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PHYSICOCHEMICAL, MICROBIOLOGICAL AND SENSORY EVALUATION OF SHELLED BANANA JUICE

AVALIAÇÃO FÍSICO-QUÍMICA, MICROBIOLÓGICA E SENSORIAL DE VITAMINA DE BANANA COM CASCA

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aproveitamento de resíduos alimentares; alimentos de baixo custo; controle de qualidade.

Keywords:
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Abstract

This work aimed to evaluate the physical-chemical, microbiological and sensory characteristics of banana vitamins with peel. Bananas from the Nanica cultivar (Musa acuminata Dwarf Cavendish) were in the 7th stage of maturation. The UHT whole milk used had 3% fat. The treatments included 0%, 10%, 25% and 35% addition of banana peel to the banana smoothie. The physicochemical analyses (acidity, pH, density, humidity, ash and fat) were carried out in triplicate, according to the methods of Adolfo Lutz. For microbiological evaluation, analyses of total coliforms (35°C) and thermotolerant coliforms (45°C) were carried out using the multiple tube method, and the results were expressed in MPN/g. The sensory evaluation was applied to 50 untrained panel participants using a blind test with a nine-point structured hedonic scale. The data were submitted to ANOVA and the Tukey test with 5% significance to verify interactions between means. Acidity showed a statistically significant difference, with an average of 1.59%. The average pH was 6.57 and showed significant differences between treatments. For density, moisture, fat and ash, the averages were 1,543 g/dm3, 84.17%, 1.03% and 0.83%, respectively. Microbiological analyses were negative for total coliforms and thermotolerant coliforms, indicating that good manufacturing practices were efficient. For sensory evaluation, the highest acceptance rate was for the treatment of 25%, and 54% of tasters consumed banana vitamins at least once a month. The results of the physical-chemical analyses allow us to infer that the banana vitamin with peel is a low-fat food, thus showing that it can be considered a low-calorie food. Microbiological analyses showed that the vitamin was produced within good manufacturing practices, as the results for coliforms were negative for all samples. The sensory analysis allowed us to verify that the treatment with the best acceptance rate was the one with 25% bark, but we will recommend the treatment with 35% bark, as there was no significant difference between the formulations in relation to acceptance.

Resumo

Este trabalho teve como objetivo avaliar as características físico-químicas, microbiológicas e sensoriais de vitamina de banana com casca. As bananas da cultivar Nanica (Musa acuminata Dwarf Cavendish) estavam no 7° estágio de maturação. O leite integral UHT utilizado estava com 3% de gordura. Os tratamentos foram 0%, 10%, 25% e 35% de adição de casca de banana à vitamina de banana. As análises físico-químicas (acidez, pH, densidade, umidade, cinzas e gordura) foram realizadas em triplicata, segundo os métodos de Adolfo Lutz. Para avaliação microbiológica, as análises de coliformes totais (35 °C) e coliformes termotolerantes (45°C) foram realizadas pelo método de tubos múltiplos e os resultados expressos em MPN/g. A avaliação sensorial foi aplicada a 50 participantes do painel não treinados, utilizando um teste cego com escala hedônica estruturada de nove pontos. Os dados foram submetidos à ANOVA e ao Teste de Tukey com 5% de significância para verificar as interações entre as médias. A acidez apresentou diferença estatística significativa, com média de 1,59%. O pH médio foi de 6,57 e apresentou diferenças estatísticas entre os tratamentos. Para a densidade, umidade, gordura e cinzas, as médias foram de 1.543 g/dm3, 84,17%, 1,03% e de 0,83%, respectivamente. As análises microbiológicas foram negativas para coliformes totais e coliformes termotolerantes, indicando que as boas práticas de fabricação foram eficientes. Para avaliação sensorial, o maior índice de aceitação foi para o tratamento de 25% e 54% dos provadores consomem vitamina de banana pelo menos uma vez por mês. Os resultados das análises físico-químicas nos permitem inferir que a vitamina de banana com casca é um alimento de baixo teor de gordura, mostrando assim, que pode ser considerado um alimento de baixo teor calórico. As análises microbiológicas mostraram que a vitamina foi produzida dentro das boas práticas de fabricação, pois os resultados para coliformes foram negativos para todas as amostras. A análise sensorial, nos permitiu verificar que o tratamento com melhor índice de aceitação foi a com 25% de casca mas, nós indicaremos o tratamento com 35% de casca, pois não houve diferença estatística entre as formulações em relação à aceitação.

INTRODUCTION

Brazil has great importance in fruit production, standing out in the domestic and international markets (BRASIL, 2018); however, waste is still high, observed from harvest to losses in the market and in households. One way to minimize banana losses would be to consume the fruit while it is still green, which can be used in various types of food, improving nutritional quality and providing useful physiological effects to the body (RANIERI; DELANI, 2014).

Many families in their homes have bananas as their staple fruit, as they are found in every market and accessible to all social levels. In addition to having a high nutritional value, it can be consumed *fresh* or processed (SINGH et al., 2016).

Ripe bananas are made up of a small portion of starch and a high amount of sugar, making them a food with excellent energy value. In addition to carbohydrates, it contains appreciable amounts of vitamins A (retinol), B1 (thiamine), B2 (riboflavin) and C (ascorbic acid) and the minerals potassium, phosphorus, calcium and iron (EMBRAPA, 2003).

The expansion of trade in dairy products, linked to consumers looking for health and disease prevention, has led the food industry to search for healthier products (SILVA; UENO, 2013). The sale of milk and derived products, directly from the producer to the consumer, without any prior treatment, especially pasteurization, risks the population to illnesses such as tuberculosis and brucellosis, in addition to not guaranteeing the distribution of a complete product. Given the health risks inherent to ingesting milk obtained and processed in unsatisfactory and precarious conditions, it is essential to pay attention to a competent heat treatment to exterminate pathogenic microorganisms that does not cause significant changes to the nutritional quality of the product, such as degradation of fat, protein or carbohydrate. The physical-chemical and microbiological quality control of pasteurized milk needs to be one of the priorities of bodies that oversee public health, given the importance of this food (LEITE et al., 2002; MENDES et al., 2005).

This project aimed to verify the physical-chemical, microbiological and sensorial evaluation of the banana vitamin with peel.

MATERIALS AND METHODS

Raw material selections

The bananas used as raw material for the elaboration of this project were dwarf bananas (*Musa acuminata'Dwarf Cavendish'*), which were found to have a ripeness level of 7, a value defined according to the parameters described by Tadini et al. (1998) evaluated for shell color. The bananas were first selected to avoid fruits with mechanical damage and poor quality. The banana, sugar and UHT milk were purchased at the local market, located in the Vale de São Patrício region.

Processes with raw materials

ppm chlorinated solution for 15 minutes and rinsed with drinking water to eliminate the remaining impurities and residues of chlorinated solution. The milk used was full UHT with 3% fat, as this type of milk did not require pasteurization. Sixty grams of sugar was added to sweeten the banana smoothie with peel. Once ready, the vitamins were stored and placed in the refrigerator, so the products used in the research were prepared and stored within good manufacturing practices.

Physicochemical and microbiological analyses were carried out on the finished product, as it was this final product that was subject to sensory analysis.

Formulations

The treatments were according to the percentage of banana with peel (0%, 10%, 25% and 35%).

The unpeeled banana smoothies were processed in domestic blenders, which were previously sanitized in a chlorinated solution for 15 minutes. All ingredients (Table 1) were placed at once in the blenders and homogenized for 3 minutes.

Table 1: Ingredients and quantities used in preparing banana smoothies with peel

Ingredients	Shell percentages			
	0%	**10%**	**25%**	**35%**
Milk (mL)	1,000	1,000	1,000	1,000
Banana (g)	100	-	-	-
Banana with Peel (g)	-	100	250	350
Sugar (g)	60	60	60	60

Physicochemical analysis

The analyses were carried out at the Instrumental Laboratory of the Federal Institute Goiano - Campus Ceres. Titratable acidity, pH, humidity, ash, density and fat content analyses were carried out in accordance with the standards described by Adolf Lutz (1976) in triplicate.

Microbiological Analysis

The analyses were carried out at the Microbiology Laboratory of the Instituto Federal Goiano - Campus Ceres, Ceres-GO. Fecal, total (35°C) and thermotolerant (45°C) coliform analyses were performed. Microbiological analyses were carried out using the multiple tube fermentation technique (TFTM) in triplicate with three dilutions (10^{-1}, 10^{-2} and 10^{-3}), and the dilutions were made in 0.1% peptone water. The quantification of microorganisms was carried out using the most likelymost probable number (MPN) per 100 mL of sample. The determination of the most likelymost probable number of total and thermotolerant coliforms was carried out by combining positive tubes of Caldo Verde Brilhante 2% (total coliforms) and EC broth (thermotolerant coliforms), which estimates the amount of microorganisms present in the original sample. with a 95% probability (SILVA et al., 2010).

Sensory Analysis

The tests were conducted with the participation of 50 individuals present at the Institution at the time of the sensory analysis. Students (technical level, undergraduate and postgraduate) and employees of the Institution (teachers, administrative technicians and outsourced workers) of different sexes (male and female), color/race (white, black, mixed race), age range (from 18 years old) and level of education (primary to postgraduate). Before starting the tests, consumers participating in the research signed the free and informed consent form (ICF), which was placed on the home page of the annexes.

The acceptance test (blind) of banana vitamin samples consists of attributes of appearance, aroma, flavor, texture, color and overall impression. The judges evaluated the samples using a structured hedonic scale of nine points, ranging from 1 (I truly disliked it) to 9 (I truly liked it), according to MINIM (2010).

The samples, approximately 20 mL, were served in disposable plastic cups coded with three digits (blind test), and water biscuits were made available to

the tasters (MINIM, 2010). Samples were served at room temperature.

The project was forwarded to the Research Ethics Committee of the Federal Institute of Goiano for an opinion.

The benefits arising were indirect and were based on determining the best banana vitamin formulation (*Musa* spp.*)* with peel.

People under the age of 18 did not participate in the research, as did anyone who declared they had intolerance to lactose, fructose or diabetes.

Statistical Analysis

A completely randomized design (DIC) was used. The data obtained were subjected to ANOVA and Tukey's test at a level of 5%.

RESULTS AND DISCUSSION

Chemical physical analysis

Titratable acidity, pH, density, humidity, ash and fat analyses were carried out, and the results are shown in Table 2 and Table 3.

The statistically titratable acidity values differed from each other ($p<0.05$), with the highest value being T35 and a general average of 1.49% (Table 2). This acidity in this treatment is due to the greater addition of peel, progressively increasing with its use, as banana peel is composed of organic acids. During ripening, starch hydrolysis occurs, which is converted to soluble sugars, which distinguishes the sweet flavor, softening of the skin and pulp, and decreased astringency. As ripening progresses, there is also an increase in organic acids, the main of which is malic acid (MERCALI, 2009; MOHAPATRA; MISHRA; SUTAR; 2010). It was observed in the work of Neris et al. (2018) that the acidity analyses of *fresh banana peels from* different cultivars and maturation stages differ from the results found in this study, observing that the acidity of the Maçã banana (green – 0.25; ripe – 1.10 and senescence – 0.69), dwarf banana (green – 0.13; ripe – 0.07 and senescence – 0.29), plantain (green – 0.48; ripe – 0.72 and senescence – 0.17), silver banana (green – 0.04; ripe – 0.23 and senescence – 0.14), and it is evident that generally when at the ripe stage, acidity increases. The more banana peel is added to the smoothie, the higher the acidity of the drink will likely be.

In the pH analysis, there was a significant difference, with the highest value of 6.63 in T10 and an overall average of 6.57 between treatments (Table 2). Higher pH results than those obtained in the present study were reported by Lucatto (2013) in banana-flavored symbiotic yogurt obtained from cow's milk and green banana pulp, with pH values of 4.33 to 4.38. In contrast, the pH of *fresh peels* at the ripe stage in different types of bananas, such as apple bananas (5.84), dwarf bananas (6.77), terra bananas (6.28) and silver bananas (7. 84), a reduction in pH may occur during ripening (Neris et al. 2018). According to Garcia (2014), in his study, the author found a pH value of 4.41 for banana pulp. Lara (2007), when working with bananas to make brandy, obtained a pH in the range of 4.4 to 4.6, results that differ from those found in this study. This is due to the addition of milk to make the banana smoothie with peel, as the pH of the vitamin was very close to the pH of the milk.

Regarding the density of the banana vitamin with peel, statistically, the values differed from each other ($p<0.05$), with the highest density being the drink T0 (without added peel), with a general average of 1543 g/dm³ between treatments (Table 2). Thuwapanichayanan et al. (2008) dried banana pulp on a foam bed, obtaining a density of 0.3 g/cm³ using 5% fresh egg white and shaking the formulation for 20 minutes. This result shows that the peel reduces the density of the vitamin.

Table 2: Evaluation of physicochemical analyses (acidity, pH, density) in banana vitamin formulations with peel

Treatments	Titratable acidity (%m/v)	pH	Density (g/dm³)
T0	1.42 ± 0.18 ab	6.55 ± 0.03 b	1,584 ± 1.10 a
T10	1.16 ± 0.18b	6.63 ± 0.03 a	1,492 ± 1.10 b
T25	1.69 ± 0.18 a	6.54 ± 0.03b	1,579 ± 1.10 a
T35	1.71 ± 0.18 a	6.67 ± 0.03 ab	1,518 ± 1.10b
Overall Average	1.49	6.57	1,543
CV (%)	11.86	0.38	0.71

Tukey's test at the 5% significance level revealed no difference between the means.
CV: Coefficient of variation
T0: 0% bark; T10: 10% bark; T25: 25% bark; T35: 35% bark.

For moisture content, there was a significant difference between treatments, with a general average of 84.56% and the highest value being in treatment T10. The results obtained through the analyses are represented in Table 3. According to Matsuura and Folegatti (2001), moisture in banana can be reduced as it ripens due to the transfer of water from the peel to the pulp. Lara (2007) portrays in her study a moisture content of 74% for banana pulp. This is due to the addition of milk to make the banana smoothie with the peel, as the mixture of the peel with the milk resulted in a greater increase in moisture.

In the ash analysis, there was no significant difference between the treatments, with a general average of 0.83% and the highest ash value being in treatment T25 (Table 3). This differs from the results for ash and banana peels, which were 0.95, and the edible part of the banana, which was 0.80 (Gondim et al., 2005). The edible part is similar to the results found in this study, especially for the largest proportion. In studies by Pádua et al. (2017), the ash content in banana flavored yogurt enriched with jabuticaba peel flour showed different results for ash of 0.71%.

For fat analysis, there was a significant difference between treatments, with an overall average of 1.03%. T0 had a higher fat index than T35 (Table 3). In other words, as the skin was added, the fat % decreased. According to Silveira et al. (2017), the fat content was higher than that found in this study, and the fat content in yogurts enriched with green banana biomass in proportions of 5, 10 and 15% was 2.50, 2.50 and 2.57%, respectively. In studies by Pádua et al. (2017) with banana-flavored yogurt enriched with jabuticaba peel flour, the results were more similar to a previous study, presenting fat values of 2.70.

Table 3: Evaluation of physicochemical analyses (moisture, ash, fat) in banana vitamin formulations with peel

Treatments	Moisture (%)	Ash (%)	Fat (%)
T0	84.77 ± 0.11b	0.84 ± 0.02 a	1.46 ± 0.35 a
T10	85.21 ± 0.11 a	0.82 ± 0.02 a	1.27 ± 0.35 ab
T25	83.92 ± 0.11c	0.85 ± 0.02 a	0.85 ± 0.35 ab
T35	82.80 ± 0.11d	0.81 ± 0.02 a	0.52 ± 0.35b
Overall Average	84.17	0.83	1.03
CV (%)	0.13	2.73	34.41

Tukey's test at the 5% significance level revealed no difference between the means.
CV: Coefficient of variation
T0: 0% bark; T10: 10% bark; T25: 25% bark; T35: 35% bark.

Microbiological Analysis

The presence of coliforms at 45°C is considered an indicator of unsatisfactory hygiene conditions in the production or handling of food (FRANCO, 2005). The analyses of fecal, total (35°C) and thermotolerant (45°C) coliforms in all samples were negative in the presumptive analysis (Table 4); therefore, it was not necessary to carry out a confirmatory analysis. Therefore, all banana vitamin samples met the standards established by Brazilian legislation (10^2 NMP/g), indicating that the four formulations were suitable for consumption and that good manufacturing and storage practice standards were followed.

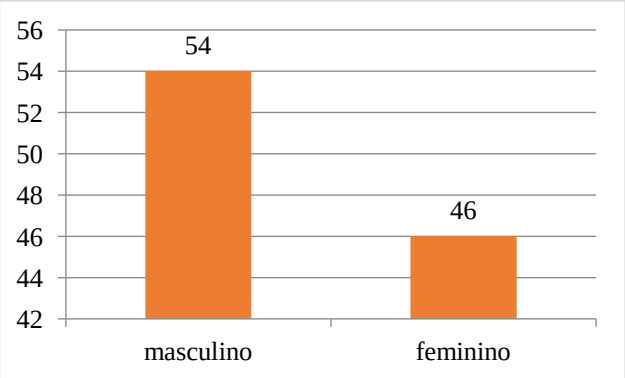
Table 4: Results of presumptive microbiological analyses on banana vitamin formulations with peel

Treatments	NMP.g $^{-1}$
T0	< 0.3
T10	< 0.3
T25	< 0.3
T35	< 0.3

T0: 0% bark; T10: 10% bark; T25: 25% bark; T35: 35% peel
NMP: Most likely number.

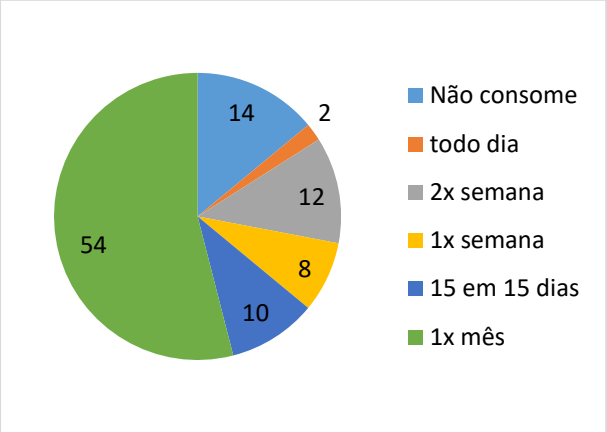
Sensory Analysis

The majority of the 50 judges were male (Graph 1), which represents the composition of the school community at IF Goiano Ceres, where the analysis was carried out.



Graph 1: Representation in % of male/female judges

Of these, 54% consume banana smoothies at least once a month (Graph 2); that is, if they add the peel to this frequency of consumption, it would greatly reduce the waste it generates for the environment.



Graph 2: Representation in % of the judges' frequency of banana vitamin consumption.

The banana vitamin with peel had a good acceptance rate, with the highest acceptance being the T25 treatment, with 76.98% (Table 5). This was related to the fact that it did not include much bark.

Regarding appearance and aroma, there was no significant difference, although the aroma of T35 was well praised by the tasters, as it is the one with the highest composition of unpeeled banana. However, the flavor, texture and color were different. The one with the best flavor was T25 because it did not have much skin inclusion. Regarding the texture, as the skin was added, it improved because it became thicker, which was praised by the judges. For color, the judges liked T25 more, as T35 was very dark due to the addition of the peel, which darkened the vitamin, and the others were very light, with just the color of milk (Table 5).

Pádua et al. (2017) also reported good acceptance by tasters in relation to color, aroma and texture. The color also pleased the tasters due to the addition of jabuticaba flour, showing an interesting factor. Likewise, the unpeeled banana smoothie may

have caused such an effect in the tasters. On the other hand, Silveira et al. (2017) observed that the color of yogurts was not influenced by the addition of green banana biomass, and the tasters did not observe differences in color and aroma. For texture, the results indicated that the most accepted treatment was 5%.

Table 5: Evaluation of the sensory analysis of banana vitamin formulations with peel

Treatments	Appearance	Aroma	Flavor	Texture	Color	AI (%)
T0	6.30 ± 1.54 a	6.80 ± 1.53 a	6.02 ± 1.73 bc	5.30 ± 1.81 b	5.92 ± 1.77 b	67.42
T10	6.52 ± 1.54 a	6.60 ±1.53 a	5.86 ± 1.73c	5.68 ± 1.81 ab	6.26 ± 1.77 ab	68.42
T25	6.98 ± 1.54 a	7.14 ± 1.53 a	7.08 ± 1.73 a	6.34 ± 1.81 a	7.10 ± 1.77 a	76.98
T35	6.64 ± 1.54 a	7.18 ± 1.53 a	6.90 ± 1.73 ab	6.54 ± 1.81 a	6.52 ± 1.77 ab	75.06
Overall Average	6.61	6.93	6.47	5.97	6.45	-
CV (%)	23.26	22.14	26.82	30.32	27.40	-

Tukey's test at the 5% significance level revealed no difference between the means. AI: acceptance index. CV: Coefficient of variation. T0: 0% bark; T10: 10% bark; T25: 25% bark; T35: 35% bark.

CONCLUSION

The results of the physical-chemical analyses allow us to infer that the unpeeled banana smoothie is a low-fat food, thus showing that it can be considered a low-calorie food.

analyses showed that the vitamin was produced within good manufacturing practices, as the results for coliforms were negative for all samples.

Sensory analysis allowed us to verify that the treatment with the best acceptance rate was the one with 25% bark, but we will indicate the treatment with 35% bark, as there was no significant difference between the formulations in relation to acceptance.

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