SCIENCE
AND FOOD
TECHNOLOGY

DOI: 10.12957/demetra.2019.33380

DEMETRA
Alimentação, Nutrição & Saúde

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Biscuit with spices and corn flours and pumpkin seed: development and quality assessment

Biscoito com especiarias e farinhas de milho e semente de abóbora: desenvolvimento e avaliação da qualidade

Abstract

Corn is one of the most used cereals in food production, being mostly transgenic. Therefore, the objective was to develop and evaluate formulations of biscuits with non-transgenic corn flour (NTCF) and pumpkin seed meal (PSM), added with spices. Initially, three brands of TCF (transgenic corn flour), and a brand of NTCF were chemically analyzed. In parallel, a survey was carried out with 80 consumers on the proposed biscuit. Three formulations were formulated: F1 (without PSM), F2 (with 25% PSM) and F3 (with 50% PSM). Each cookie formulation was evaluated for microbiological, sensory and chemical characteristics. Regarding the characteristics of corn flour, NTCF showed a higher amount of protein and antioxidant capacity. Market research has indicated that the proposed biscuit formulations have commercial potential, and that oregano and basil should be added. All biscuit formulations were microbiologically safe; however, formulation 2 was the one that showed the best acceptance for taste, overall impression, purchase intention, and was

the preferred formulation by tasters. The acceptability index (IA) indicated formulation 2 with potential for consumption and commercialization. In relation to the centesimal and chemical composition, formulation 3 showed better characteristics as it contained more ash (7.73), proteins (34.22), lipids (28.77), energy (494.43), iron reduction (23.34) and total phenolics (196.40). Considering the above, only formulation 2 has commercial potential, since it contains an acceptance index equal to the minimum established for commercialization, while formulation 3 presented better chemical characteristics.

Keywords: Corn flour. Pumpkin seed meal. Transgenic. Herbs. Cookies.

Resumo

O milho é um dos cereais mais utilizados na produção de alimentos, sendo em sua maioria transgênico. Diante disso, objetivou-se desenvolver e avaliar formulações de biscoitos com farinha não transgênica de milho (FMNT) e farinha de semente de abóbora (FSA), adicionados de especiarias. Inicialmente, foram analisadas quimicamente três marcas de FMT (farinha de milho transgênica) e uma marca de FMNT. Paralelamente, realizou-se pesquisa com 80 consumidores sobre o biscoito proposto, sendo então elaboradas três formulações: F1 (sem FSA), F2 (com 25% FSA) e F3 (com 50% FSA). Cada formulação de biscoito foi avaliada quanto às características microbiológicas, sensoriais e químicas. No que se refere às características das farinhas de milho, a FMNT apresentou maior quantidade de proteínas e capacidade antioxidante. A pesquisa de mercado indicou que as formulações de biscoito propostas têm potencial comercial, e que deveriam ser adicionados orégano e manjericão. Todas as formulações de biscoito estavam seguras microbiologicamente, mas a formulação 2 foi a que apresentou melhor aceitação no que se refere a sabor e impressão global, assim como melhor intenção de compra, além de ser a preferida pelos provadores. O índice de aceitabilidade (IA) indicou a formulação 2 com potencial para consumo e comercialização. Em relação à composição centesimal e química, a formulação 3 apresentou características melhores por conter mais cinzas (7,73), proteínas (34,22), lipídios (28,77), energia (494,43), redução do ferro (23,34) e fenólicos totais (196,40). Diante do exposto, somente a formulação 2 apresenta potencial comercial, uma vez que contém um IA igual ao mínimo estabelecido para comercialização, enquanto que a formulação 3 apresentou melhores características químicas.

Palavras-chave: Farinha de milho. Farinha de semente de abóbora. Transgênico. Ervas. Biscoito.

INTRODUCTION

Soybean, corn and cotton are among the transgenic crops most commonly grown in Brazil.[1] Studies carried out by the *Instituto Brasileiro de Defesa do Consumidor* (Brazilian Institute for Consumer Protection) and the World Health Organization found possible health and environmental risks caused by transgenics. Major risks would be an increased rate of allergies and use of toxic substances during cultivation, and pests' resistance to pesticides.[2] Law no. 11.105, of the Presidency of the Republic, dated March 24, 2005, defines a genetically modified organism (GMO) as that whose genetic material has been altered by using any genetic engineering technique, and regulates safety and enforcement mechanisms.[3]

The versatility of corn makes it one of the most important raw materials used for foods production.[4] From the nutritional point of view, corn is considered an energy food due to its composition, mostly carbohydrates (80%). In addition, corn is largely used in the production of animal feeds and human foods and by the food industry for production of flours.[5,6]

According to Brazilian legislation, flour is a product made by milling the edible portion of vegetables, which may have undergone prior adequate technological processes. Corn flour is a product obtained from toasting or milling corn grains ***(Zea maya, L.)***, degerminated or not, previously ground, crushed and strained.[7]

Due to the versatility of use of corn in food products, in recent years there has been a growing market for corn snacks.[8] Considering the Brazilian population, in 2016, the consumption of cookies by 205 million people was 8.20 kg/year/person and moved $ 21.853 billion reais in the same year.[8] According to the Brazilian legislation,[7] cookie, or biscuit, is a product resulting from convenient kneading and cooking of dough prepared with flour, starch, fermented or nonfermented root starches, and other food substances.

Considering the increasing demand for nutritionally healthy, economically viable foods,[9] crop residues and industrial wastes that would otherwise be discarded by industries, e.g., pumpkin seeds, began to be used. These seeds can be consumed toasted, as flour, meal or as

a culinary ingredient, and also as extracted oil.[10] Such use adds economic value to production and contributes to the formulation of new food products, thus minimizing waste.[9]

Numerous studies have shown the nutritional,[11-13] functional and technological[14] importance of pumpkin seeds. They are rich in lipids, proteins and amino acids,[15] dietary fibers[11] and antioxidant compounds.[16] In addition, pumpkin seeds have been effective in reducing high blood pressure and in the control of diabetes, in reducing risk of prostate cancer, in regulating LDL cholesterol,[17] and in the activity against benign prostatic hyperplasia.[16] In the Brazilian popular medicine, pumpkin seeds are used because of their vermifuge activity.[17]

Considering the high consumption of corn and derivative products, and possible risks in the consumption of transgenic foods, as well as the good use of pumpkin seed and its beneficial effects on health, this study aimed to develop three formulations of cookies made with spices and non-transgenic corn flour and pumpkin seed meal, based on a previous survey with consumers, and evaluate the microbiological, sensory, chemical characteristics and centesimal composition of the cookies.

MATERIALS AND METHODS

Ethical issues

This work was previously approved by the Research Ethics Committee of the Federal University of Sergipe (UFS), on October 9, 2017, process number 2.321.492.

Survey of consumers

Before developing the corn cookies formulations, a survey was conducted with 80 people, among them students, teachers and employees of the Federal University of Sergipe, aged between 18 and 50 years, of both sexes. The survey consisted of administration of a questionnaire with nine multiple-choice objective questions.[18] The questions comprised corn consumption (habit and consumption frequency), corn chips (habit and consumption frequency), the most important features to consider before purchasing a food product (flavor, price, brand, or if they are beneficial to health) and consumption of food products with beneficial properties to health (habit and which are the beneficial substances to health: dietary fibers, omega 3, carotenoids, and soybean protein). In addition, consumers were asked to give their opinion on the choice of ingredients for formulation of a new product (dietary fibers, omega 3, carotenoids, soy protein and spices or herbs: coriander, black pepper, pink pepper, onion, basil, oregano, parsley, pumpkin seed, and without spices or herbs) as well as a price estimate in reais ($ 3.50-4.00; $ 4.00-4.50; $ 4.50-5.00; $ 5.00-5.50 /100g) that they would be ready to pay for the new product.

Centesimal composition and chemical characteristics of flocked corn flour

Three brands (A, B, C) of transgenic flocked corn flour bought at supermarkets in Aracaju-SE were analyzed, as well as one brand of non-transgenic corn flour (NTCF) obtained from a farming community located in the same city. Two samples of each corn flour were assessed (500g).

The corn flour samples were analyzed at the Laboratory for Food Analysis of the Nutrition Department) at the Federal University of Sergipe (UFS), São Cristóvão campus. The following analytical parameters were adopted, all of them tested three times, according to the Adolf Lutz Institute:[19] moisture – determined by the constant weight after oven-drying at 105°C; proteins - determined by the total nitrogen of the sample using the Kjeldahl method, determined at the semi-micro level. A factor of 5.65 was used for conversion of nitrogen to protein, expressed in g/100g of sample; lipids – determined in Soxhlet with solvent, petroleum ether, expressed in g/100g of sample. In addition, total carbohydrates were determined by differences and the energy values were estimated by the Atwater conversion factors of 4kcal/g for proteins, 4kcal/g for carbohydrates and 9kcal/g for lipids.

Total phenolics (TP) and anti-oxidant capacity (DPPH and FRAP) were determined. For this purpose, extracts made of 1g of sample were used, diluted in 10 mL of methanolic solution (80:20-methanol/water), and TP contents,[20] DPPH[21] (radical 2,2-diphenyl- 1-picrylhydrazyl) and FRAP[22] (Ferric Reducing Antioxidant Power) were verified. TP was expressed in µg of gallic acid equivalent/g of sample; DPPH was expressed in µg of Trolox equivalent/g of sample; and FRAP was expressed in mol of iron sulfate equivalent/g of sample.

Cookie making

The cookie formulations with spices and non-transgenic corn flour and pumpkin seed meal were made with the following ingredients: non-transgenic corn flour (Crioulo), water (Indaiá), eggs (Avine), butter (Tirolez), salt (União), baking powder (Dr. Oetker), pumpkin seed meal (Vida Boa), dehydrated oregano and basil (Maratá). All ingredients were weighted in semi-analytical balance (Ohaus Adventurer, ARC120, US).

Three formulations of cookies were prepared (F1, F2 and F3). F1 did not contain pumpkin seed meal (PSM), and in the other formulations, PSM replaced NTCF partially, i.e., 25% in F2 and 50% in F3. Firstly, pre-tests were performed without participation of tasters, with the purpose of reproducing a cookie with acceptable sensory characteristics.

The cookies began to be made by weighting the ingredients in a semi-analytical balance and then mixed with hands. When a homogeneous mixture was obtained, the dough was manually shaped into a disk, with three centimeters in diameter. The dough was baked in gas

oven at 200°C for 20 minutes. Then, the cookies were cooled at room temperature for 30 minutes. The cookies were packed in polyethylene bags and vacuum sealed using a vacuum sealer RG-300a (Registron).

Microbiological analysis

Before the sensory analysis, samples of 200 g of each cookie formulation were sent to the *Laboratório de Microbiologia de Alimentos do Departamento de Nutrição* (Laboratory for Foods Microbiology of the Department of Nutrition) at UFS, São Cristóvão campus. The microbiological analyses were conducted to verify the processing conditions of the cookie formulations.

RDC n° 12, of January 2, 2001, of ANVISA,[23] which regulates the sanitary microbiological standards for foods and beverages, establishes for unstuffed cookies thermotolerant coliforms counts of up to 10 NMP/g, coagulase-positive staphylococci counts of up to $5x10^2$ CFU/g and absence of ***Salmonella sp*** in 25g of cookie. In addition to these analyses, enumeration of molds and yeasts (fungi) and total coliforms were also performed.

Analysis of total coliforms is a prerequisite for the analysis of thermotolerant coliforms, while fungi analysis is indicated for foods with low water activity, such as cookies. All analyses and expression of results were carried out based on Silva et al.[24]

Sensory analysis

The sensory assessment was carried out using monadic and randomized presentation by 70 untrained tasters (18 to 50 years), of both sexes. The participants were asked to read and sign the Free and Informed Consent Form before the assessment. The samples were assessed in individual cabins under white light. Before being served to the tasters, the cookies were removed from the vacuum-packed polyethylene bags. About 20g of each sample was served at 25°C in polypropylene cups codified with three-digit figures.

The three formulations of cookies were assessed for preference (sorting test), acceptance (hedonic scale) and purchase intention. The formulations preference was evaluated according to the Friedman test.[25] Acceptance was evaluated by a 9-point hedonic scale (9 – like very much and 1 – greatly dislike) for appearance, aroma, flavor, color, texture, and overall impression. The purchase intention scale ranged from one to five, and had the following classification: 1 – certainly would not buy; 2 – probably would not buy; 3 – maybe would buy, maybe not; 4 – probably would buy; 5 – certainly would buy.[25] The acceptance index (AI) was evaluated by means of the expression AI (%) = A x 100 / B, where A = average score given to the product and B= maximum score given to the product. AI was considered as having good acceptance when > 70%.[26]

Centesimal composition and chemical characterization of the cookies

After the sensory evaluation, the three cookie formulations (F1, F2 and F3) were analyzed for centesimal composition and chemical characterization at the Laboratory for Food Analysis of the Department of Nutrition at UFS, São Cristóvão campus. The same methodologies applied for flocked corn flour were used. [19 20-22]

Statistical analysis

With the IBM SPSS software program, version 21 (Statistical Package for the Social Sciences, 2012),[27] the data of sensory analysis, chemical analysis and centesimal composition were subjected to analysis of variance (ANOVA) for repeated measures, to check for means homogeneity. The means that were homogeneous ($p>0.05$) were subjected to Tukey's test. P-values were considered significant when they were below 0.05. The results of the sensory preferences for the cookie formulations were analyzed by the Friedman test, whereby the sum of orders of the cookie formulations are compared with the critical absolute value of difference of the sum of orders (minimum significant difference), to determine significant preference at 5% probability level, as obtained in specific table.[25]

RESULTS AND DISCUSSION

Centesimal composition and chemical characterization of transgenic and non-transgenic flocked corn flours

Table 1 shows the centesimal composition and chemical characterization of transgenic and non-transgenic corn flours.

Table 1. Centesimal composition and chemical characterization of transgenic and non-transgenic flocked corn flours. Aracaju, SE, 2017.

	CORN FLOUR*			
CHARACTERÍSTICS**	Non-transgenic	Transgenic		
		Brand A	Brand B	Brand C
Moisture	12.82±0.05[a]	11.68±0.11[c]	12.33±0.24[b]	11.39±0.16[c]
Ash	0.36±0.02[a]	0.25±0.03[b]	0.24±0.01[b]	0.24±0.00[b]
Proteins	13.41 ±0.95[a]	10.57±0.38[b]	10.58±0.29[b]	10.65±0.30[b]
Lipids	0.96±0.11[b]	2.71±0.03[a]	2.92±0.21[a]	2.67±0.00[a]
Carbs	72.45±1.08[b]	74.79±0.46[a]	73.92±0.11[ab]	75.03±0.42[a]
Calorie	352.07±0.33[b]	365.80±0.53[a]	364.90±1.40[a]	366.90±0.63[a]
DPPH	114.87±3.57[a]	27.24±0.46[d]	41.14±1.95[c]	52.05±1.21[b]
FRAP	7.35±0.47[a]	5.68±0.41[b]	5.93±0.40[b]	5.81±0.14[b]
Total phenolics	156.00±14.11[a]	44.92±5.77[c]	114.92±8.89[b]	128.75±24.4[ab]

*Means and standard deviation (SD). Different letters in row indicate significant difference by the Tukey's test ($p<0.05$).

**Moisture, proteins, lipids and ash, all expressed as g/100g of sample; total carbs expressed as % and energy expressed as kcal. Total phenolics: expressed as µg gallic acid equivalent/g of sample; DPPH: expressed as µg Trolox equivalent/g of sample; FRAP: expressed as mol iron sulfate equivalent/ 1g of sample.

Given the above, it can be seen that there was a significant difference ($p<0.05$) for the four kinds of flocked corn flours in all characteristics assessed, and the NTCF exhibited the highest means for moisture (12.82), ash (0.36), proteins (13.41), DPPH (114.87) and FRAP (7.35). The NTCF had fewer lipids (0.96), carbs (72.45) and energy (352.07), when compared to the transgenic flours (A, B and C). Total phenolics of NTCF (156) were equal ($p>0.05$) to the TCF of brand C (128.75).

The Brazilian legislation establishes 15% as the maximum moisture value in flours;7 it can then be seen that the transgenic and non-transgenic corn flours meet this specification, favoring preservation and making contamination more difficult, due to their low water activity (Table 1). The moisture levels found in the corn flours (11.39 to 12.82), also shown in Table 1, are close to the levels found in rice flour (12.27%).28

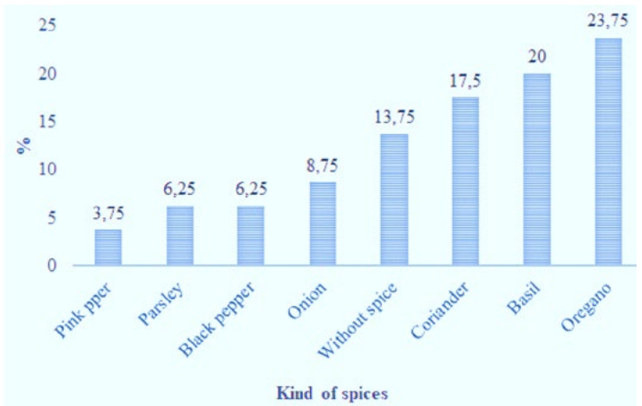
Ash analysis determines the amount of mineral matter that can be found in foods.[29] Ash contents in the corn flours ranged from 0.24 to 0.36% (Table 1), lower than the ones found in coconut flour (2.78%)[30] and rice flour (0.5%).[31]

Survey of customers

With regard to the habit of consuming corn products, it can be seen that 93.75% of the respondents like corn and 62.5% usually consume it. Although the majority of the participants (66.25%) do not have the habit of consuming corn chips, 67.5% of them stated that they would consume corn chips added with pumpkin seed meal. Of 80 participants, the majority (53.75%) stated that flavor is the most important characteristic of a product, followed by the benefits that healthy foods provide to health (45%). When asked about the functional ingredients that could be added to the cookie formulations, the majority (57.5%) indicated fibers as the functional ingredient. With respect to the cost/benefit ratio and how much the participants were ready to pay for 100g of the proposed cookie, within a price range of 3.50 to 5.00 reais, the value ranged from $ 3.50 to $ 4.00 reais for 71.25% of the respondents.

Fig. 1 describes the percentages of choice of the spice to be added to the cookie formulations.

Figure 1. Indication of the spice composition in the cookie.



Of the 80 respondents, 23.75% stated that they would prefer oregano to compose the cookie formulation, followed by basil (20%) (Fig. 1). Oregano and basil achieved the highest percentage of choice, which was determinant for cookie formulations in the form of a mix of both herbs (Fig. 1). Besides adding sensory features (aroma, color and flavor), these herbs will contribute to antioxidant and antimicrobial activities.[32-34]

Microbiological assessment

The three cookie formulations that were assessed exhibited negative tubes for total coliforms and thermotolerant coliforms, being expressed as <3.0 MPN/mL. The Petri dishes did not show growth of typical colonies of fungi and ***S. aureus***, expressed as <1 x 10^2 CFU/g; and typical colonies of ***Salmonella sp.*** were absent in 25g of cookie. Thus, taking as reference the microbiological standards for unstuffed cookies (thermotolerant coliforms up to 10 MPN/g, positive-coagulase staphylococci up to 5x102 CFU/g and absence of ***Salmonella sp*** in 25g of cookie),[23] the cookies served to the tasters in the sensory analysis were microbiologically safe.

Sensory evaluation

Sensory acceptance and purchase intention

The sensory acceptance of the three cookie formulations with herbs and non-transgenic corn flour and pumpkin seed meal is shown in Table 2.

Table 2. Sensory acceptance and purchase intention of cookies formulation with herbs and non-transgenic corn flours and pumpkin seed. Aracaju, SE, 2017.

Sensory attributes	FORMULATIONS*		
	F1	F2	F3
Aroma	6.30±1.79[a]	6.06±1.63[a]	5.86±1.76[a]
Texture	4.64±1.98[b]	6.49±1.66[a]	5.87±1.93[a]
Flavor	4.60±1.89[b]	6.16±1.84[a]	5.11±2.32[b]
Color	6.47±1.85[a]	6.27±1.62[a]	5.20±1.9[b]
Overall impression	5.09±1.88[b]	6.31±1.52[a]	5.14±2.02[b]
Purchase intention	2.21±1.05[b]	3.23±1.25[a]	2.46±1.33[b]

*Means and standard deviation (SD). Different letters in row indicate significant difference by the Tukey's test (p<0.05). PSM = pumpkin seed meal. F1 = without PSM; F2 = with 25% PSM; F3 = with 50% PSM

It can be seen that the only parameter that did not differ significantly (p>0.05) among the formulations was aroma.

Formulation 2 was the sample that achieved the best acceptance for flavor (6.16) and overall impression (6.31), as well as the best purchase intention (3.23). The texture that achieved the highest acceptability was presented by formulations 2 (6.49) and 3 (5.87), and color achieved the best acceptance with formulations 1 (6.47) and 2 (6.27). In the hedonic scale, it can be seen that the formulations had an acceptance between "dislike slightly" (4) and "like moderately" (7). In the purchase intention scale, the formulations achieved scores between "probably would not buy" (2) and "probably would buy" (4). Considering the overall impression and purchase intention, it can be seen that the addition of 25% of pumpkin seed (formulation 2) made the cookie more attractive commercially (Table 2).

With regard to the rating scale for purchase intention (1 to 5), it was found that the sums of the parameters between "maybe would buy" and "certainly would buy" for formulation 1, formulation 2 and formulation 3 were, respectively, 42.86%, 74.29% and 41.43%, showing that formulation 2 had the best purchase intention compared to the other formulations of corn cookie with pumpkin seed and herbs.

The literature indicates that the addition of pumpkin seed meal has a sensory effect on the proposed product, as found by Silva et al.[35] When they made seven cookie formulations with pumpkin seed meal and different sweeteners and sucrose, these authors obtained an overall acceptance of 85%. However, Silva et al.[36] prepared five formulations of cookies with addition of 0%, 25%, 50%, 75% and 100% of PSM, and found that the addition of PSM amounts above 50% caused sensory rejection, considering that the acceptability was lower than 70% with respect to the attributes flavor, texture and overall acceptance of the cookies.

Preference

Regarding the order of preference, there is a significant difference for preference among the formulations assessed. Formulation 2 was the preferred one (p<0.05) by the tasters. There was no significant preference between formulations 1 and 3 of cookies with herbs and non-transgenic corn flour and pumpkin seed meal and herbs.

The AI obtained by the sensory attributes of the cookie formulations with non-transgenic corn flour were, respectively, 60.22% (F1), 70% (F2) and 60.44% (F3); so, we can say that only formulation 2 has great potential for consumption, considering that the results for the different attributes are nearly 70%.[26]

Centesimal composition and chemical characteristics of cookie formulations

Table 3 shows the centesimal composition and chemical characteristics of the cookie formulations with spices and non-transgenic corn flour and pumpkin seed and herbs.

Table 3. Centesimal composition and chemical characterization of cookie formulations with herbs and non-transgenic corn flours and pumpkin seed. Aracaju, SE, 2017.

CHARACTERÍSTICS**	FORMULATIONS*		
	F1	F2	F3
Moisture	10.06±0.29[a]	4.01±0.12[b]	3.99±0.03[b]
Ash	7.53±0.09[b]	7.48±0.02[b]	7.73±0.01[a]
Protein	17.14±1.17[c]	27.72±1.22[b]	34.22±0.73[a]
Lipids	10.03±0.66[c]	20.45±1.33[b]	28.27±0.23[a]
Carbs	55.23±0.61[a]	40.33±0.94[b]	25.78±0.82[c]
Calorie	379.76±2.34[c]	456.27±6.88[b]	494.43±1.27[a]
DPPH	189.03±0.76[c]	201.75±1.52[a]	196.40±0.76[b]
FRAP	18.70±0.45[b]	19.45±0.56[b]	23.34±0.24[a]
Total phenolics	394.33±35.12[c]	470.00±5.29[b]	539.00±28.16[a]

*Means and standard deviation (SD). Different letters in row indicate significant difference by the Tukey's test ($p<0.05$). PSM = pumpkin seed meal. F1 = without PSM; F2 = with 25% PSM; F3 = with 50% PSM

**Moisture, ash, proteins, lipids: expressed as g/100g of sample; total carbs expressed as % and energy expressed as kcal.; DPPH: expressed as µg Trolox equivalent/g of sample; FRAP: expressed as mol iron sulfate equivalent/ 1g of sample; total phenolics: expressed as µg gallic acid equivalent/g of sample

It can be seen that there was a significant difference ($p<0.05$) for all characteristics assessed in the three cookie formulations. Formulation 3 achieved the highest mean values for ash (7.73), proteins (34.22), lipids (28.77), energy (494.43), FRAP (23.34) and total phenolics (196.40), showing that the addition of pumpkin seed meal with higher concentration (formulation 3) increased significantly these parameters. On the other hand, formulation 1 exhibited the highest moisture (10.06%) and carb (55.23) contents, as shown in Table 3.

The increased protein and lipid contents found in the cookies made with corn flour and pumpkin seed and herbs (Table 3) may be associated with the chemical composition of PSM,

considering that literature shows that PSM has on average 21.57% of protein and 38.10% of lipids.[36] It was also found that the addition of PSM in cookies[36,37] and cakes[38] increased the protein and lipid contents of the proposed food products, corroborating the increased levels of these nutrients (poly-unsaturated lipid and protein) in the cookies developed in this study (Table 3).

The antioxidant activity inhibits the oxidative chain propagation reactions.39 The non-transgenic sample of corn flour exhibited a higher antioxidant activity, when compared to transgenic corn flour (Table 1). Therefore, it can be assumed that the use of NTCF added antioxidants to the proposed cookie formulations. In this regard, it was found that besides the NTCF used in the cookies, the addition of pumpkin seed meal enhanced the antioxidant protection of the cookie formulations 2 and 3, and the replacement of NTCF with 50% of pumpkin seed meal (formulation 3) showed a higher antioxidant activity (Table 3), which probably reflects the better conservation of this cookie.[39]

Vacuum packing was chosen because it causes the suppression of oxygen, tending to increase the shelf life of foods, considering that it delays the loss of moisture and antioxidant activity, changes in texture, and also delays the enzymatic browning and microbial development.[40,41]

CONCLUSIONS

It was found that non-transgenic flocked corn flour achieved better results in its centesimal composition (higher contents of moisture, ash and protein; lower calorie value) and higher antioxidant activity (DPPH and FRAP), when compared to the transgenic flocked corn flours assessed.

The survey with consumers identified that the majority of the respondents like corn; usually consume it; would consume corn chips containing pumpkin seed; stated that flavor is the most important characteristic when choosing a product; that would add fibers to the cookie formulations; and that they would pay between $ 3.50-4.50 reais for hundred grams of the proposed cookie. In addition, oregano and basil were the most indicated herbs to compose the corn cookie.

All cookie formulations studied were microbiologically safe. Formulation 3 was the greatest source of minerals (ash), protein, lipid, calorie and total phenolics, and has greater power to reduce iron (FRAP). On the other hand, formulation 2 was the only one that achieved AI with good potential for sale and was the preferred one among the other formulations.

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Collaborators

Amaral LF participated in the survey execution and in writing the scientific paper. Ferreira IM participated in the microbiological, chemical and physicochemical analyses and in the interpretation of results. LVN Santos participated in the product making, sensory analysis and interpretation of results. Oliveira and Silva AM participated in the interpretation of results and in writing the manuscript. Fagundes AA contributed to the interpretation of results and in writing the scientific paper. Carvalho MG participated in the conduction of the entire survey, interpretation of results and writing the scientific paper.

Conflict of Interest: The authors declare no conflict of interest.

Received: March 28, 2018
Reviewed: April 03, 2019
Accepted: April 29, 2019