

Camu-Camu (*Myrciaria dubia* HBK): Yogurt Processing, Formulation, and Sensory Assessment

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Abstract

The objective of this study is to formulate and assess technologies for producing yogurt with camu-camu pulp, which has market potential and can be included in school meals, providing the general population with a nutritious and functional product. Three formulations of yogurt with camu-camu pulp were prepared, F1 10%, F2 13%, and F3 15%, with the following ingredients: whole UHT (Ultra High Temperature) milk, camu-camu pulp, dairy culture, and sugar. The microbiological characteristics of the final products were within the standards recommended by ANVISA. Regarding sensory assessment, formulation 1 achieved the highest acceptability. The chemical, physical, and microbiological parameters were within the limits established by the legislation, and the acceptability of the formulation containing 10% camu-camu pulp was satisfactory. This is a more quality food option for the Amazonian and Brazilian population.

Keywords

Amazonian Fruit, Sensory Analysis, Processing, Formulation, Yogurt

1. Introduction

Yogurt is a dairy product obtained by fermenting milk with lactobacilli. It is a functional food classified as a probiotic, that is, a preparation or a product containing live microorganisms in high enough numbers to impact health, changing the natural intestinal flora by repeated oral dosages [1]. Yogurt is a highly recommended product because of its sensory, probiotic, and nutritional characteristics. It may contain not only milk with high-solid

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content, dairy culture, and sugar, but also powdered milk, proteins, vitamins, minerals, low-fat content, and/or no fat [2], and even be associated with a variety of fruits. Camu-camu (*Myrciaria dubia* HBK) is a small fruit from a bush native to the Amazon Rainforest, characterized by high vitamin C content [3]. Until 2002 it was considered the best natural dietary source of ascorbic acid in the world. However, the ascorbic acid content makes the fruit very sour, compromising palatability. However, it is critical to develop technologies for creating camu-camu-based products with aggregated value, such as yogurt with typical Amazonian flavors. Hence, this study proposed to create and characterize camu-camu yogurt, and assess the acceptability of different formulations, providing the population with a more nutritious and functional food option.

2. Material and Methods

The fruits were collected at a particular location of the highway BR 174, at km 08, Manaus, Amazonas, and transported to the Laboratory of Food and Nutrition of the Coordination of Health Sciences Researches/INPA. They were selected according to the degree of ripeness and mechanical injuries. Next, they were rinsed with running water, sanitized with 2% sodium hypochlorite, pulped, and stored at -18°C until ready for use. The yogurt was prepared using basic ingredients, namely whole UHT milk, dairy culture, camu-camu pulp, and sugar. The milk was heated to 90°C for 15 minutes, the dry extract culture corrected with skimmed milk powder to 26%, and the mixture cooled to 43°C and inoculated with dairy culture. The inoculated mixture was kept in an incubator at 42°C while monitoring the pH, allowed to drop from 6.0 to 4.5, and acidity, allowed to exceed 0.90% of lactic acid. After cooling, three amounts of camu-camu pulp were added: F1 10%, F2 13%, and F3 15%.

2.1. Milk Preparation

The fat-free dry extract content of the milk was corrected by adding sugars and/or skimmed milk powder and homogenizing until complete dissolution.

The experiment consisted of three treatments to correct the fat-free dry extract content and camu-camu pulp content (10%, 13%, and 15%) after the natural yogurt was ready, that is, before adding the pulp or flavors. **Figure 1** shows the experiment.

2.2. Yogurt Preparation

After correction, the milk was pasteurized at 90°C for 30 minutes and immediately cooled to 42°C . Dairy culture with the bacteria *Streptococcus salivarius* subsp. *thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* was added and the mixture placed in an incubator until it reached the desired acidity. After this stage the abovementioned pulp contents were added (**Figure 2**).

After processing, the yogurts were submitted to pH, acidity, and total solids determination using the methods recommended by Institute Adolfo Lutz [4]. The microbiological analyses were performed at times zero, 15 and 30 days of storage, following the methods proposed by ICMSF [5]. A team of 15 testers participated in the sensory assessment. The testers were selected previously and not trained for this type of analysis. They were asked to use a 9-point Hedonic scale where 1 point is “I disliked it very much” and 9 points is “I liked it very much”, a paired preference test according to Institute Adolfo Lutz [4]. The Hedonic results were normalized through the testers’ answers and assessed by analysis of variance (ANOVA). The means were compared by the Tukey test. The significance level was set at 5% ($p < 0.05$) for all tests. The data were treated by the software Statistica version 7.0.

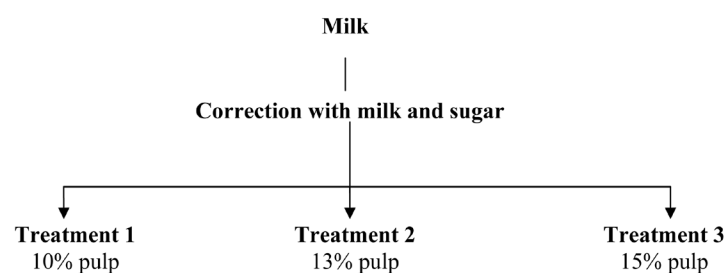


Figure 1. Flowchart of the experimental design for the development of camu-camu yogurt.

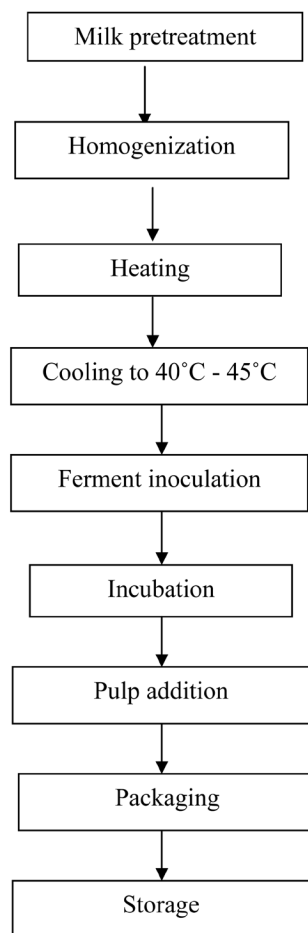


Figure 2. General diagram of the yogurt production.

3. Results and Discussion

The means of the physical and chemical analyses (**Table 1**) show that the yogurt was strongly acidic with a mean pH of 4.08 and titratable acidity 1.01, indicating a high concentration of organic acids.

The mean microbiological counts (**Table 2**) for total and fecal coliforms are expressed as most probable number per gram (MPN·g⁻¹). The yogurts had no *Salmonella* sp. in 25 g of sample. The mesophile, psychrophile, mold, and yeast contents were within the limits established by the legislation.

The yogurt with 10% camu-camu pulp had excellent acceptance by untrained testers with an average score of 8.0 (I liked it very much) in a 9-point Hedonic scale. ANOVA showed that the acceptability of the other formulations did not differ significantly ($p < 0.05$).

The percentage of lactic acid was also within the legislation for fermented milk (lactic acid content varying from 0.60 to 2.00%) [6]. The acidities were within the standard when compared with traditional yogurts, which may be due to longer fermentation periods. Acidities within the limits established by the legislation were also found by Oliveira *et al.* [7] in yogurt containing araticum (*Annona coriacea*) pulp in concentrations of 0%, 12.5%, 25%, and 50%, with acidities of 0.74, 0.78, 0.70, and 0.65%, respectively.

This result is considered low given that yogurt should have pH ranging from 4.5 to 4.6 [8]. According to Kurmann [9], the ideal pH for fermented milks is approximately 4.5. Therefore, lower values could induce consumer rejection and favor curd contraction because of lower protein hydration, causing draining. The whey separates when the pH exceeds 4.6 because not enough gel was formed [10].

Although the legislation does not provide a solid content range, the solid content of the study yogurt was similar to that of commercial yogurts, characterizing the desired texture of a more consistent yogurt, another way of aggregating value to commercial yogurt.

Table 1. Mean values (\pm standard deviation) of the physical and chemical composition of camu-camu yogurt with different pulp contents^a.

Parameters	Pulp concentration (%)		
	F ₁ (10%)	F ₂ (13%)	F ₃ (15%)
pH	4.07 \pm 0.0	4.09 \pm 0.0	4.1 \pm 0.0
Acidity (%)	0.97 \pm 0.0	1.04 \pm 0.0	1.03 \pm 0.0
Total solids (%)	24.2 \pm 0.6	25.6 \pm 1.5	26.6 \pm 2.0

^aMean of three determinations.**Table 2.** Microbiological characteristics of the yogurt during 30 days of storage at 4°C.

Yogurt	Time (days)	Total Coliform MPN/g	Fecal Coliform MPN/g	Mesophiles CFU/g	<i>S. aureus</i> CFU/g	Molds and yeasts CFU/g	<i>Salmonella</i> sp. in 25 g
Camu-camu	0	0/g	0/g	<10 UFC/g	<10 UFC/g	<10 UFC/g	Absence
	15	0/g	0/g	<10 UFC/g	<10 UFC/g	<10 UFC/g	Absence
	30	0/g	0/g	<10 UFC/g	<10 UFC/g	<10 UFC/g	Absence

The microbiological results were below the limits established by ANVISA [6] and there was no variation during the storage time, showing that all formulations had very good microbiological quality.

Souza *et al.* [11] got a mean score of 8.5 for a yogurt containing passion fruit pulp and linseed, higher than the mean score obtained for the study yogurt.

For a yogurt with 10% avocado pulp, Cancian *et al.* [12] obtained a mean score of 7.7, a score similar to that found by the present study for the formulation containing 10% camu-camu pulp. Different results were found by Barroso *et al.* [13] for the acceptability of yogurt containing different concentrations of guava pulp, with scores of 6.0 to 6.9 for the attribute color and scores of 5.8 to 6.7 for the attribute flavor.

4. Conclusion

The chemical, physical, and microbiological parameters of the dairy product developed in the current study were within the limits established by the legislation. Additionally, the formulation with 10% pulp obtained satisfactory acceptance. This yogurt is a more quality food option for the Amazonian and Brazilian population.

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