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Potencial funcional do iogurte de beterraba

Functional potential of beet yogurt

Potencial funcional del yogur de remolacha

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Resumo

Objetivo: Elaborar um iogurte com adição de farinhas de beterraba e banana verde, no intuito de agregar valor nutricional e fazer dessa bebida um alimento funcional, já que o aporte de

vitaminas, minerais e fibras pode auxiliar na prevenção de Doenças Crônicas Não Transmissíveis (DCNT). Métodos: Foram realizados testes microbiológicos, físico-químicos e sensoriais, para atestar a inocuidade à saúde, a agregação de valor nutricional e a aceitação pelos consumidores, respectivamente. Resultados: O iogurte elaborado com 4% de cada uma das farinhas apresentou coliformes a 45ºC dentro dos valores máximos estabelecidos pela legislação vigente e se mostrou enriquecido em seu valor nutricional, com destaque para um aumento de proteínas em 21% e minerais em 133%. Ainda, apresentou redução no teor de umidade, resultando em um produto com maior vida de prateleira. Para o teste sensorial elaborou-se 3 formulações de iogurtes (4%, 3% e 2%) e foi observada uma tendência à preferência pela formulação que continha menos concentração de farinha de beterraba ($p>0.05$). Entretanto, em relação a intenção de compra, os resultados obtidos demonstram que os provadores talvez comprassem o produto, se o mesmo estivesse disponível no mercado. Conclusão: As farinhas de banana verde e de beterraba comportaram-se como ingredientes promissores, do ponto de vista funcional, por enriquecer o iogurte com compostos antioxidantes e bioativos, demonstrando potencial do novo produto elaborado em prevenir danos oxidativos à saúde.

Palavras-chave: Farinha de beterraba; Farinha de banana verde; Prevenção de doenças.

Abstract

Aims: To produce a yogurt with the addition of beet and unripe banana flours in order to add nutritional value and make this drink a functional food, since the supply of vitamins, minerals, and fibers can help in the prevention of non-transmissible chronic diseases (NTCDs). Methods: Microbiological, physicochemical, and sensory analyses were performed to certify its innocuousness to health, nutritional improvement, and acceptance by consumers, respectively. Results: The yogurt containing 4% of each flour presented coliforms at 45ºC within the maximum values established by the current legislation, as well as increased nutritional value, with emphasis on a 21% increase in proteins and 133% in minerals. It also had a decrease in moisture content, resulting in a longer shelf-life product. Three yogurt formulations (4%, 3%, and 2%) were prepared for the sensory analysis, which showed a preference for the formulation with the lowest concentration of beet flour ($p>0.05$). Concerning the purchase intention, the results indicated the tasters might buy the product if it were available on the market. Conclusion: unripe banana and beet flours behaved as promising ingredients, from a functional point of view, as they enrich yogurt with antioxidant

and bioactive compounds, demonstrating the potential of this new food product in preventing oxidative damage to health.

Keywords: Beet flour; Unripe banana flour; Prevention of diseases.

Resumen

Objetivo: preparar un yogur con la adición de harina de remolacha y plátano verde, para agregar valor nutricional y hacer de esta bebida un alimento funcional, ya que el suministro de vitaminas, minerales y fibras puede ayudar en la prevención de enfermedades crónicas. Enfermedades no transmisibles (ENT). Métodos: Se realizaron pruebas microbiológicas, físico-químicas y sensoriales para certificar la seguridad de la salud, la adición de valor nutricional y la aceptación por parte de los consumidores, respectivamente. Resultados: El yogurt elaborado con el 4% de cada una de las harinas presentó coliformes a 45ºC dentro de los valores máximos establecidos por la legislación vigente y se mostró enriquecido en su valor nutricional, con énfasis en un aumento del 21% en proteínas y 133% en minerales. También mostró una reducción en el contenido de humedad, dando como resultado un producto con una vida útil más larga. Para la prueba sensorial, se prepararon 3 formulaciones de yogurt (4%, 3% y 2%) y se observó una tendencia a la preferencia por la formulación que contenía menos concentración de harina de remolacha ($p > 0.05$). Sin embargo, en relación con la intención de compra, los resultados obtenidos demuestran que los catadores podrían comprar el producto, si estuviera disponible en el mercado. Conclusión: las harinas de plátano verde y remolacha se comportaron como ingredientes prometedores, desde el punto de vista funcional, para enriquecer el yogur con compuestos antioxidantes y bioactivos, lo que demuestra el potencial del nuevo producto diseñado para prevenir el daño oxidativo para la salud.

Palabras clave: Harina de remolacha; Harina de plátano verde; Prevención de enfermedades.

1. Introduction

The food industry is composed of several areas, including the dairy sector, which already stands out among the top four, with a participation of about 10% in the food industry revenue (Valiatti et al., 2017).

Brazilian production and the consumption of dairy products have increased significantly in recent years, due to the concern to adapt to better eating habits, leading to a demand for healthy food. Yogurt fits in this context because, according to Cruz et al. (2015),

this drink can be improved by nutrients such as fibers, proteins, minerals, and vitamins, adding nutritional value to the final product.

According to the Technical Regulation of Identity and Quality of Fermented Milks, yogurt is defined as a product resulting from milk fermentation by cultures of Streptococcus salivarius subsp. thermophilus and Lactobacillus delbrueckii subsp. bulgaricus, which can be accompanied, in a complementary way, by other lactic acid bacteria that, because of their activity, contribute to determining characteristics of the final product (Brasil, 2007).

Considering the concept of healthiness, the consumption of healthier foods has increased and generated new discussions regarding the use of artificial coloring, flavorings, and chemical stabilizers. Consumers seek more natural foods that ensure nutritional health benefits (Pinto et al., 2019).

However, according to data on the purchase of food for home use and individual food consumption by the Brazilian population, based on the Family Budget Research (POF), 2008–2009, there is an insufficient intake of vegetables, inversely association with ultra-processed food intake (Canella et al., 2018). Another factor related to the decreased consumption of vegetables is that they are not sensorially appreciated, especially by children, and tend to be ingested in insufficient quantities (Cruz et al., 2015).

A solution to this problem is suggested by Pereira (2016), who reports that vegetables can be consumed when they are added to yogurt, as it is a dairy dessert with good acceptance.

Canella et al. (2018) claim that the beet is among the vegetables acquired by Brazilians for home use. One of the benefits of consuming this vegetable is the reduction of blood pressure, besides being a great natural antioxidant agent, acting against cell aging and reducing the risk of some types of cancer. Beet is a root vegetable with carotenoids, flavonoids, vitamins, minerals, all of which have numerous nutritional and health benefits (Panghal et al., 2017).

Several studies have recorded the physiological activity of unripe banana, as it contains flavonoids that protect the gastric mucosa, in addition to resistant starch, which contributes to the development of normal flora and improves intestinal transit (Oliveira and Santos, 2016), which characterizes it as a functional food.

About functional food, it is important to remember that it does not cure diseases, but rather prevents their appearance and helps the body to fight them more effectively, in the case of disease establishment. Thus, this kind of food should not be used as a medicine, but incorporated into the diet so that it can be consumed daily, helping the body to become stronger. Diets rich in functional food lead to a greater well-being of the consumers, giving

them more energy and disposition, thus contributing to their life quality improvement (Vidal et al., 2012).

Vegetables and fruits can be added to yogurt in the form of flour, such as in the case of beet and unripe banana flours, which are already found in the market. In this sense, we sought to prepare a yogurt based on unripe bananas and beets to offer the consumers a drink with functional properties.

2. Methodological Procedures

This is a laboratory study through physical-chemical analysis based on the AOAC (2002) methods, microbiological analysis based on the methods proposed by Da Silva et al. (2017), and field research, through sensory analysis following the method described by Gutierrez et al. (2008).

2.1 Pilot test

Bulk beet and unripe banana flours were purchased in the market in the state of Paraíba, Brazil, and subjected to microbiological analysis in the Food Microbiology Technology Laboratory of the Center for Human, Social, and Agrarian Sciences (CCHSA) of Federal University of Paraiba (UFPB).

The beet flour was within the current standards (Brasil, 2001), containing even colonies of Bacillus subtilis, which possibly has probiotic activity, still studied by researchers such as Modanêsi et al. (2016). On the other hand, the unripe banana flour presented coliforms at 45ºC in a number higher than the maximum determined by the current legislation, including even Escherichia coli, showing contamination of fecal origin. This impacted how the product was acquired, resulting in the purchase of flour in an establishment that attested to its quality and safety.

2.1.1 Acquisition of beet and unripe banana flours

Beet and unripe banana flours were purchased from the company “Chá e Cia - Produtos Naturais” (CNPJ 08.852.492/0001-55), located on Carlos Frederico Werneck Lacerda Avenue, Cidade Jardim, Jacareí, São Paulo State.

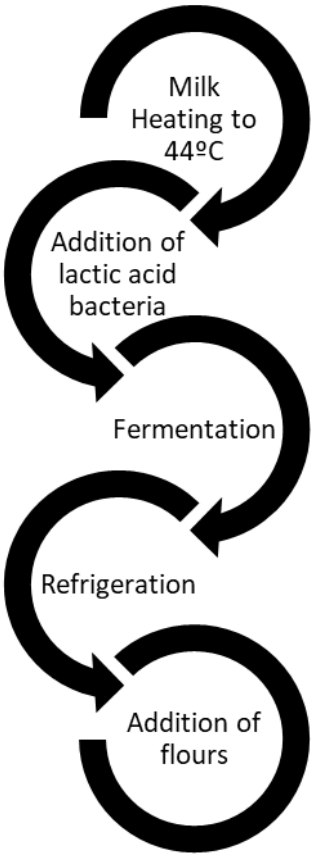
2.2 Methods

2.2.1 Production of yogurt using beet and unripe banana flours

According to the Technical Regulation of Identity and Quality of Fermented Milks (Brasil, 2007), fruit pieces, pulp, and juice, as well as other preparations based on fruits can be added to the formulation of yogurt. Other food substances are also included in this regulation, such as honey, coconut, cereals, vegetables, chocolate, spices, coffee, etc. However, these optional non-dairy ingredients, alone or in combination, must be present in a maximum proportion of 30% of the final product.

Initially, yogurt was made with the addition of 4% beet flour, 4% unripe banana flour, and 10% sugar (Figure 1). UHT milk was used, considering the same brand and batch. The product was made in the Milk and Derivatives Technology Laboratory of the CCHSA/UFPB.

Figure 1. Flowchart for the production of yogurt based on beet and unripe banana flours.



Source: Author.

The milk was heated to 44°C (±1°C), with the subsequent addition of lactic culture

(Streptococcus thermophilus and Lactobacillus delbrueckii subsp. Bulgaricus), according to the manufacturer's recommendations. The mixture was fermented for six hours, at 42°C (±1°C), in a stabilized oven. After checking the firmness of the clot, fermentation was considered complete. Then, the yogurt was cooled to 4°C (±1°C). Afterwards, unripe banana and beet flours were added. The products were placed in plastic bottles of high-density polyethylene and stored at 6°C (±1°C), until the analyzes were performed.

2.2.2 Microbiological analysis of yogurt made with the addition of beet and unripe banana flours

The yogurt made with the addition of beet and unripe banana flours was subjected to microbiological analysis. The RDC No. 12 of January 2, 2001 requires the analysis of coliforms at 45ºC, according to the method proposed by Da Silva et al. (2017).

2.2.3 Physicochemical analysis of yogurt made with the addition of beet and unripe banana flours

Two yogurt formulations were made for physicochemical analysis to verify possible changes in the product's nutritional value, resulting from the addition of beet and unripe banana flours. The whole yogurt was formulated without the addition of flour (F0) and with the addition of flour (F1).

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

2.2.4 Sensory analysis

As the formulation containing 4% (F1) of each flour had been the only one microbiologically and physicochemically analyzed, it was decided to offer more possibilities to the consumers in the sensory analysis. Thus, two other formulations were prepared, with 3% (F2) and 2% (F3) of each flour.

The yogurt was sensorially evaluated by students (6–12 years old) of a municipal school in the municipality of Bananeiras (Paraíba State, Brazil). The participants were

selected according to the following inclusion criteria: consumed yogurt and had no type of disease that could interfere with the final results of sensory analysis. This analysis was performed through the acceptance test applied to 56 tasters, evaluating appearance, color, aroma, flavor, and consistency, in addition to overall evaluation, using a 5-point hedonic scale, ranging from 1 (very disgusted) to 5 (I liked it very much). The participants also contributed to a subsequent purchase intention test, using a 5-point hedonic scale (Gutierrez et al., 2008).

Before applying the test, the School received a copy of the project, with a Free and Informed Consent Form to authorize the research.

2.2.5 Statistical analysis

Statistical analysis was performed using descriptive (mean and standard error) and inferential (Tukey test) statistical tests to determine statistically significant differences ($p<0.05$), between the treatments. The SigmaStat 3 software was used for statistical treatment.

2.2.6 Evaluation by the research ethics committee

This research was evaluated and approved (registration No. CAAE: 917225318.7.0000.8069) by the research ethics committee of the Medical Sciences Center of the Federal University of Paraíba.

3. Results and Discussion

3.1 Microbiological analysis of yogurt made with the addition of beet and unripe banana flours

The microbiological analysis of the yogurt from formulation 1 (F1) (4% of each flour) showed that the functional drink was suitable for consumption, as the results were within the limits established by the current legislation (Brasil, 2001).

Similar results were found by Brandão and Mendonça (2015) and Zarpelon *et al*. (2017), who detected no coliforms at 45ºC in a symbiotic fermented soybean drink, containing unripe banana flour, and in a probiotic fermented drink of beet, carrot, and apple,

indicating there was hygienic-sanitary control both in the acquisition of raw material and elaboration of products.

3.2 Physicochemical analysis of yogurt made with (F1) and without (F0) the addition of beet and unripe banana flours

The results of the physicochemical analysis of the yogurts from F1 (with flours) and F0 (without flours, but added with sugar) are shown in Table 1.

Table 1. Physicochemical analysis of yogurts made with (F1) and without (F0) the addition of beet flour (BF) and unripe banana (UBF).

Product	Physicochemical parameters					
	Moisture (% ± SE)	**Ash (% ± SE)**	**Lipids (% ± SE)**	**Protein (% ± SE)**	**Reducing Sugars (% ± SE)**	**Total Sugars (% ± SE)**
F1 (4%)	78.86 ± 0.77a	0.56 ± 0.09a	3.50 ± 0.19a	3.83 ± 0.18a	2.53 ± 0.03a	9.53 ± 0.15a
F0	80.10 ± 0.78a	0.33 ± 0.08a	3.30 ± 0.17a	3.00 ± 0.17b	2.16 ± 0.03b	9.30 ± 0.14a

Values followed by equal letters in the column did not differ statistically by the Tukey test at 5% probability. Different letters in the column indicate a statistical difference ($p<0.05$).
Source: Author.

From Table 1, it is observed that the yogurt made with the addition of flours (F1) had an increase in protein content and reducing sugars of 28% and 17%, respectively ($p<0.05$), with no difference for the other analyzed physicochemical parameters. Santos *et al*. (2020) also found an increase in the percentage of reducing sugars in yogurt added with unripe banana flour, serving as a substrate for lactic acid bacteria, resulting in a greater amount of lactic acid. Pereira (2016), who also used unripe bananas in the production of yogurt, found lower values of proteins. In our study, it is assumed that the increased protein is due to the addition of beet flour, because the above-mentioned authors used tamarind, in addition to unripe bananas.

3.3 Sensory Analysis

The results of the acceptance test, for yogurts made with the addition of UBF and BF, are shown in Table 2.

Table 2. Mean values and standard error of hedonic scores, obtained from acceptance test, and Acceptance Index for yogurt formulations containing unripe banana flour (UBF) and beet flour (BF), considering the evaluated characteristics.

ATTRIBUTES	Yogurt formulations containing UBF and BF					
	Acceptance test			Acceptance Index		
	4%	3%	2%	4%	3%	2%
Appearance	4.10 ± 0.13a	4.17 ± 0.13a	4.42 ± 0.14a	82	83.4	88.4
Color	3.80 ± 0.12a	3.96 ± 0.14a	4.08 ± 0.14a	76	79.2	81.6
Aroma	3.03 ± 0.18a	3.16 ± 0.19a	2.85 ± 0.16a	60.6	63.2	57
Flavor	2.55 ± 0.20a	2.66 ± 0.21a	2.25 ± 0.19a	51	53.2	45
Consistency	3.35 ± 0.16a	3.69 ± 0.16a	3.78 ± 0.18a	67	73.8	75.6
Overall evaluation	3.25 ± 0.17a	3.44 ± 0.17a	3.83 ± 0.18a	65	68.8	76.6

Values followed by the same letter in the lines did not differ statistically by the Tukey test at 5% probability. Source: Author.

The tasters gave similar scores for the 3 yogurt formulations ($p>0.05$), showing a preference for the formulation containing 2% of each flour, considering appearance, color, consistency, and overall evaluation (Table 2).

A similar result was also found by Silveira *et al*. (2017), who observed a greater preference for yogurt enriched with a lower concentration (5%) of unripe banana biomass. Cruz *et al*. (2015), using a method different from the one used in our study, recorded a mean score around 6, on a 7-point hedonic scale. This was probably due to the different ways of adding vegetables in the yogurt since these authors added carrot in the form of "caviar". Discordant result was also found by Macêdo et al. (2019), who found 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.

According to Michaelsen and Alves (2017), a product is considered sensorially accepted when it has an Acceptance Index higher than 70%. Although the acceptance index for flavor and aroma, in all formulations, has been lower than that considered minimum, the overall evaluation of the yogurt from formulation 3 (2%) had an acceptance index above 76%.

An affective test was also performed, using a facial hedonic scale, for the yogurts added with beet flour and unripe banana flour (Table 3).

Table 3. Affective evaluation of yogurts made with the addition of unripe banana flour (UBF) and beet flour (BF), using a facial hedonic scale.

Yogurt formulations containing UBF and BF	Mean ± SE
4%	3.14 ± 0.20a
3%	3.17 ± 0.18a
2%	3.37 ± 0.20a

Values followed by equal letters in the column do not statistically differ from each other (p>0.05). Source: Author.

Regarding the facial hedonic scale (Table 3), concepts were attributed to figures, ranging from left to right in "very bad", "bad", "neither good nor bad", "good", and "very good". Numerical values were also assigned, ranging from 1 (very bad) to 5 (very good). In which "neither good nor bad" corresponded to 3. Thus, the mean acceptance scores obtained for all samples was above 3.00, indicating a possibility of consuming the product, as the scores were between "neither good nor bad" and "good".

The tasters also provided purchase intention data (Table 4).

Table 4. Purchase intention of yogurt made with the addition of unripe banana flour (UBF) and beet flour (BF).

Treatment	Mean ± SE
4%	3.01 ± 0.22a
3%	2.98 ± 0.23a
2%	2.98 ± 0.23a

Values followed by equal letters in the column do not statistically differ from each other (p>0.05). Source: Author.

The results of the participants' purchase intention (Table 4) indicated a possible purchase of the product if it were available on the market, regardless of the concentration of flours used to make the yogurt, showing no significant interference (p>0.05).

Silveira *et al*. (2017) found a mean purchase intention of approximately 4.02, 3.68, and 3.26, for yogurt added with unripe banana biomass, using a scale ranging from 1–5 for formulations containing 5%, 10%, and 15% of this ingredient, respectively. Their results indicated a preference to buy the product containing the lowest concentration of unripe banana biomass. Almeida (2016) developed a dessert with vegetables (beet-based pudding) and recorded mean scores ranging from 5 (I would certainly buy) to 3 (I don't know if I would buy) for four formulations, using a 5-point scale.

4. Conclusion

Given the above, it was observed that the unripe banana and beet flours behaved positively, as they enriched the yogurt with protein compounds, demonstrating the nutritional and functional potential of the new product developed in our study.

The drink was reasonably accepted by the tasters; therefore, further research is needed to test other formulations, containing different percentages of these flours, as well as using other types of vegetables.

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