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Review Of Research

DEVELOPMENT, SENSORY ASSESSMENT, AND NUTRITIONAL COMPOSITION OF COALHO CHEESEENRICHED WITH TUCUMÃ (ASTROCARYUM ACULEATUM MEYER) PULP, STATE OF AMAZONAS (BRAZIL)

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ABSTRACT

In order to offer a regional alternative for the local industry, the objective of this study was to establish the processing and determine the chemical composition, and the sensory, and microbiological characteristics of coalho cheese (a type of cheese curd made with rennet) enriched with tucumã (Astrocaryum aculeatum Meyer). Three product formulations with different percentages of tucumã pulp and milk, respectively, were tested: 30+70 (A), 40+60 (B), and 50+50 (C). The products were submitted to chemical, sensory, and microbiological analyses. The development of mixed coalho cheeses by combining cow milk and tucumã pulp results in products with different chemical compositions and sensory characteristics. Cheeses with higher percentages of tucumã pulp are not as well accepted as those with higher percentages of cow milk because of tucumã's characteristic taste. The development of mixed coalho cheese is viable: the mixed coalho cheese A with 30% tucumã is viable from the nutritional and sensory points of view, representing a potential alternative for the dairy product industry to increase product selection.

KEYWORDS: *Sensory assessment, tucumã, cheese curd.*

INTRODUCTION

Coalho cheese is a typically Brazilian cheese, very popular in the Brazilian northeast. This product has great commercial value mainly because of the simple

manufacturing technique and high yield. It is manufactured mainly by small and medium-sized dairy product manufacturers and family farmers, which has contributed to the socioeconomic development of this region (Cerri 2002; Borges 2006). This cheese has been produced from raw and/or pasteurized milk for more than 150 years by many northeast states in Brazil. Although this popular product is part of the northeastern Brazilian culture, its manufacturing is not standardized, and the frequent use of raw milk endangers consumer's health (Cavalcante et al., 2007). Carotenoids are one of nature's major antioxidant pigments, found in several fruits. The reactive oxygen species (ROS) are highly reactive molecules and the body controls their degradation through two integrated antioxidant systems: an endogenous enzymatic system and exogenous control through the entry of non-enzymatic antioxidant molecules derived from the diet or produced by the body (Böhm, Edge, & Truscott, 2012). However, the biological properties of several fruits rich in carotenoids are not well characterized. This is the case of tucumã (Astrocaryum aculeatum, Mar, 1824), which belongs to the Arecaceae family and is distributed in the central region of the Amazon basin rom south to north, tucumã grows in Bolivia, Brazil, Guyana, Suriname, Trinidad, and, Venezuela. This fruit has several popular names chonta, tucumo, and panima in Bolivia; tucumã, tucumã-arara, tucumã-piranga, tucumã-piririca, tucumã-uassu-rana, tucum-assu, tucum-bravo, tucum-da-serra, tucum-do-matto, and tucum-purupuru in Brazil; akuyuro palm, cuyuru-palm, and tucumou in Guyana; amana, toekoemau, and warau in Suriname; and cumare and yavaide in Venezuela (Kahn, 2008). Tucumã is a type of palm. Average in height, it comes from the Amazon rainforest. The trunk is heavily spined, and even the inflorescences are covered by a thorny spathe. Centesimal composition analysis of the tucumã using methods described by the Association of Official Analytical Chemists showed that the mesocarp contains 412.73 ± 2.12 kcal, 44.9 ± 0.30 g wet content, 10.9 ± 0.1 g fibers, 3.5 ± 0.07 g proteins, 8.5 ± 0.6 g carbohydrates, and 40.5 ± 0.5 g fats per 100 g of pulp. Previous studies have shown that the oil extracted from tucumã consists of 74.4% unsaturated and 25.6% saturated fatty acids and is rich in omega-3, -6, and -9 fatty acids (Aguiar, 1996). The orange-yellow fruit (about the size of a chicken egg) is an excellent source of carotenoids. This fruit contains 21 different types of carotenoids in which all-trans-β-carotene (47.36 µg), the precursor of vitamin A and which represents 75% of all carotenoids, is identified and quantified in this fruit (De Rosso & Mercadante, 2007). The vitamin A value found in tucumã is 850 RE/100 g, which is higher than other fruits such as papaya (19−74 RE/100 g), acerola (148−283 RE/100 g), and vegetables like carrots (308−625 RE/100 g) and broccoli (131−194 RE/100 g) (De Rosso & Mercadante, 2007). It is also an important source of vitamin B2 (riboflavin) and presents bioactive compounds like catechin and quercetin (Gonçalves, Lajolo, & Genovese, 2010). The underuse of the fruit and low economic importance are due to a lack of technological research of the pulp, which would increase its shelf life and off-season availability. Carotenoids can play a role in the human antioxidative system (Michalska-Małecka et al., 2015). Sagrillo et al., (2015) confirmed that tucumã pulp extract is rich in β-carotene and quercetin, as previously described in the literature. However, high levels of these compounds were also found in tucumã peel extract. The extracts also contained significant amounts rutin, gallic acid, caffeic acid, and chlorogenic acid. Their presence is important once the retina becomes abundantly illuminated and has greater demands for oxygen (Landrum & Bone, 2001).

In order to provide a regional alternative for the local industry, the objective of this study was to establish the processing and determine the chemical composition and sensory and microbiological characteristics of coalho cheese enriched with tucumã (Astrocaryum aculeatum Meyer) pulp.

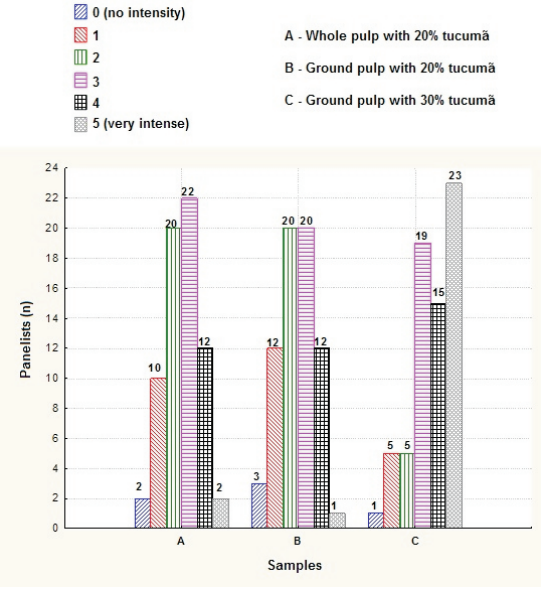
MATERIALS AND METHODS

The milk used for manufacturing the cheese was acquired from the company Indústria de Laticínios Autalac, located at Marechal Castelo Branco Street, 82, Downtown, Autazes - AM. Tucumã fruits were acquired from farmer's markets in Manaus City. The fruits were transported to the food physical-chemistry laboratory of Instituto Nacional de Pesquisas da Amazônia (INPA, National Institute for Research in the Amazon Rainforest), where they were selected, rinsed, soaked in a sodium hypochlorite solution (400 ppm) for 30 minutes, peeled, and manually pulped. Three different cheeses containing different percentages of tucumã pulp and coalho cheese, respectively, were submitted to sensory assessment: 30+70 (A), 40+60(B), and 50+50 (C). They were prepared in 500 g trays and pressed for one hour. The samples were then removed from the trays, vacuum

packed, and stored at 10oC. Later, the samples were submitted to microbiological analyses for determination of total and thermotolerant coliforms (MPN), mold and yeast counts (CFU/g), mesophile count (CFU/g), Listeria sp. and Salmonella sp. in 25g (absent), and coagulase-positive Staphylococcus/g (ICMSF, 1983). A multiple-comparison sensory test determined the panelists' preferred product (Chaves, 2005). Moisture content was determined by measuring the weight lost in an incubator at 105oC. Protein content was determined by the Kjeldahl method. Lipid content was determined by a Soxhlet extractor using ether as solvent. Ash content was determined in a muffle at 550ºC. Insoluble and soluble fiber contents were determined by the enzymatic-gravimetric method. Carbohydrate content was determined by subtracting the moisture, protein, lipid, and ash contents from 100, as instructed by Adolfo Lutz Institute (2008). The minerals iron, copper, calcium, magnesium, zinc, manganese, sodium, and potassium were determined by atomic absorption spectroscopy using specific lamps as instructed by the manufacturer. The samples were digested by the microwave digester MARS – Xpress CEM Corporation, MD – 2591, as instructed by Adolfo Lutz Institute (IAL, 2008).

RESULTS AND DISCUSSION:

For the attribute appearance (Graph 1), samples C, A, and B had acceptances of 83%, 53%, and 47%, respectively, corresponding to 57, 36, and 33 panelists, respectively, who attributed a score of 3 or higher.



Graph 01 – Assessment of the samples' appearance

The attribute aroma (Graph 2) received scores ranging from zero (no aroma) to five (excessive). Sample C received a score of five from 22 panelists and four from 19 panelists, corresponding to 32.4%; sample B received a score of 2 from 22 panelists, corresponding to 32.4%; and sample A received a score of 3 from 20 panelists, corresponding to 29.4%; and the other scores had a prevalence of 5.8%. Samples C, A, and B received a score of zero from one, two, and six panelists, respectively.

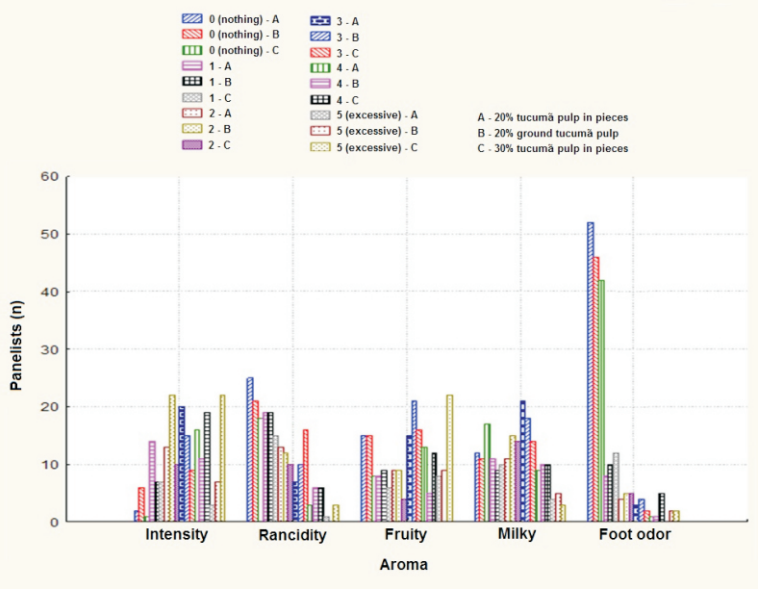
For the attribute rancidity, sample A received a score of zero from 25 panelists (36.8%), sample C received a score of zero from 21 panelists (31%), and sample B received a score of zero from 18 panelists (26.5%). Sample A received scores of four and five from four panelists; sample B, from six panelists; and sample C, from nine panelists, totaling 5.7%.

For the attribute fruity, samples A and B received a score of zero from 15 panelists each (22.1%); and sample C, from 8 panelists (11.8%). Sample B received a score of three from 21 panelists (30.1%); sample C, from 16 panelists (23.5%); and sample A, from 15 panelists (22.1%).

For the attribute milky, sample C received a score of zero from 17 panelists (25%); sample A, from 12

panelists (17.7%); and sample B, from 11 panelists (16.2%). Sample B received a score of two or three from 33 panelists; sample A, from 32 panelists; and sample C, from 28 panelists. Sample C received a score of five from three panelists; sample A, from four panelists; and sample B, from five panelists.

For the attribute foot odor, sample A received a score of zero from 52 panelists; sample B, from 46 panelists; and sample C, from 42 panelists. Samples A and B were considered to have the best scents.



Graph 02 – Assessment of the samples' aroma

The taste of all samples received a score ranging from zero (nothing) to five (excessive) (Graph 3).

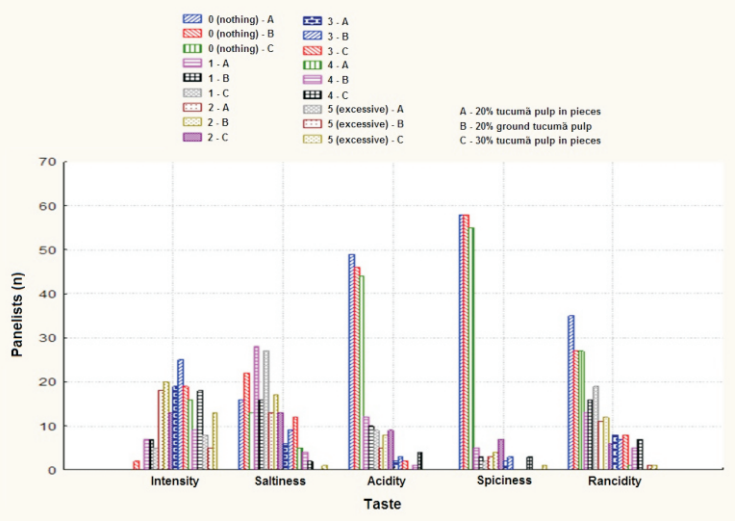
For intensity, samples A and C did not receive a score of zero from any panelist, and sample B received a score of zero from two panelists. Sample B received scores of two and three from 45 panelists; sample A, from 37 panelists; and sample C, from 32 panelists. Samples C, A, and B received a score of five from 13, 8, and 5 panelists, respectively.

For saltiness, samples A, C, and B received scores of zero and one from 44, 40, and 38 panelists, respectively.

For acidity, samples A, B, and C received scores of zero and one from 61, 56, and 53 panelists, respectively, indicating a preference for sample A.

For spiciness, samples A, B, and C received scores of zero and one from 61, 61, and 57 panelists, respectively. Samples A, B, and C received scores of 4 and 5 from 0, 0, and 4 panelists, respectively. Therefore, the panelists preferred samples A and B.

For rancidity, samples A, B, and C received a score of zero from 35 (51.5%), 27 (40%), and 27 (40%), respectively. Again sample A presented higher quality.



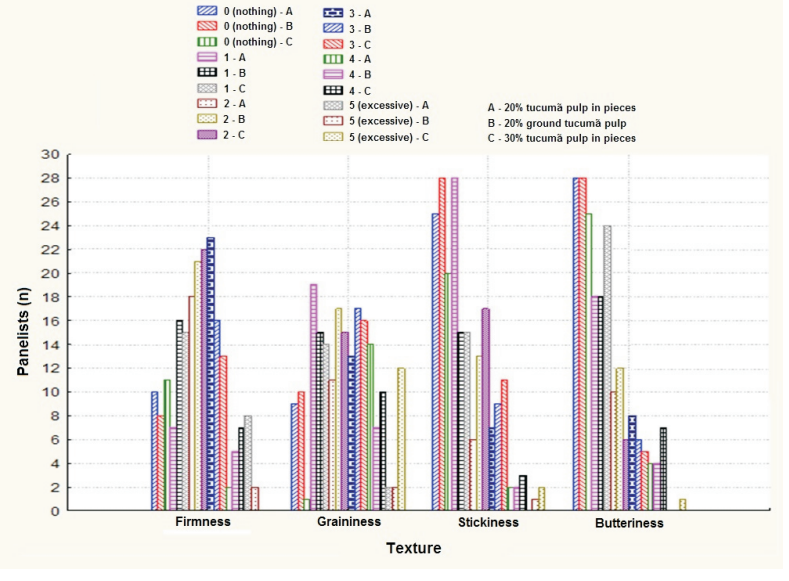
Graph 03 – Assessment of the samples' taste

Regarding texture (Graph 4), the firmness of samples C, B, and A received scores of zero and one from 26 (38.2%), 24 (35.3%), and 17 (25%) panelists, respectively. Samples A, B, and C received a score of five from 8, 2, and 0 panelists, indicating that sample A had the highest consistency.

For graininess, samples A, B, and C received scores of zero and one from 28 (41%), 25 (37%), and 15 (22%) panelists, respectively. Samples A, B, and C received a score of five from 2, 2, and 12 panelists, respectively. Therefore, the panelists preferred samples A and B.

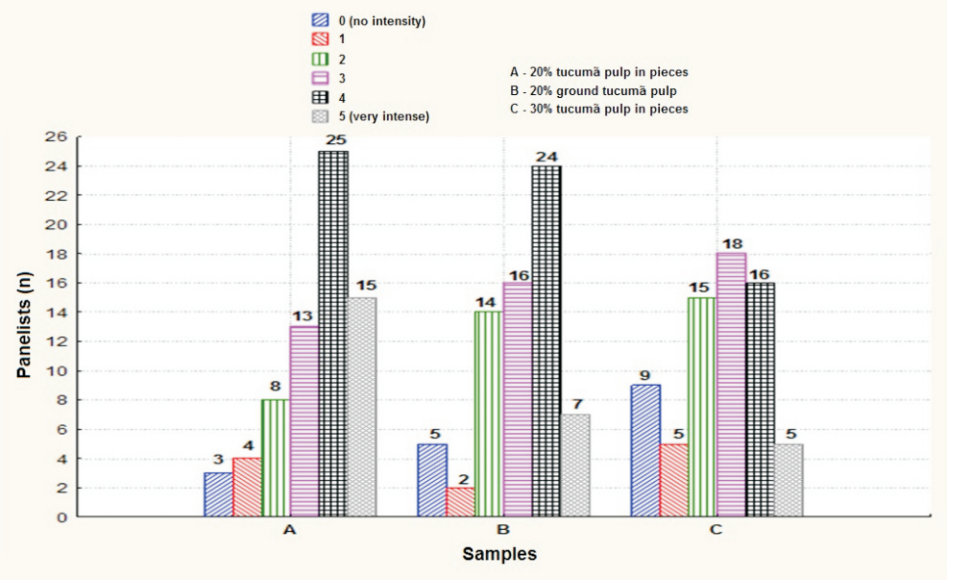
For stickiness, samples A, B, and C received scores of zero and one from 53 (78%), 43 (63%), and 25 (37%) panelists, respectively. Samples A, B, and C received a score of 5 from 0, 1, and 2 panelists, respectively, indicating a preference for sample A.

For bitterness, samples C, A, and B received scores of zero and one from 49 (70.5%), 46 (68%), and 43 (63%) panelists, respectively. Samples C, A, and B received a score of five from 1, 0, and 0 panelists, respectively.



Graph 04 – Assessment of the samples' texture

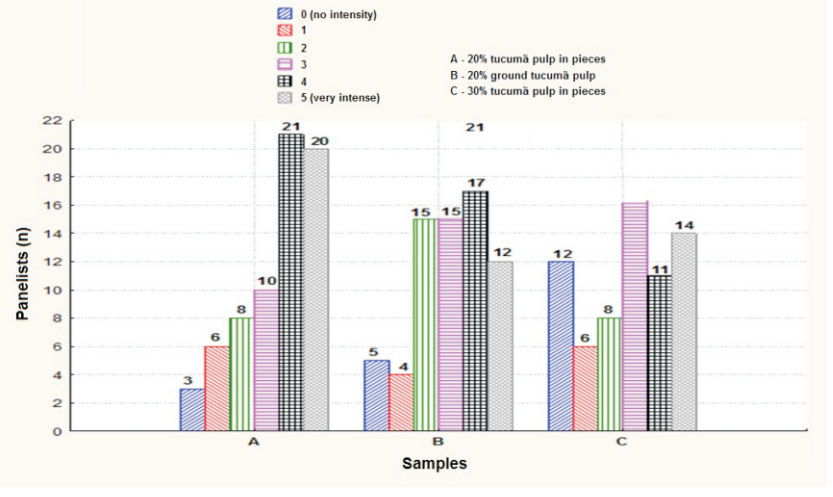
The scores for global assessment ranged from zero (don't like) to five (like it very much) (Graph 5). Samples A, B, and C received scores of zero and one from 7, 7, and 14 panelists, respectively. Samples A, B, and C received scores of 4 and 5 from 40 (59%), 31 (45.6%), and 21 (31%) panelists, respectively. Thus, the panelists preferred sample A.



Graph 05 – Global appreciation of the samples

Purchase intention received scores ranging from zero (wouldn't buy) to five (would certainly buy) (Graph 6). Samples A, B, and C received scores of zero and one from 9, 9, and 18 panelists, respectively. Samples A, B, and C received scores of four and five from 41 (60.1%), 29 (43%), and 25 (36.8%), respectively.

The affective test (Graph 6) confirms the panelists' preference for sample A, confirming the scores given to the other attributes, where sample A prevailed significantly.



Graph 06 – Purchase intention of the samples

Table 1 shows the mean results for the composition of the cheeses. Moisture content varied from 52.63% to 54.84%, complying with Normative Instruction no. 30 (2001), which establishes that coalho cheese

should have a moisture content ranging from 36% to 54.9% (Table 1).

Table 1: Proximate composition and minerals in coalho cheese enriched with tucumã

Item	A	B	C
Moisture (%)	54.84%	53.45%	52.63%
Ash (%)	3.99%	3.94%	3.99%
Proteins (%)	18.87%	18.08%	17.56%
Lipids (%)	17.07%	16.46%	14.79%
Carbohydrates (%)	5.23%	8.07%	11.03%
Energy (Kcal)	250.03	252.74	247.47
Calcium (mg)	139.6	120.93	108.21
Magnesium (mg)	20.86	20.05	21.33
Potassium (mg)	286.16	305.93	299.24
Sodium (mg)	506.18	500.10	585.45
Manganese (mg)	0.14	0.25	0.24
Copper (mg)	Tr	Tr	Tr
Zinc (mg)	1.25	2.08	1.31
Iron (mg)	0.55	0.68	0.88

Tr- trace amount

The lipid contents of all three samples were similar: the fat content varied from 14.79% to 17.07%, showing that moisture and lipid contents decrease significantly as the amount of tucumã pulp increases. Sheehan et al.(2009) reported that moisture and fat contents increase proportionally with cow milk content. Their moisture and fat contents varied from 43.59% to 46.05% and from 25.22% to 28.65%, respectively. Protein content varied from 17.56% to 18.87%, decreasing with increasing amount of tucumã pulp. The ash content varied from 3.94% to 3.99%, corroborating Gomes (1997), who found that the ash content of fresh cheeses vary from 1.0% to 6.0%. Freitas Filho & Ferreira (2008) and Uliana & Rosa (2009) found similar ash contents in handmade colonial cheese (3.85% to 4.31%) and coalho cheese (2.77% to 2.87%), Shimma and Tanimoto (2016) find values in the composition ranging from non-fatty and fatty cheese fat 3.7 30,7g / 100g protein 38,8 to 26,3g / 100g, moiusture 53.1 to 43.8 g / 100 g and ash 3.7 to 1.7g / 100g. Carbohydrate content varied from 5.23% to 11.03%. The carbohydrate and fiber contents of the dairy cattle's diet may vary, which directly affects the carbohydrate content of the milk (Fagan, 2006; Oliveira et al., 2004). The variations in the carbohydrate content of the study cheeses may also stem from dietary management. Genetic changes have a slow influence on the composition of milk, while changes in management, environmental conditions, and nutrition may change composition faster and more economically. According to González et al. (1996), the proportion of each milk component is influenced to different degrees by the cow's diet and metabolic condition, which directly and indirectly reflects on the proximate composition of milk and dairy products. The study cheeses had good calcium (108.21mg to 139.6mg), magnesium (20.05mg to 21.33mg), and potassium (286.16mg to 305.93mg) contents. These mineral content differences were significant, corroborating Perry (2004) and Shimma and Tanimoto (2016) found calcium levels ranging between 1.23 and 0.50 g / 100g. The microbiological analyses showed that all the samples complied with the limits provided by Normative Instruction no. 30 (2001) for coliforms at 35°C and 45°C (MPN/g), coagulase positive Staphylococcus (log CFU/g), Salmonella spp./25g, and Listeria monocytogenes/25g for cheeses with moderate to high moisture content (36% to 54.9%). Normative Instruction no. 30 (2001) provides the General Technical Regulation for the Identity of Coalho and Butter Cheeses to prevent these cheeses from posing a health risk to consumers. The fermentation that occurs as cheeses mature, which includes the formation of lactic acid, is essential to inhibit the development of pathogenic microorganisms. Buriti et al. (2005) reported that the addition of lactic acid and the presence of lactic cultures ensure good continuous production of lactic acid, which lowers pH during storage and produces other antimicrobial compounds.

CONCLUSIONS

• Mixed coalho cheeses made with different proportions of cow milk and tucumã (Astrocaryum aculeatum

Meyer) pulp results in products with different physical properties, chemical composition, and sensory characteristics.

- Cheeses containing higher amounts of tucumã pulp are not as well accepted by consumers as those containing higher amounts of cow milk because of the characteristic tucumã taste.
- The mixed cheese A containing 30% tucumã pulp is viable from the nutritional and sensory points of view, representing a potential alternative for the dairy product industry to increase product selection.

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