journal of Natural Products and Resources**, v. 5, p. 75-82, 2014.

MERRILL, A. L.; WATT, B. K. **Energy value of foods**: basis and derivation. Washington, DC: United States Department of Agriculture, 1973.

POSSAMAI, T. N.; WASZCZYNSKYJ, N.; POSSAMAI, J. C. Honey bread enriched with alimentary fiber. **Visão Acadêmica**, v. 10, p. 40-46, 2009.

SANTOS, D. S. D.; STORCK, C. R.; FOGAÇA, A. O. Cookie with added lemon peel flour. **Disciplinarum Scientia. Série: Ciências da Saúde**, v. 15, n. 1, p. 123-135, 2014.

SHIBAO, J.; BASTOS, D. H. M. Products of the Maillard reaction in food: implications for health. **Revista de Nutrição**, v. 24, p. 895-904, 2011.

SILVA, D. B. *et al*. Vegetative propagation of *Brosimum gaudichaudii* Tréc. (mama-cadela) by root cuttings. **Revista Brasileira de Plantas Medicinais**, v. 13, n. 2, p. 151-156, 2011.

VIEIRA, C. J. *et al.* Influence of the addition of tapioca starch on the characteristics of tea-type bread. **Boletim CEPPA**, n. 28, p. 37-48, 2010.

YONEMOTO, G. P. *et al*. Effect of grain size on selected and physicochemical characteristics of wheat starch. **Food Science and Technology**, v. 27, p. 761-771, 2007.