



## CHARACTERIZATION AND SENSORIAL ANALYSIS OF DIET COOKIES PREPARED WITH DIFFERENT LEVELS OF CUMBARU NUT

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### ABSTRACT

The objective of this work is to prepare diet cookies with cumbaru nut as an ingredient in replacement for wheat flour used in the traditional formulation, analyzing its physical-chemical composition and sensorial acceptance. Cookies were composed of five different formulations: F1 = Standard formulation (0%) - without addition of cumbaru nut, and the others with the addition of 2.5% (F2), 5% (F3), 7.5% (F4) and 10% (F5) of cumbaru nuts. The products were submitted to sensory analysis. Tests were applied to elderly patients with Diabetes Mellitus, and physical-chemical analysis of moisture, ashes, proteins, lipids and minerals was performed. There were no significant differences between the attributes evaluated (aroma, flavor, texture, color, sweetness, global acceptance and purchase intention), demonstrating a good sensorial acceptance. Higher levels of moisture, ashes, proteins, lipids, calories, fibers, magnesium, chromium, molybdenum, potassium and lower carbohydrate contents were observed in F5 when compared to F1. Thus, the preparation of the products allowed proving that the addition of up to 10% was well accepted by tasters, obtaining a sensory acceptance similar to the standard product.

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### INTRODUCTION

According to the World Health Organization (WHO), the overall prevalence of diabetes in 2014 was 8.5% (approximately 422 million people), and almost the double

when compared with a prevalence of 4.7% in 1980 (approximately 108 million people) (World Health Organization, 2016). People with this disease need a balanced diet that facilitates glycemic control (Ministry of Health, 2006). The importance of the preparation of foods with functional properties, which control glucose ingestion and satisfy the consumer, is emphasized (Pereira *et al.*, 2011). In this scenario, the preparation of dietary cookies has a great

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importance, mainly because it is easy to eat, has a high nutritional value, and is affordable (Assis *et al.*, 2009). Based on this, the use of the cumbaru nut (*Dipteryx alata* Vog.) in the composition of cookies is highlighted. Cumbaru is a typical fruit of the Brazilian Cerrado found mainly in Mato Grosso do Sul, Mato Grosso, Tocantins and Goiás (Paglarini *et al.*, 2013). Thus, the objective of this work is to prepare diet cookies using cumbaru nut as an ingredient in replacement for wheat flour, which is used in the traditional formulation, analyzing its physical-chemical composition and sensorial acceptance by patients with Diabetes Mellitus.

## MATERIAL AND METHODS

**Formulations:** The ingredients were purchased in supermarkets in the city of Campo Grande, MS, and cumbaru was collected in Campo Grande, MS, at the following geographic coordinates: 20°30'0.70" S and 54°35'57.08" W. The fruits were harvested on the ground, and presented an optimum point of ripeness and absence of injuries. Cookies were prepared according to five different formulations: F1 = standard formulation (0%) - without addition of cumbaru nut, and the other formulations contained 2.5% (F2), 5% (F3), 7.5% (F4) and 10% (F5) of cumbaru nuts. In addition to the percentages of cumbaru nuts, the ingredients used in the formulations were sucralose and acesulfame K (6%), margarine (14%), egg (6%), whole milk (9%), whole wheat flour (18%), oatmeal (8%), oat flakes (5%), baking powder (2%), inulin (11%) and wheat flour (F1: 21%, F2: 18.5%, F3: 16%, F4: 13.5% and F5: 11%). The cumbaru almonds were toasted at 180°C for 20 minutes. After manual skin/peel removal, the almonds were chopped. Then, all ingredients were mixed manually until they formed a homogeneous dough, leaving the almonds to be added at the final stage of the formulation. The cookies were molded manually (4 cm in diameter) and arranged in aluminum baking sheets previously greased with margarine and baked for 18 minutes in a conventional oven preheated at 200°C.

**Sensory Evaluation:** For the sensory evaluation, the project was submitted to the Ethics Committee in Research of the Federal University of Mato Grosso do Sul, and approved (Protocol No. 529/2013) regarding its ethical and methodological aspects according to the Guidelines established in the Resolution 466 of December 12, 2012 of the National Health Council. 75 untrained testers participated in the analysis. They were elderly people with Diabetes Mellitus of both genders, over 60 years of age, participants in the Diabetes Mellitus Patient Groups of the Basic Units of Family Health (UBSF) and Centers of Habitation of the Elderly (CCI) of Campo Grande, MS. The products were submitted to sensory analysis in a room of the Health Units. One taster was evaluated at a time. Each test was performed in individual booths, and the taster was assisted by the researchers to fill in the answers. The tasters assessed the attributes appearance, aroma, flavor, texture, color and sweetness through a hedonic scale containing 5 points (1 - Disliked very much and 5 - Liked a lot) adapted from Dutcosky (06). The global acceptance test was applied using a 5-point scale (1 - Disliked very much and 5 - Liked very much), and purchase intention was analyzed using a 3-point scale (1 - would not buy, 3 - would certainly buy) adapted from Minim (Minim, 2006). Each tester received a portion of each sample (approximately 10 g) in white plastic plates, coded with three-digit numbers, in a randomized way, accompanied by a glass of water as the blank between the

samples. Cookies were offered to the tasters in a sequential monadic form, always with the aid of the researcher.

**Acceptability index (AI):** The calculation of the acceptability index of the five formulations was performed according to Dutcoski (2011) and the formula:  $AI (\%) = A \times 100/B$  (A = average score obtained by the product; B = maximum score assigned to the product).

**Physical-chemical analyses:** The samples selected for sensorial analysis were analyzed as for moisture content, ashes and proteins according to the AOAC (AOAC, 2011), lipids by extraction with hot solvent (Brazil, 2005), and carbohydrate analysis (including fiber) was performed by theoretical calculation (by difference) among the results of the triplicates according to the formula: % Carbohydrates = 100 - (% moisture + % proteins + % lipids + % ash). In the determination of fibers, the Family Budgets Survey Table (IBGE, 2009) and the Brazilian Food Composition Table (TACO, 2011) were used. The nutritional information of cumbaru was based on Takemoto *et al.* (2001). The total caloric value (kcal) was calculated using the following values: lipids (8.37 kcal/g), protein (3.87 kcal/g) and carbohydrates (4.11 kcal/g) (Merrill and Watt, 1973).

Minerals were determined in the Laboratory of Mineral Metabolism and Biomaterials of the Federal University of Mato Grosso do Sul (UFMS), Campo Grande, Mato Grosso do Sul. Samples were digested with HNO<sub>3</sub> (MERCK) and H<sub>2</sub>O<sub>2</sub> (MERCK) in pressurized, heated, digested flasks of Hostafion (Thermo Fisher Scientific, Cambridge, England). After digestion of the samples, the resulting solution was transferred to volumetric flasks, and the volume was filled with purified water, obtained by deionization using a Milli-Q equipment (Millipore). For the determination of minerals, the ICP OES (Thermo Fisher Scientific, Cambridge, England), iCAP 6300 Duo (Poussel; Mermet, 1995), optically coupled plasma emission spectrometry machine, was used.

**Determination of the daily reference value (RV):** The RV was calculated in relation to a 30-g sample based on the mean values recommended for people over 51 (Institute of Medicine, 2005). The average between the values found for men and women (51-70 years) in relation to the number of participants was 53 women and 22 men, resulting in 1,719.62 kcal/day, 214.65 g/day of carbohydrates, 69.06 g/day of protein, 64.14 g/day of lipids and 15.60 g/day of dietary fiber.

**Statistical analysis:** The data were analyzed using the Statistical Package for the Social Sciences (SPSS), version 22.0, through analysis of variance (ANOVA) and Tukey test for more than two groups and Student t test for comparison of means between two groups. Values were considered significant when  $p < 0.05$ .

## RESULTS AND DISCUSSION

**Sensory Analysis:** By evaluating the results of Table 1, there was no significant difference ( $p > 0.05$ ) in the attributes aroma, flavor, texture, color, sweetness, global acceptance and purchase intention among samples. Alves *et al.* (2010) opted to replace 25% of wheat flour of cookies for cumbaru pulp, and performed a sensorial analysis at three moments (beginning, middle and end of the experiment).

**Table 1. Means of affective sensory acceptance and purchase acceptance tests performed for standard cookies and diet cookies added with cumbaru nut**

Formulations/ Attributes	F1	F2	F3	F4	F5
	Mean±MSE	Mean±MSE	Mean±MSE	Mean±MSE	Mean±MSE
Appearance	4.67±0.62 <sup>a</sup>	4.34±0.94 <sup>b</sup>	4.36±0.88 <sup>b</sup>	4.44±0.87 <sup>ab</sup>	5.0±0.00 <sup>a</sup>
Aroma	4.47±0.85 <sup>a</sup>	4.37±0.83 <sup>a</sup>	4.43±0.77 <sup>a</sup>	4.40±0.80 <sup>a</sup>	4.46±0.93 <sup>a</sup>
Flavor	4.67±0.60 <sup>a</sup>	4.47±0.84 <sup>a</sup>	4.32±0.89 <sup>a</sup>	4.47±0.86 <sup>a</sup>	4.62±0.80 <sup>a</sup>
Texture	4.39±0.96 <sup>a</sup>	4.28±1.10 <sup>a</sup>	4.23±1.07 <sup>a</sup>	4.36±0.88 <sup>a</sup>	4.49±0.82 <sup>a</sup>
Color	4.55±0.80 <sup>a</sup>	4.40±0.82 <sup>a</sup>	4.31±0.10 <sup>a</sup>	4.44±0.84 <sup>a</sup>	4.47±0.81 <sup>a</sup>
Sweetness	4.42±1.01 <sup>a</sup>	4.33±1.12 <sup>a</sup>	4.33±1.11 <sup>a</sup>	4.32±1.07 <sup>a</sup>	4.49±0.96 <sup>a</sup>
Global Acceptance	4.70±0.63 <sup>a</sup>	4.53±0.76 <sup>a</sup>	4.61±0.71 <sup>a</sup>	4.64±0.80 <sup>a</sup>	4.72±0.74 <sup>a</sup>
Purchase Intention	2.77±0.59 <sup>a</sup>	2.75±0.55 <sup>a</sup>	2.77±0.56 <sup>a</sup>	2.81±0.51 <sup>a</sup>	2.80±0.52 <sup>a</sup>

MSE: Mean standard error; F1: standard; F2: 2.5% of cumbaru; F3: 5% of cumbaru; F4: 7.5% of cumbaru; F5: 10% of cumbaru.  
AI: Acceptability Index.

**Table 2. Physical-chemical composition and recommended daily values - RV\* (average portion of 30 grams - 3 units) of standard cookie (F1) and cookies added with 10% cumbaru nut (F5), compared to a reference product \*\***

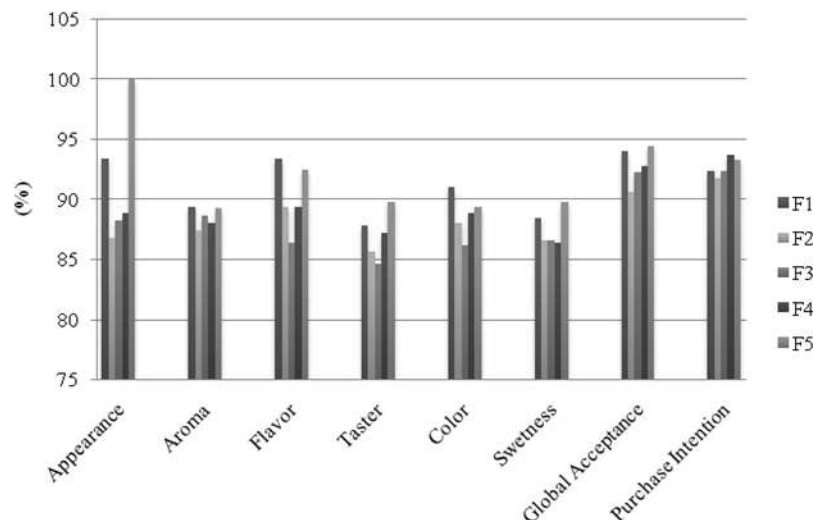
Evaluation	F1		F5		Reference**
	Mean±SD	RV(%)	Mean±SD	RV(%)	
Moisture (%)	4.75±0.44 <sup>b</sup>	NA	9.00±0.49 <sup>a</sup>	NA	NA
Ashes (g.100 g <sup>-1</sup> ) ***	2.18±0.03 <sup>b</sup>	NA	2.46±0.01 <sup>a</sup>	NA	NA
Proteins (g.100 g <sup>-1</sup> ) ***	7.79±0.60 <sup>b</sup>	3.38	9.02±0.28 <sup>a</sup>	3.92	10.00
Lipids (g.100 g <sup>-1</sup> ) ***	13.06±0.17 <sup>b</sup>	6.11	18.86±0.16 <sup>a</sup>	8.82	7.50
Carbohydrates (g.100 g <sup>-1</sup> ) ***	72.22±1.02 <sup>a</sup>	10.09	60.66±0.49 <sup>b</sup>	8.47	77.50
Calories (kcal.100 g <sup>-1</sup> ) ***	436.28±2.3 <sup>b</sup>	7.61	451.09±1.3 <sup>a</sup>	7.86	400.00
Dietary Fiber****	14.94	28.73	16.06	30.88	2.50

Different letters on the same row indicate significant differences by the Student t test ( $p < 0.05$ ); \*RV: nutrients evaluated by the mean of (Institute of Medicine, 2005), based on a diet of 1,719.62 kcal/day; \*\* Values compared to "Whole-grain cookies with cashew nuts - Vitao"(Philippi, 2012); \*\*\* Calculated values on a wet basis; \*\*\*\* Theoretical calculus; SD: means standard deviation; NA: Not Available

**Table 3. Mineral composition and recommended daily values - RV\* (average portion of 30 grams - 3 units) of standard cookie (F1) and cookies added with 10% cumbaru nut (F5)**

Minerals (mg.100 g <sup>-1</sup> )	F1		F5		RDA** (mg/day)
	Mean±SD	RV (%)	Mean±SD	RV (%)	
Potassium	386.50±25.6 <sup>b</sup>	16.56	481.90±11.17 <sup>a</sup>	20.65	700.00
Sodium	836.00±28.28 <sup>a</sup>	19.29	951.10±57.84 <sup>a</sup>	21.95	1,300.00
Phosphorus	235.50±39.74 <sup>a</sup>	1.50	378.90±33.80 <sup>a</sup>	2.41	4,700.00
Nickel	0.023±0.0009 <sup>b</sup>	NA	0.042±0.0030 <sup>a</sup>	NA	NA
Manganese	0.600±0.0286 <sup>a</sup>	9.24	0.615±0.0327 <sup>a</sup>	9.48	1.946
Magnesium	19.959±0.7745 <sup>b</sup>	1.71	23.396±1.0157 <sup>a</sup>	2.00	349.333
Iron	1.584±0.5021 <sup>a</sup>	5.94	2.327±0.1907 <sup>a</sup>	8.72	8.000
Cobalt	0.002±0.0005 <sup>b</sup>	NA	0.003±0.0006 <sup>a</sup>	NA	NA
Silicon	2.702±0.1031 <sup>a</sup>	NA	2.081±0.1492 <sup>b</sup>	NA	NA
Molybdenum	0.009±0.0016 <sup>b</sup>	6.00	0.030±0.0073 <sup>a</sup>	20.00	0.045
Chrome	0.025±0.0106 <sup>a</sup>	34.09	0.023±0.0115 <sup>a</sup>	31.36	0.022
Cadmium	0.002±0.0011 <sup>a</sup>	NA	0.002±0.0013 <sup>a</sup>	NA	NA
Aluminum	1.276±0.1000 <sup>a</sup>	NA	1.077±0.1709 <sup>a</sup>	NA	NA

Different letters on the same row indicate significant differences by the Student t test ( $p < 0.05$ ); \* RV: values assessed by the RDA average (Institute of Medicine, 2006); \*\* Average of recommendations for men and women (51 - 70 years); SD: standard deviation of the mean; NA: Not Available

**Figure 1. Acceptability Index of formulations of standard diet cookies (F1) and cookies added with 2.5% (F2), 5% (F3), 7.5% (F4) and 10% (F5) of cumbaru nuts in relation to the attributes evaluated**

They noticed in all formulations that the scores varied from Liked slightly to Liked very much, indicating a good acceptability as to taste. Regarding texture, there was no statistical difference between the samples. However, during the preparation process of cookies, the formulations with a higher percentage of nuts had a softer mass than the standard, a factor that can be attributed to the decrease of wheat flour. Regarding color, the highest average was attributed to the cookie without cumbaru nut, which may be due to the clearer and uniform color caused by the absence of color of the nuts and because it has zero sugar. In a study by Moraes *et al.* (2010), with cookies with different concentrations of sugar, the biscuits with a low sugar concentration were also lighter than the other cookies. Regarding Acceptability Index, as shown in Figure 1, all formulations presented indexes greater than 70% for all attributes. According to Teixeira *et al.* (1987), acceptability indexes above 70% classify the product with a good sensory acceptance. Therefore, the five formulations of diet cookies can be classified as well accepted by the tasters, evidencing a possible market purchase, which was confirmed in Table 1 by the purchase intent test. Some attributes such as aroma and flavor are probably the most relevant characteristics influencing the sensory properties of food products (Franco *et al.*, 2014). Therefore, the F5 sample (10%) was selected for comparison with the standard formulation (F1), since it was the one with the highest cumbaru nut content and with an acceptance similar to a standard one.

**Physical and chemical composition and minerals:** Table 2 shows the physical-chemical composition values of the standard diet cookie and the addition of 10% cumbaru nuts compared to a reference product. Different moisture and ash contents ( $p < 0.05$ ) were observed between F1 and F5. By comparing them with a study by Clerici *et al.* (2013), who evaluated cookies with a partial replacement of wheat flour for defatted sesame flour, the moisture in F1 was similar to that of the mentioned study, since F5 showed a higher content of moisture. However, both samples were in accordance with the Resolution RDC No. 263, dated from September 22, 2005, of the National Agency of Sanitary Surveillance (ANVISA), which provides technical regulations for cereal products, starches, flours and meal for the preparation of biscuits or crackers. The maximum moisture content is 15.0% (Brazil, 2005). Regarding ashes, the F5 sample had a higher content than F1, which is due to the addition of the cumbaru nut. The formulations F1 and F5 presented a higher amount of cash in their composition compared to the study by Clerici *et al.* (2013).

Silva *et al.* (2014), developed cookies with pequi almonds, which is a typical fruit of Brazilian Cerrado, and obtained values for proteins, lipids and carbohydrates, respectively: 9.89%, 23.33% and 57.47%, contents similar to those found in this study. The addition of 10% of cumbaru nut (F5) to cookies provided an increase of 44.41% in lipids and 15.78% in proteins when compared to F1. It should be noted that cumbaru nut lipids are composed mainly of monounsaturated and polyunsaturated fatty acids, which contribute to the reduction of the Low Density Lipoprotein (LDL) and Very Low Density (VLDL) fractions, responsible for the increase in serum cholesterol (Freitas, Naves, 2010). Júnior *et al.* (2007) prepared biscuits with different contents of cumbaru nut flour: 0%, 2%, 4%, 6% and 8%. The biscuit containing 8% of cumbaru almond flour presented only 1.49% of fibers.

However, the fiber content found in this work is higher (F5 = 16.06%), i.e., 542.40% above the value of the reference product (2.50%) (Table 2). This result can be explained by the addition of 11% inulin in the composition of cookies. According to the RDC No. 54 of November 12, 2012, a product is considered a source of dietary fiber when presenting at least 3% of fiber, and has a high content of at least 6% of fiber (Brazil, 2012). In this way, F5 can be considered as a product with a high fiber content, which considerably increased the RV in relation to the reference product. The consumption of fiber by diabetic patients may bring several benefits, such as obesity prevention, and may lower the risk of other non-communicable chronic diseases (Lachman *et al.*, 2014). In addition, fibers also exert effects on the human body, helping to avoid acute episodes of hyperglycemia and contributing to the stabilization of the glycemic curve, important variables in the control of Diabetes Mellitus (Henriques *et al.*, 2013; Lachman *et al.*, 2014). Table 3 describes the mineral values of the standard diet cookie and cookies with 10% of cumbaru nut and compares them with the Recommended Dietary Allowances (RDA) (Institute of Medicine, 2006). There was a statistical difference ( $p < 0.05$ ) between F1 and F5 for Nickel, Silicon, Cobalt, Molybdenum, Potassium and especially Magnesium, with a 17.22% increase in F5 composition. Ingestion of Magnesium may contribute to the reduction of the risk of Diabetes because this mineral is related to the increase in insulin sensitivity (Barbagallo; Domingues, 2013).

According to the RDC No. 54 of November 12, 2012, a product is considered a source of minerals when presenting at least 15% of minerals, and has a high content of at least 30% of the recommended daily intake (Brazil, 2012). Based on this legislation, we may consider that F5 is a source of molybdenum and potassium and has a high content of chromium. It is noteworthy to emphasize the importance of chromium, since its deficiency contributes to glucose intolerance and changes related to the lipid profile. This can be explained because its primary function is to potentiate the effects of insulin, with improved glucose tolerance, and consequently of the metabolism of carbohydrates and lipids (Gomes *et al.*, 2005). When comparing sodium and potassium values, an increase of 13.77% and 24.68%, respectively, was observed in the composition of F5, which can be explained by the addition of the cumbaru nut in its preparation. The increase in potassium content is emphasized since its ingestion is potentially beneficial for the control of blood pressure and prevention of cerebral vascular accidents (Aburto *et al.*, 2013).

## Conclusion

In this study, the development of the products allowed verifying that a level of addition of up to 10% of cumbaru nut in diet cookies was well accepted by the tasters, obtaining a sensorial acceptance similar to the standard product. The use of cumbaru nuts in the formulation of diet cookies changed the physical-chemical composition of the product, increasing the protein, lipid, fiber and mineral content and reducing carbohydrates. The addition of cumbaru nuts allowed a high fiber supply, improving the nutritional profile of the cookies. Thus, regional fruits such as cumbaru nuts can be incorporated into products for diabetics, with high expectations of market acceptance, suggesting future studies on packaging and shelf life.

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