Green bananas and carrots add nutritional and sensory value to yoghurt

Banana verde e cenoura adicionam valor nutricional e sensorial ao iogurte

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ABSTRACT

The actions and priorities of the Strategic Action Plan to Combat Chronic Non-Communicable Diseases in Brazil include the consumption of vegetables and fruit, as they are sources of vitamins, minerals and fibers. Thus, also meeting the demand for foods with convenient consumption, together with microbiological and nutritional security, we...
sought to develop a product adding green bananas and carrots to yoghurt, in order to offer the consumer a practical, nutritious food, with a low-glycemic index. For this purpose, we performed microbiological, physicochemical and sensory tests. We determined the Most Probable Number (MPN/g) of thermotolerant coliforms, evaluated the centesimal composition and performed acceptance and purchase intention tests with elementary school students in the city of Bananeiras, Paraíba. The MPN/g of thermotolerant coliforms was 9.2, which is below the maximum established by current legislation. There was a 23% increase in protein content and 33% in minerals, as well as a reduction in moisture content, which indicates an adding nutritional value and longer shelf life of yoghurt with the addition of flour. In the sensory analysis, the judges had the opportunity to evaluate three yoghurt formulations, with concentrations of 2%, 3% and 4% of green banana and carrot flours and they classified the yoghurt in the “good” category. The addition of green banana and carrot flours is promising in yoghurt production, providing pleasant flavor according to the tasters, and promoting a greater supply of nutrients, especially protein and fiber, which indicates functional characteristics of the product.

**Keywords:** Green bananas. Yoghurt. Vegetables.

**RESUMO**

As ações e prioridades do Plano de Ação Estratégico de Combate às Doenças Crônicas Não Transmissíveis no Brasil incluem o consumo de vegetais e frutas, pois são fontes de vitaminas, minerais e fibras. Assim, atendendo também à demanda por alimentos com consumo conveniente, aliados à segurança microbiológica e nutricional, buscamos desenvolver um produto que agregue bananas verdes e cenouras ao iogurte, a fim de oferecer ao consumidor um alimento prático e nutritivo, com baixo índice glicêmico. Para tanto, foram realizados testes microbiológicos, físico-químicos e sensoriais. Determinamos o Número Mais Provável (MPN / g) de coliformes termotolerantes, avaliamos a composição centesimal e realizamos testes de aceitação e intenção de compra com alunos do ensino fundamental da cidade de Bananeiras, Paraíba. O MPN / g de coliformes termotolerantes foi de 9,2, valor abaixo do máximo estabelecido pela legislação vigente. Houve um aumento de 23% no teor de proteínas e 33% em minerais, além de uma redução no teor de umidade, o que indica um valor nutricional agregado e maior vida útil do iogurte com a adição de farinha. Na análise sensorial, os juízes tiveram a oportunidade de avaliar três formulações de iogurte, com concentrações de 2%, 3% e 4% de farinhas de banana e cenoura verdes e classificaram o iogurte na categoria “bom”. A adição de farinhas de banana e cenoura é promissora na produção de iogurte, proporcionando sabor agradável de acordo com os provadores e promovendo um maior suprimento de nutrientes, principalmente proteínas e fibras, o que indica características funcionais do produto.

**Palavras-chave:** Bananas verdes. Iogurte. Legumes.

1. **INTRODUCTION**

The constant search for quality of life has encouraged the development of food products with functional properties. These products have been seen as a new trend in the food market, as they positively contribute to one or more of the organism's physiological
purposes, promoting health and collaborating on reducing disease risk (SILVA et al., 2016).

Among food products with functional properties, yoghurt stands out for being also an important source of nutrients for metabolism (PIOVESAN et al., 2016). Its production is obtained through bacterial fermentation that leads to increased durability, adding countless nutritional properties, and it is also considered safe from a microbiological point of view (SILVA et al., 2012).

In Brazil, the Brazilian Health Regulatory Agency (ANVISA) regularized functional foods according to Resolution RDC No. 02, January 7, 2002, which certifies the technical regulation of bioactive substances and probiotics isolated with claim of functional or health property. Functional foods can be attributed to several typologies. Some may be added, specifically designed to decrease the risk of disease for a particular group of people, others may be conventional foods with added bioactive components, which are associated with positive health outcomes (BALDISSERA et al., 2011).

Green bananas contain bioactive compounds and their addition in flour form to yoghurt can be a great innovation alternative to add functional value and increasingly attract the consumer. Green banana flour (GBF) is a great source of resistant starch and protein, potassium, copper, phosphorus, magnesium, among others, and can be used in baking, confectionery, infant food and for the production of dietary supplement products (SILVEIRA et al., 2017)

The GBF has a pleasant flavor and light color and it can be used to replace other flours without damaging the sensory characteristics. This flour is obtained by natural or artificial drying of green banana pulp, with a considerable amount of protein, mineral salts and high levels of dietary fibers. In addition to the nutritional and physiological advantages, the manufacture of green banana flour generates a positive result in the banana production chain through the utility of byproducts (CARMO, 2015).

The utilization of vegetables by means of flour is another technically and economically viable option, since dehydration reduces the risk and time of deterioration, besides minimizing the volume and facilitating transportation (PEREIRA et al., 2014). Carrot flour is a good choice for substituting part of wheat flour in bakery product elaborations, with the benefit of improving the nutritional product’s value. It is a great source of carotenoids, fibers, vitamins, minerals and other bioactive items, of which the most important is β-carotene (TEIXEIRA et al., 2011).
Thus, we sought to make yoghurt with banana and carrot flours, and to characterize its microbiological, physicochemical and sensory quality, in order to offer a nutritious product with functional properties.

2. METHODOLOGICAL PROCEDURES

2.1 MATERIALS

2.2.1 Acquisition of carrot and green banana flours

The green banana (GBF) and carrot (CF) flours were purchased from the company “Chá e Cia - Produtos Naturais”, CNPJ: 08.852.492 / 0001-55, located at Avenida Carlos Frederico Werneck Lacerda, Cidade Jardim, Jacareí – SP, Brazil. The products are guaranteed by their manufacturers, distributors and importers, attesting to the quality of their products.

2.3 METHODS

2.3.1 Producing yoghurt with carrot and green banana flours

Initially, we made the yoghurt adding 4% of carrot flour, 4% of green banana flour and 10% of sugar, according to the flowchart shown in Figure 1. UHT milk from the same brand and lot was used. The production took place at the Milk and Dairy Technology Laboratory of the Center for Human, Social and Agrarian Sciences, Federal University of Paraíba.

Figure 2. Production flowchart of yoghurt with green banana and carrot flours.
2.3.2 Microbiological analysis of yoghurt with the addition of green banana and carrot flours

Even though the industrialized flours have their quality attested by the supplier company, the microbiological evaluation of the yoghurt was performed with its addition. According to RDC No. 12 of January 2, 2001, the analysis of coliforms at 45°C is required.

2.3.3 Physicochemical analysis of yoghurt with the addition of carrot and banana flours and yoghurt without the addition of flours

For this stage, two yoghurt formulations were made: one with the addition of flour, at a concentration of 4% each (F1); and another without the addition of flour (F0). The aim was to investigate the increase in nutritional value after the addition of flour.

The determination of the centesimal composition of yoghurt was made according to the methodology proposed by the Association of Official Analytical Chemists (AOAC, 2002) in triplicate, obtaining the centesimal fractions of moisture, ash, total fat and total protein. We also determined the levels of reducing and total sugars.

2.3.4 Sensory analysis

For sensory evaluation, we made three formulations with the same sugar concentration (10%), but with variation in the amount of flour: formulation 1 (F1): 4% of each flour (GBF and CF); formulation 2 (F2): 3% of each flour (GBF and CF) and formulation 3 (F3): 2% of each flour (GBF and CF).

The yoghurt sensory evaluation was performed from the acceptance test, with 60 pre-selected tasters according to their interest and consumption of the food product. The judges were elementary school students from a municipal school in the city of Bananeiras - PB, ranging from 6 to 12 years of age, from any social class, non-yoghurt consumers who had some kind of disease that could interfere with the final results of the sensory analysis were excluded from the test.

Prior to the application of the test, the School received a copy of the project, with free and informed consent, to authorize the research.

Students assessed the attributes appearance, color, aroma, flavor, consistency, and global evaluation on a 5-point hedonic scale, ranging from 1 (very bad) to 5 (very good) (GUTIERREZ et al., 2008).
In addition, the Acceptability Index (AI) was calculated using the equation described by Castro et al. (2007), in which: \( AI = \frac{\text{Average score obtained for the product}}{\text{Highest score given to the product}} \times 100. \)

### 2.3.5 Statistical analyses

Statistical analyses were performed using descriptive (mean and standard error) and inferential (Tukey’s test) statistical tests to determine statistically significant differences (\( p < 0.05 \)) between the applied treatments. For statistical treatment, we used the Sigma-Stat 3.5 software.

### 2.3.6 Research Ethics Committee Evaluation

The study was evaluated by the Research Ethics Committee of the Center for Medical Sciences of the Federal University of Paraíba and approved under the CAAE registration: 91725318.7.0000.8096.

### 3. RESULTS AND DISCUSSION

#### 3.1 MICROBIOLOGICAL ANALYSIS OF F3 YOGHURT (4%)

The Most Probable Number of Thermotolerant Coliforms was 9.2, below the maximum established by current legislation (BRASIL, 2001). This could be due to the hygienic care during yoghurt production that prevented post-production contamination, since the main factors for coliforms growth in yoghurt production are microbiological quality of any ingredients introduced into yoghurt (KIROS et al., 2016).

Cruz et al. (2015), in previous research with yoghurt, showed that the product was fit for consumption, because also did not detect the presence of this group of microorganisms. These data were similar with the results reported by Kiros et al. (2016), who observed that yeast and mould (YMC) and coliform counts (CC) were below 10 CFU/g\(^{-1}\) (i.e., below the detection limit). Salwa et al. (2004) reported also that the use of carrot with yoghurt was advantageous due to its antibacterial and antifungal properties as well as its inhibitory effect on aflatoxin M1. In addition carrot is safe for public health and used as vitaminized food supplement.

3.2. Physicochemical analyses of yoghurt with (F1) and without (F0) addition of green banana (GBF) and carrot (CF) flours.
The results of the physicochemical analyses performed with yoghurt without addition and with addition of GBF and CF are expressed in Table 1.

According to Brasil (2007), in order to consider a product as yoghurt, it must have firm consistency, and there may be at most 30% of additions, white or similar to the increment used, characteristic odor and flavor or according to the added substances. GBF and CF-added yoghurts met all these requirements.

We observed an increase in protein content from 3.0% to 3.7% and reducing sugars from 2.15% to 2.62% at a 5% significance level.

Medeiros et al. (2011), who also worked with yoghurt, has found similar results with the addition of jackfruit, and did not find significant differences in lipid, ash and protein values, but only in carbohydrates, with an increase from 13.15% to 17.41%.

Table 1. Physicochemical analyses of yoghurt made with (F1) and without (F0) the addition of green banana (GBF) and carrot (CF) flours.

| Product | Physicochemical Parameters |
|---------|---------------------------|
|         | Humidity (% ± SE) | Ash (% ± SE) | Lipid (% ± SE) | Protein (% ± SE) | Reducing Sugar (% ± SE) | Total Sugar (% ± SE) |
| F1 (4%) | 78,33±0.10ª | 0,40±0.08ª | 3,7±0.14ª | 3,7±0.04ª | 2,62±0.04ª | 9,1±0.29ª |
| F0 (0%) | 80,10±0.78ª | 0,32±0.04ª | 3,3±0.17ª | 3,0±0.17b | 2,15±0.02b | 9,3±0.12a |

Yoghurt formulations with equal letters in the column did not differ statistically by Tukey’s test at 5% probability.

SE = standard error.

3.3 SENSORY ANALYSIS

The results of the acceptance test can be seen in Table 2. For the attributes appearance, color, aroma, consistency and global evaluation there were no significant differences between the yoghurt formulations, but for the flavor attribute, a difference was detected between the formulations 1 (4%) and 3 (2%), and the formulation with higher concentration of flour received higher scores. Even realizing the difference, the children could not identify which type of vegetable was present.

In a research by Cruz (2015) using carrot caviar in yoghurt, it was found that the children consumed the product and also could not notice which vegetable was present there. According to him, this can be a positive aspect in infant nutrition, considering children usually have sensory resistance to the consumption of carrots and thus, they can consume the product and enjoy the nutrients present in vegetables.
Table 2. Mean and standard error values of the hedonic scores of the acceptance test, and Acceptability Index for yoghurt formulations, according to the evaluated attributes.

| Attributes       | Yoghurt formulation GBF and CF | Acceptance test | Acceptability Index |
|------------------|--------------------------------|-----------------|---------------------|
|                  | (F1) 4%                        | (F2) 3%         | (F3) 2%             |
| Appearance       | 3.86±0.09a                     | 3.85±0.08a      | 3.86±0.09a          | 77.2  | 77   | 77.2 |
| Color            | 4.13±0.09a                     | 4.00±0.09a      | 3.90±0.09a          | 82.6  | 80.2 | 78.0 |
| Aroma            | 4.10±0.13a                     | 3.71±0.11a      | 3.73±0.12a          | 82.6  | 74.2 | 74.6 |
| Flavor           | 4.23±0.16a                     | 3.78±0.15a      | 3.50±0.14b          | 84.6  | 75.6 | 70.0 |
| Consistency      | 3.88±0.11a                     | 4.18±0.12a      | 3.93±0.12a          | 77.6  | 83.6 | 78.6 |
| Overall rating   | 4.43±0.10a                     | 4.41±0.10a      | 4.46±0.10a          | 88.6  | 88.2 | 89.2 |

Yoghurt formulations with equal letters on the line did not differ statistically by Tukey’s test at 5% probability.

In disagreement with Cruz (2015), we suggest that educational actions should be taken to inform children about the importance of consuming vegetables, explaining about their health benefits and how their use can become versatile and creative, so they start consuming them in a pleasant and conscious way.

Regarding the Acceptability Index, yoghurts had acceptability ranging from 70% to 89.2%. According to Teixeira et al. (2018), in order to be considered accepted by the tasters, a product must obtain acceptability index scores greater than 70%. We observed that the most appreciated yoghurt was the 4% concentration one, what caused surprise and satisfaction, as it contains the highest amount of carrot and green banana flours.

Similar results were found by Schmidt et al. (2012), in an acerola cherry pulp yoghurt, which also reached acceptability index greater than 70%, but the yoghurt with the lowest concentration was the most appreciated one, differing from the mentioned work.

In the facial hedonic sensory evaluation test, concepts were attributed to the figures that varied numerically from left to right in 1. “very bad”, 2. “bad”, 3. “neither good nor bad”, 4. “good” and 5. “very good”. According to the results, the average acceptance scores obtained for all samples was about 4.00, qualifying the yoghurts in the “good” category. The yoghurt made by Gonçalves e Leão (2013) with mixed flour containing passion fruit peel and apple pomace did not have good acceptance, since the score was between 5 (neither like nor dislike) and 6 (like slightly). It reinforces the idea that vegetables increase flavor and stand out in yoghurt production.
Table 3. Evaluation of affective test of yoghurt with GBF and CF by facial hedonic scale.

| Yogurt formulations with GBF and CF | Mean ± SE  |
|-----------------------------------|------------|
| (F1) 4%                           | 4.3 ± 0.15a|
| (F2) 3%                           | 3.93 ± 0.13a|
| (F3) 2%                           | 4.13 ± 0.12a|

Yoghurt formulations with equal letters in column did not differ statistically from each other (p>0.5). SE = standard error.

We also investigated the purchase intention of the judges, whose data are described in Table 4. They pointed out that they could possibly buy yoghurt with the addition of green banana and carrot flours, showing no influence between the tested concentrations, what leads us to believe that the product is promising in the market.

Table 4. Purchase intention of evaluators for yoghurt with GBF and CF.

| Yoghurt formulations with GBF and CF | Mean ± SE  |
|-------------------------------------|------------|
| (F1) 4%                             | 4.1 ± 0.15a|
| (F2) 3%                             | 3.7 ± 0.14a|
| (F3) 2%                             | 3.7 ± 0.15a|

SE = standard error

4. CONCLUSION

Dietary fibers incorporation to foods is vital with regard to nutritional and technological aspects. The use of local vegetable resources as raw materials for obtaining yoghurt, such as the green banana and carrot flours, is promising in yoghurt production, providing pleasant flavor according to the tasters. It promotes a greater supply of nutrients, especially protein and fibers, which make it a product with functional characteristics.

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