

DEVELOPMENT AND ACCEPTABILITY OF A GLUTEN-FREE

DESENVOLVIMENTO E ACEITABILIDADE DE PRODUTO ISENTO DE GLÚTEN

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Abstract: Introduction: Celiac disease (CD) and gluten sensitivity imply permanent dietary changes that can restrict food intake and result in nutritional deficiencies. In this way, the development of gluten-free products can contribute to increasing the quality and variety of food for individuals with these dietary restrictions or who choose to restrict the consumption of gluten in their dietary routine. **Objective:** To develop a gluten-free product called “banaruta gnocchi”, using whole banana and arrowroot flour and to carry out a sensory analysis for accessible identification and purchase intention of the developed product. **Methods:** This is an experimental study based on the culinary preparation of a gluten-free product made entirely using plantain and arrowroot flour called “banaruta gnocchi”. The “banaruta gnocchi” was sensorially evaluated by the test of acceptability and purchase intention. Participants received and signed an informed consent form. Samples of “banaruta gnocchi” were distributed on plates accompanied by untrained tasters (n=79), along with the evaluation form and a glass of water. The evaluation form contained the facilitated test using a structured nine-point hedonic scale, anchored in the terms: I disliked it very much (1) and I liked it very much (9) and the purchase intention test with a structured five-point scale, anchored in the terms: certainly would not buy this

product (1) and would certainly buy this product (5). Descriptive statistics were performed on the data, considering that measures of central tendency and dispersion (mean and standard deviation) were calculated for continuous or discrete variables, and absolute (N) and relative (%) frequencies for categorical variables. **Results:** The results of the sensory analysis indicated that the product presented good accessibility for all evaluated attributes (global impression, flavor, texture and aroma), with an acceptability index greater than 77%. The purchase intention of “banaruta gnocchi” was 86.1%. **Conclusion:** The “banaruta gnocchi” showed good acceptability and purchase intent, and can be used as an alternative gluten-free food for the public with restricted consumption of this protein, allowing an increase in the variety of supply for these consumers and stimulating the consumption of products traditions from the Northeast region of Brazil.

Keywords: Celiac Disease; Gluten; Gluten Free Diet.

INTRODUCTION

Celiac Disease (CD) is triggered by autoimmune mechanisms in genetically predisposed individuals and is characterized as an enteropathy related to permanent gluten intolerance, which causes intestinal inflammation and decreased villi due to the non-digestion of the fractions that constitute such protein (gliadin and glutenin), present in foods such as wheat, rye and barley ⁽¹⁾.

It is worth noting, however, that some individuals may develop a reaction to gluten without a diagnosis of celiac disease. This condition is defined as sensitivity to non-celiac gluten (NCS), with an exclusively clinical diagnosis, performed after the exclusion of other gluten-related diseases, characterized by symptoms such as abdominal distension, diarrhea, epigastric pain, nausea and constipation when consuming gluten or any of these protein fractions ⁽²⁾. There are also other gluten-related disorders (GRD) such as gluten ataxia, herpetiform dermatitis and allergy to wheat or gluten ⁽³⁾.

The estimation of the prevalence of celiac disease and gluten-related diseases in the population is hampered due to the wide clinical variability of the disorders (classical clinical manifestations, atypical or non-classical clinical manifestations, mono or oligo or asymptomatic clinical evolution) and the oscillation of the clinical characteristics of these diseases throughout the life of the individual that can result in problems related to the recognition of the diseases presented, errors of diagnosis and underreporting ⁽⁴⁾.

Considering this limitation, it is estimated that the worldwide prevalence of celiac disease and gluten sensitivity in the population is 1% and 6%, respectively ⁽⁵⁾. In Brazil there are no official

statistics on the occurrence of these diseases ⁽⁶⁾. A doença celíaca pode se desenvolver em qualquer idade, sendo que mais de 70% dos novos casos são diagnosticados em indivíduos com idade >20 anos. Celiac disease can develop at any age, and more than 70% of new cases are diagnosed in individuals aged >20 years. The disease primarily affects women, first and second degree relatives of patients with celiac disease, individuals with Down syndrome, with type 1 diabetes mellitus and other autoimmune diseases ⁽⁴⁾.

The treatment of celiac disease, gluten sensitivity and other gluten-related disorders consists of the exclusion of foods containing gluten from the diet and the tracking of micronutrient deficiencies, since dietary restrictions can lead to the development of nutritional deficiencies due to food monotony and constant dissatisfaction of individuals with such pathologies with the restrictive diet⁽⁷⁾. Thus, it is necessary to develop preparations and products that use ingredients that do not have gluten and their protein fractions in their composition, but that preserve the nutritional quality for the composition of an adequate and healthy diet.

Restrictions on the consumption of gluten are imposed not only by the pathologies related to the consumption of this protein, since the number of healthy individuals who choose to perform this restriction is growing due to the adoption of a lifestyle that contemplates this food practice. In these cases it is also important to emphasize that, as gluten-free diets are often poor in whole grains and fiber, food substitutions should be carried out in a targeted and careful way to avoid damage to health ⁽⁹⁾.

In the context of healthy food options that replace foods that contain gluten, arrowroot flour stands out as a gluten-free food that has claims of functional properties, due to the composition of prebiotics and immunomodulatory effect⁽⁸⁾. From a gastronomic and technological point of view, arrowroot flour stands out for the potential to replace traditional flours, constituting itself as a viable food for dietary consumption of individuals with celiac, sensitive or carriers of other diseases related to the consumption of gluten, and may also diversify the diet of individuals who choose to restrict or exclude gluten from the dietary routine by choice or lifestyle^(10,11).

The banana of the earth, in turn, is rich in zinc, phosphorus, calcium, iron, vitamin A and vitamin C, in addition to being considered a delicacy in cooking, due to its versatility and potential for use in sweet and savory preparations. However, conventionally only the pulp from food is used, disregarding the use of the peel, which can increase the nutritional intake of the preparations and reduce the disposal of waste produced in the food preparation and also increase the yield of the preparations⁽¹²⁾.

Thus, the objective of this study was to develop a gluten-free product using fully using arrowroot and plantain flour (typically northeastern products and of high nutritional quality) and to

perform sensory analysis to identify acceptance and purchase intention of the product developed for use in patients who have disorders related to the consumption of gluten and the healthy population that chooses to restrict the consumption of this protein.

METHODOLOGY

This is an experimental study developed in the Laboratories of Dietary Technique and Sensory Analysis of the Adventist College of Bahia (FADBA) in October 2022. Untrained tasters were recruited randomly as convenient on the university campus of the educational institution, located in Cachoeira - BA.

The preparation was identified as "nhoque banaruta". After the acquisition of the ingredients at a local free market, individualized washing of each vegetable (vegetable/fruit) was carried out under running water to remove apparent dirt and then disinfection was carried out using sauce in a chlorinated solution with water and sodium hypochlorite from 2.0 to 2.5% for 15 minutes.

For the preparation of the dough, the ingredients were weighed in a precision scale with a capacity of up to 10 kg and a scale of 1 gram. 446 grams of plantain with an adequate degree of maturation (mature), 26 grams of previously processed acquired araruta flour and 1 gram of salt were used. Initially, all raw ingredients immersed in chlorinated solution were sanitized for 15 minutes. Then he proceeded with steaming the bananas for eight minutes using a stainless steel pan for two-layer steam cooking brought to the medium fire of a 4-burner industrial stove. Subsequently, the shells were removed with the help of a knife with stainless steel blades. The peels were reserved in a glass container with a lid of adequate capacity for the volume of the food (approximately 500 grams) Then the pulp of the earth banana was kneaded on a glass board suitable for food and specific for vegetables with the help of a stainless steel fork and mixed with the araut flour and salt, until the consistency was homogeneous. The dough was wrapped in the shape of strips on a previously sanitized smooth surface (marble countertop) and cut into pieces of approximately 1.5 cm with the aid of a knife with stainless steel blades. After preparation, the pieces of the dough of the "banaruta shog" were poured into 2 liters of boiling water contained in a stainless steel pan with adequate capacity (approximately 4.5 liters). The cooking time was determined when the dough emerged to the surface (approximately 2 minutes).

The ingredients of the sauce were also weighed on a precision scale with a capacity of up to 10 kg and a 1 gram scale. The liquid ingredient (extra virgin olive oil) was measured using a small measuring cup (15 ml and 1 ml scale). Banana peels (128 grams), white onion (119 grams), garlic (19 grams), tomato (274 grams), green pepper (47 grams), cilantro (20 grams), extra virgin olive oil (14

milliliters), salt (4 grams), black pepper (1 gram), paprika (1 gram) and saffron (1 gram) were used. For preparation tomatoes, peppers, onions, garlic and coriander were chopped and sauteed in a stainless steel frying pan brought over medium heat from a 4-burner industrial stove for 15 minutes. After cooling (3 minutes at room temperature) the preparation was subjected to the blender for 1 minute for processing and was then sifted in a fine-weft stainless steel sieve. The peel of the earth's banana (previously reserved) was incorporated into the sauce, part cut into small cubes (43g) and part crushed next to the sauce in a blender (85g). After the incorporation of the banana peel, the sauce was poured into a stainless steel pan with a capacity of 5.0 liters until boiling, when black pepper, paprika, saffron and salt were added.

The sensory analysis was performed at the Sensory Analysis Laboratory of the FADBA. Initially, the volunteer testers were gathered in a room attached to the laboratory and at this time informed about the type of sensory analysis, preparation in test and the way of filling out the analysis forms and after agreement the participants were referred to the individualized test booths equipped with white light, according to the order of arrival.

The present study was approved by the Research Ethics Committee of the Adventist College of Bahia (CAAE 61403822.2.1.0000.0042). All participants signed the Free and Informed Consent Form (TCLC), being excluded from the research, participants with the flu or in allergic crisis, who presented intolerance/allergies to any of the components of the preparation and who did not like gnocchi or banana from the earth.

Each taster received a tray containing a sample of 20 grams of gnocchi with 20 grams of sauce, served in 200 milliliter disposable white dishes, randomly distributed and identified according to codes of the Manual of Sensory Analysis of the Adolfo Lutz Institute⁽¹³⁾ along with an evaluation sheet, a glass of water to wash the palate before the sample tasting, a napkin, a disposable fork and a pencil.

The samples were subjected to the global acceptance test using a nine-point hedonic scale⁽¹⁰⁾, ranging from "I liked it very much" (9) to "I disliked a lot" (1). The attributes of appearance, aroma, flavor, texture and overall impression were evaluated.

The purchase intention test was carried out by filling a structured five-point scale, anchored in the terms "I would certainly not buy this product" (1) and "I would certainly buy this product" (5). Ranging between the options "I would probably not buy this product" (2), "I have doubts whether or not I would buy this product" (3) and "I would probably buy this product" (4).

Table 1 presents the analysis form provided to untrained volunteers.

Taste the sample and indicate your opinion regarding appearance, aroma, flavor, texture and overall impression, using the scale below:

Appearance:	
Aroma:	
Flavour:	
Texture:	
Global Impression:	

9. I liked it too much
8. I really liked it
7. I liked it moderately
6. I liked it slightly
5. I neither liked/disliked
4. Slightly disliked
3. Moderately disliked
2. I really disliked it
1. I disliked too much

Indicate your intention to purchase the product:

- I would certainly not buy this product (1)
- I probably wouldn't buy this product (2)
- I have doubts whether or not I would buy this product (3)
- I would probably buy this product (4)
- I would certainly buy this product (5)

Source: Prepared by the authors, 2022.

All data were posted in a Microsoft Excel spreadsheet. Performed descriptive statistics of the data. For continuous or discrete variables, measures of central tendency and dispersion (mean and standard deviation) were calculated, and for categorical variables, absolute (N) and relative (percentages) frequencies. The averages obtained were used to calculate the Acceptability Index (IA) being calculated by the expression: $IA (\%) = \frac{A \times 100}{B}$, where A= average score obtained for the product and B= maximum score given to the product ⁽¹³⁾.

RESULTS

Participated 79 untrained volunteers with an average age of 23.0 years (SD=6.0).

Table 1 presents the characterization of the sample of tasters according to sex, function performed in the institution and undergraduate course.

Table 1 – Characterization of the sample of tasters according to sex, function and undergraduate courses, Cachoeira - BA, 2022

VARIABLE	NUMBERS OF TASTERS	%
Sexo		
Male	24	30,38
Female	55	69,62
Function		

Student	71	89,87
Teacher	2	2,53
Employee	6	7,60
Students' undergraduate course		
Nutrition	38	53,52
Dentistry	14	19,72
Psychology	8	11,27
Theology	3	4,23
Pedagogy	2	2,82
Administration	1	1,41
Law	1	1,41
Accounting	1	1,41
Tech management. of information	1	1,41
Physioteraphy	1	1,41
Nursery	1	1,41

Source: Prepared by the authors, 2022.

The results of the sensory analysis of the preparation are described in Table 2 according to the sensory attributes evaluated.

Table 2 - Sensory analysis of “banaruta gnocchi” according to the attributes of interest, Cachoeira – BA, 2022 (n = 79).

SENSORY ATTRIBUTE	AVERAGE ± DP	ACCEPTABILITY INDEX (%)
Aroma	8,00 ± 0,95	90,1
Texture	8,00 ± 1,11	89,5
Flavour	8,00 ± 1,40	89,2
Impressão Global	7,00 ± 2,18	81,7
Appearance	7,00 ± 1,70	77,7

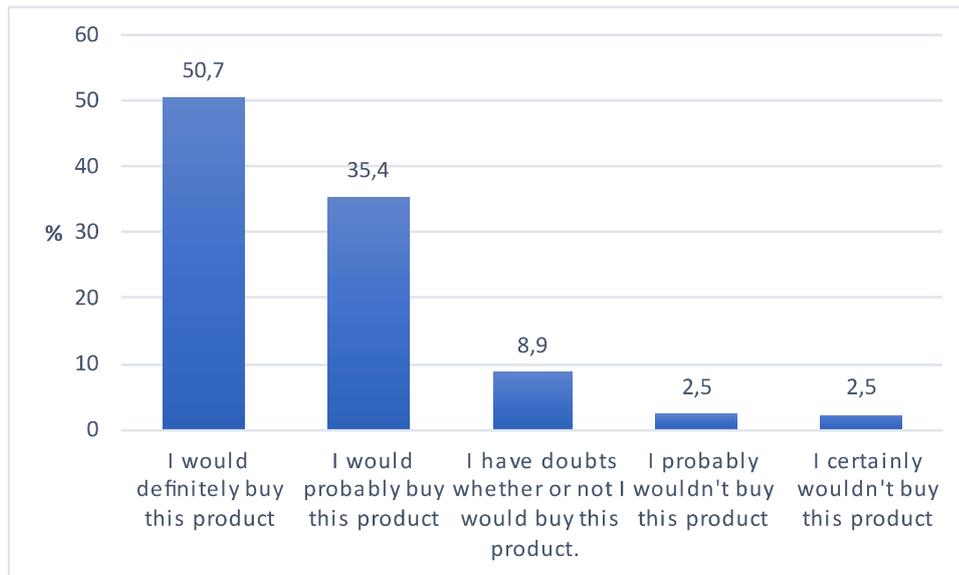
Source: Prepared by the authors, 2022.

Legend: SD = Standard Deviation

It is noteworthy that all sensory attributes received scores higher than 77.7%, noting that in relation to the attributes evaluated, the "gnocchi banaruta" obtained a higher index of acceptability in the aroma aspect (90.1%) and lower in relation to appearance (77.7%).

In graph 1, is contained the information related to the purchase intention of the "snhoque banaruta".

Graph 1 - Purchase intention of “banaruta gnocchi”, Cachoeira – BA, 2022 (n = 79).



Source: Prepared by the authors, 2022.

It is noted that 50.6% (n=40) and 35.4% (n=28) indicate that they would "certainly buy" and that they would "probably buy" the product, respectively. Thus, adding up such purchase intentions, it is understood that the positive purchase intention of the "banaruta nhoque" is 86.1% (n=68).

The doubt about the purchase of the product was presented by 8.9% (n=7) of the tasters ("I have doubt whether or not I would buy this product").

The negative intention to buy, in turn, was manifested by 2.5% (n=2) which states that "certainly would not buy" and by another 2.5% (n = 2) who indicate that "probably would not buy" the product, totaling 5.0% (n = 4) of negative purchase intention.

DISCUSSION

The "banaruta snuck" showed good acceptance for all the sensory attributes evaluated, with emphasis on aroma, flavor, texture and global impression (acceptability index >80%). In addition, the product obtained satisfactory purchase intention (86.1%). These results indicate the feasibility of using the product developed in this study, in sensory terms, in the feeding routine of patients with celiac disease, sensitivity and gluten-related disorders. In addition, it is emphasized the possibility of including this product in the daily life of healthy individuals who wish to limit or exclude gluten from their diets.

The scientific literature indicates that gluten-free nutritional prescriptions have difficulty in executing among individuals with pathologies related to the consumption of this protein, as reported in the review study carried out by Vilarinho et al.⁽¹⁴⁾ that gathers evidence that the performance of a gluten-free diet is complex mainly among children and adolescents.

Corroborating these findings, Rodrigues et al.⁽¹⁵⁾ indicate that 20% of the participants in their study report not being able to avoid foods with gluten at all times, failing to comply with the dietary prescription on a voluntary basis (53.8%), mainly due to the high cost and low acceptance of the gluten-free diet (30.8%) due to monotony and low food variability. On the other hand, Levran et al.⁽¹⁶⁾ point out that 70.0% of parents of patients with gluten-related disorders interviewed report that their children have never consumed gluten consciously and that 50.0% consume foods that have gluten residues, especially given the difficulty of finding and identifying gluten-free foods in the market.

The problems in the execution of the gluten-free diet are also extended to healthy individuals who choose to restrict the consumption of gluten in their eating routine even without presenting disorders related to the consumption of this protein, because the misguided exclusion of food sources of gluten, without proper nutritional care, can cause a decrease in food variability, imbalance in the proportion of macronutrients and the supply of vitamins and minerals⁽¹⁷⁾.

In this context, it is worth highlighting the position of the Brazilian Food Society on a gluten-free diet that indicates that there is not enough scientific evidence to assume that healthy individuals have benefits such as the consumption of a gluten-free diet, establishing the counterpoint that these diets can be healthy for the general population, provided that the withdrawal of foods with gluten is compensated by the ingestion of other whole grains, and vegetables of low energy density⁽⁹⁾.

In this perspective, the "banaruta gnocchi" can be incorporated into an adequate, balanced and healthy diet both for celiac patients, with sensitivity or disorders related to gluten, and for the general population, since its formulation uses as a basis rich in nutrients and traditional foods from the Northeast region of Brazil (earth banana and araruta), in addition to adding the logic of sustainability and food economy by promoting the integral use of the banana of the earth, constituting itself as a viable food substitution option to avoid imbalance and nutritional deficiencies related to food monotony, in addition to financial expenditure, since, another limiting factor For the follow-up of the nutritional prescription of gluten exemption is the financial one, as pointed out in a study conducted in the city of São Paulo, which indicates that a diet with gluten-free products can be approximately 44.0% more expensive than a diet with conventional products⁽¹⁸⁾.

In this way, the applicability of the development of new products for the population with gluten restriction is reinforced, with culinary preparations that explore regional foods, easily accessible and low cost, enabling variety of preparations and food diversity, respecting the eating habits of individuals, the palatability and acceptability of products.

In the present study, the smallest conceptual attribute in the sensory evaluation was the appearance (average grade 7.00 ± 1.70 and acceptability index 77.7%), this result can be the attribute

the color of the product, impacted by the addition of the banana peel of the land that modified the characteristic color of the traditional tomato sauce (bright red), this fact probably interfered with the visual affective memory linked to the product and the note assigned, consequently. However, despite the result below that observed in the other attributes, it is emphasized that the "gnocchi banaruta" also presented visual acceptance (appearance) of the product.

When analyzing gluten-free gnocchi enriched with green banana biomass, Santos et al.⁽¹⁹⁾ obtained acceptance results regarding the flavor of 78%, aroma of 90%, appearance of 60%, texture of 66% and overall acceptance of 80%, results below those observed in the present study. Paiva et al.⁽²⁰⁾, in turn, when evaluating doughs based on sorghum flour and corn flour also did not obtain satisfactory sensory analysis results, since the sensory attributes were less than 70% both for the compound dough 100% of sorghum flour and for the mixture 50% of sorghum flour and 50% corn flour.

Thus, the present study stands out with promising results of acceptability, prioritizing the use of easily accessible ingredients in the Northeast region, such as arrowroot flour and plantain. This initiative has technological potential, since no publications were found until the time of the present study on the development of gluten-free gnocchi prepared with full use of the ground banana and with arrowroot flour. In addition, with the gradual increase in the number of people intolerant to gluten and adapting the restriction of this protein, there is a lack of products intended for this public, which add nutritional, sensory quality and practicality in the preparation.

CONCLUSION

The "banaruta gnocchi" was prepared with low-cost ingredients and high nutritional quality in order to constitute a viable option for the replacement of foods with gluten for patients with disorders related to the consumption of this protein and for healthy individuals who choose to restrict it in their eating routine. The choice of the basic ingredients in the formulation prioritized the integral use of the earth banana in order to reduce the production of food waste and optimize the nutritional intake of the product, striving for the valorization of the food culture and the agricultural tradition of the Northeast of Brazil by giving protagonism to the earth banana and arut flour, basic products of the food routine of the northeastern people with wide applicability and dietary cuisine. The results of the sensory analysis and purchase intention presented in the present study indicate success in the elaboration of the product, indicating the practical possibility of using the "banaruta snucko" for the reduction of food monotony and improvement of the nutritional quality of diets restricted in gluten in various audiences.

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