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Physico-chemical Characterization of Blends Based on Milk and Catole Coconut Pulp

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Authors' contributions

This work was carried out in collaboration with all authors. Author JDPM designed the study, performed the physical-chemical and statistical analyzes, wrote the protocol and wrote the first draft of the manuscript. Authors RMFF and JAMQ conducted the study and managed the corrections of the manuscript. Authors LPFRS and MSM performed physicochemical analysis of the research. Authors ZRTC and SNS managed the statistical analyzes. Authors AFV and LMSR coordinated bibliographical research. All authors have read and approved the final manuscript.

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ABSTRACT

Aims: Coconut catole is the fruit of the *Syagrus cearenses* palm tree, whose pulp is usually eaten in its natural form. The formulation of blends is intended to improve the acceptance of fruit with potential to be exploited. The objective of this work was to evaluate the physico-chemical characteristics of the whole coconut pulp and the blends formulated with the pulp and milk.
Place and Duration of Study: The coconut catole (*Syagrus cearensis*) were collected in the surroundings of location 551'30 "S, 35º21'13 "O, in Rio Grande do Norte. The work was carried out from January to February 2019.
Methodology: The formulations were elaborated by mixing the proportions of 30 and 50% of standardized commercial milk with the whole catole coconut pulp. The products were submitted to

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the analysis of moisture, water activity (a_w), titratable total acidity (TTA), total soluble solids (TSS), TSS/TTA ratio, pH, ascorbic acid, ash, lipids, proteins, color (L*, a*, b*), total sugars, reducers and non-reducers.
Results: From the results, it was observed that the addition of milk to the pulp resulted in clear samples and that a higher proportion of the milk statistically influenced the results.
Conclusion: The mixture of couscous coconut pulp and milk gave the product better nutritional characteristics, especially protein content and lipid reduction. The addition of the milk to the cocoa pulp influenced the results statistically, showing that the addition of the milk contributed to enhance the pulp.

Keywords: Syagrus cearenses; palm; formulation; fruits; semiarid.

1. INTRODUCTION

The insertion of native fruits in the diet is a growing trend in populations, stimulated by the availability, freshness and popularization of dietary indications that recommend the consumption of foods rich in vitamins and minerals. Brazil has an immense variety and availability of fruits, but many of these are not yet used through processing [1].

The Brazilian semi-arid region has a diversity of fruits typical of the Caatinga biome. Its xerophytic vegetation is fully adapted to arid conditions [2]. The family of palm trees (Arecaceae) is present in various plant formations, including the semi-arid region, with little explored economic potential given the great diversity of products to which they give rise and which can be used by local agroindustries [3].

Among the native palms of the Caatinga there is the genus Syagrus and among these is the species *Syagrus cearensis*, typical of the northeast region, measuring about 10 m in height, whose fruit is known as catole, coconut catole, coconut-babao or babao [4].

The fruits present almonds with oil potential, used in traditional medicine to treat some skin diseases [3]. The fruit may be globular or oblong, light orange flesh when ripe and thin dark brown skin measuring approximately 3.5 - 4,0 cm in length and 3 - 4 cm in diameter, with a fibrous/ arnous mesocarp of 7 - 10 mm thick and an endocarp of 3 - 5 mm thick. They have a sweet taste, being consumed by local populations in their natural form [5].

However, most of the fruit pulp is wasted at the time of harvest, due to the high perishability, the low pulp/seed ratio and the greater interest in oil obtained from the latter. This waste can be minimized by using pulp as a raw material in the formulation of industrialized foods such as nectars, dairy products, juices, mixed drinks and sweets.

Combinations that consider the addition of milk to fruit pulps are convenient in several ways, starting with the contribution of proteins and fats, the smoothing of excessively strong flavors of acidity and astringency and the incorporation of consistency and creaminess. From these combinations, we obtain beverages with differentiated flavor and improved physical, chemical and nutritional characteristics, since the composition of the fruit used is added to the nutrients from the milk.

The objective of this study was to physico-chemically characterize the whole coconut pulp and the blends formulated with the pulp and milk.

2. MATERIALS AND METHODS

2.1 Conducting Research

The coconut catole (*Syagrus cearensis*) were collected in the surroundings of location 551'30"S, 35º21'13"O, in Rio Grande do Norte. The fruits were selected by their peel color (yellow to orange) as a way to identify maturity. They were then washed in running water, sanitized by immersion in chlorine solution (50 ppm of active chlorine) for fifteen minutes, and immersed in drinking water (5 ppm of active chlorine) for five minutes for rinsing.

The pulp was extracted from the fruit in an industrial pulper and packed in polyethylene bags (500 g), sealed and stored in a freezer at -18°C, for later use in the preparation of the blends. The milk used was purchased from supermarkets of the standardized UHT type, in a multiwall carton package.

Three formulations were elaborated (Table 1): Formulation F1 - whole catole coconut pulp; Formulation F2 (*blend*) - whole catole coconut pulp (70%) and milk (30%); Formulation F3 (*blend*) - whole catole coconut pulp (50%) and milk (50%). The ingredients of the formulations were weighed and homogenized for about 30 seconds.

2.2 Physico-chemical Parameters

The physico-chemical analyses were performed in triplicate in all formulations for the characterization of each treatment. The physico-chemical parameters were determined according to the methodologies of the AOAC [6].

The vitamin C content was determined using the titration method, based on the reduction of the indicator 2.6-dichloroindophenol sodium salt hydrate by ascorbic acid, and the results were expressed in mg of ascorbic acid/100g sample [6]. The pH was obtained by direct measurement in a potentiometer, Tecnal brand TEC-2, previously calibrated with buffer solutions pH 4.0 and 7.0 [6]. Total soluble solids - TSS were determined by refractometry, using a bench-type Abbe refractometer, brand Instrutherm, RT - 30 ATC and expressed in °Brix [6]. Total titratable acidity - TTA was performed by titration with 0.1 M NaOH until the turning point of the phenolphthalein indicator (pH of 8.2) was reached and the results expressed as a percentage of citric acid [6]. The TSS/TTA ratio was calculated by the quotient of the values of total soluble solids and total titratable acidity.

The crude protein content was obtained by the micro "Kjeldahl" method, through the determination of nitrogen [6]. The protein content was calculated by the amount of total nitrogen in the product multiplied by the conversion factor 6.25.

Reducing sugars AOAC [6] and non- reducing sugars were quantified by the alkaline reduction method, which is based on the reduction of cupric salts and cuprous oxides present in Fehling solution. The results were expressed as glucose reducing glycides and non-sucrose reducing glycides, respectively. Total sugars were quantified by the sum of reducing and non-reducing sugars.

The moisture content was determined by the gravimetric method from direct drying in a vacuum oven at 70 °C to constant mass [6]. The determination of the ashes (fixed mineral residue) was performed by the quantity of inorganic elements obtained by the incineration in a muffle furnace at 525°C [6]. Lipids were determined by the method proposed by Bligh and Dyer [7], who uses chloroform, methanol and water.

The color parameters L*, a* and b* were verified through the portable spectrophotometer MiniScan Hunter Lab XE Plus, model 4500 L, in which L* defines luminosity (L* = 0 - black and L* = 100 - white) and a* and b* are responsible for the chromaticity (+a* red and -a* green; +b* yellow and -b* blue). The equipment was calibrated with a white plate (X=80.5; Y=85.3; Z=90.0), equipped with a D65 illuminant and a 10° angle of observation.

The water activity measures (a_w) were determined by direct reading at 25°C in Aqualab 3TE (Decagon Devices) equipment.

2.3 Statistical Analysis

Data analysis was performed in a completely randomized design. The experimental data obtained were submitted to analysis of variance (ANOVA) and the means compared by the Tukey test at 5% probability, through the software Assistat version 7.7 beta [8].

3. RESULTS AND DISCUSSION

Table 2 shows the physico-chemical characteristics of the formulations. The pH results show that there was a difference between the formulations, with higher results for F3. Inverse behavior was observed for acidity, where it was found that the F1 and F2 formulations did not present statistically significant differences, but from the data set there was a tendency to reduce with the increase in milk concentration, corroborated by the trend in pH values. The decrease in acidity is related to the increase in pH values, since these parameters are inversely proportional [9].

Table 1. Percentage of constituent components of catole coconut pulp and milk formulations

Formulation	Pulp (%)	Milk (%)
F1	100	0
F2	70	30
F3	50	50

Table 2. Mean values and standard deviations of physico-chemical parameters evaluated in formulations

Parameter	F1	F2	F3
Total titratable acidity (% citric acid)	0.40±0.01^a	0.37±0.00^a	0.27±0.03^b
pH	4.73±0.01	5.04±0.02	5.38 ±0.01
Total soluble solids (°Brix)	26.00±0.00^a	21.00±0.00^b	17.00±0.00^c
TSS/TTA	64.91±1.31^a	57.23±0.52^c	60.98±2.38^b
Ascorbic acid (mg of ascorbic acid/100 g sample)	1.52±0.02^a	1.25 ±0.01^b	0.51±0.00^c
Moisture (%)	70.02±0.33^c	76.02±0.3^b	79.23±0.30^a
Ashes (%)	1.08±0.06^a	1.00±0.06^{ab}	0.85±0.08^b
Lipids (%)	2.89±0.05^a	2.63±0.09^b	2.37±0.12^c
Proteins (%)	1.45±0.02^c	1.94±0.01^b	2.70±0.02^a
Total sugars (% glucose)	30.44±0.00^a	24.77±0.00^b	22.45±0.00^c
Reducing sugars (% glucose)	14.89±0.00^a	13.23±0.00^b	11.71±0.00^c
Non-reducing sugars (% sucrose)	14.77±0.00^a	10.96±0.00^b	10.20±0.00^c
Water activity	0.973±0.001^c	0.981±0.00^b	0.984±0.00^a

The means followed by the same letter in the lines do not differ statistically from each other at 5% probability

Table 3. Mean values of color parameters (L*, a* and b*) and standard deviation of formulations

Color	Formulations		
	F1	F2	F3
L*	48.62±0.26^c	55.35±0.38^b	58.97±0.24^a
+a*	7.76±0.04^a	5.83±0.09^b	4.96±0.05^c
+b*	34.25±0.22^a	30.07±0.36^b	27.48±0.38^c

The means followed by the same letter in the lines do not differ statistically from each other at 5% probability

The results of pH and acidity of the whole pulp (F1) show that the pulp is not very acidic and requires gentle treatments to preserve the product. The increase in pH is proportional to the amount of milk added to the mixture, since its pH is close to neutrality (5 and 6) and has a considerable buffer effect. Paula Filho et al. [10] when examining the physico-chemical characteristics of licuri pulp (*Syagrus coronata* (Mart.) Becc.) found a pH of 5.16. Barros et al. [11], evaluating the effect of pasteurization temperature at 72ºC, 80ºC and 88ºC for 60 seconds in the jucara pulp (*Euterpe edulis* Martius) reported a pH range of 4.47 to 5.07.

The total titratable acidity of the pulp (F1) is above the range reported by Nascimento et al. [12] (0.34%) when studying the chemical and nutritional characteristics of coconut catole. Carvalho et al. [13], studying the mixed juice of acerola (10%), pineapple (20%), acai (5%), caju (5%), caja (5%), camu-camu (5%), water (43.1%) and sugar (6.9%) found acidity values of 0.33%.

The results of total soluble solids showed a statistical difference between the formulations. The integral pulp (F1) had the highest content of total soluble solids and was similar to that found by Moura Neto et al. [14] when developing a mixed drink based on water soluble soy extract made with coconut water and umbu pulp (25 °Brix). Gazola et al. [15] when studying a soy-based beverage and pitanga obtained total soluble solids of 17 °Brix. The relation between TSS/TTA reached the range of 57.23 to 64.91, with the whole pulp achieving the highest results. The TSS/TTA ratio was lower in mixtures with 50% and 30% of milk than in whole pulp.

It was found that the highest levels of ascorbic acid were found in the whole pulp (F1) reducing with the increase in the proportion of milk. Santander et al. [16] when evaluating a mixed beverage of skimmed UHT milk with tomarillo pulp (*Solanum betaceum*) found levels of ascorbic acid of 12.97 mg/100 mL. Cardoso et al. [17], in fresh grape juice, reported 1.27 mg/100 mL, while in industrialized juice ready for drinking, they obtained 0.37, 0.86 and 1.10 mg/100 mL in 3 commercial brands.

Among the samples studied, formulation F3 showed higher moisture content. Paula Filho et al. [10] analyzed the physical-chemical characteristics of the licuri pulp (*Syagrus coronata* (Mart.) Becc.), a palm of the same genus as *Syagrus cearensis*, and obtained a close value for humidity (74.48%). Silva et al. [2] when analyzing the coconut pulp catole verified a moisture content of 72.5%.

It was found that the whole pulp (F1) presented a value higher than the blend F3 in terms of percentage of ash, with a tendency to decrease as the proportion of milk was increased. Bramont et al. [1], when characterizing athemian pulp (*Annona atmoya*) and breadfruit (*Artocarpus incisa* L) found ashes of 1.11% and 0.83%, respectively. Silva et al. [2] when analyzing the centesimal composition of *Syagrus cearenses* pulp, found a mineral content (0.6%) lower than that found in this study. According to Ordóñez [18], the presence of minerals in the fruits is very variable, depending on the soil composition and climate variations of the different geographical locations or even the different types of fertilization used.

The pulp *in natura* (F1) contains the highest content of lipids, expected result in palm fruit pulp. Silva et al. [2] when studying pulps from six species of Arecaceae reported an average value of 3.1% for *Syagrus cearenses*. Sousa et al. [19] characterized a pasteurized dairy beverage with the addition of iron, with a lipid content of 2.07%.

As for protein content, values equivalent to 1.85 to 2.79% were found by Silva et al. [20] when analyzing trademarks of chocolate-flavored dairy products. Rocha et al. [21], when developing beverages formulated with whey added with lutein, found a 2.12% protein content in the formulation with 2.0% whey.

The F1 formulation, in relation to total sugars, is superior to other pulps mixed with milk. Gobbi et al. [22] evaluating four brands of passion fruit nectars sold in supermarkets in the city of Cuiaba-MT, found two brands with sugar results of 29.47 and 25.77%, therefore, close to those determined in the formulations.

Reducing sugars show a decrease in content with an increase in the proportion of milk, explained by lactose, the main sugar present in milk, being a disaccharide. In the case of non-reducing sugars, their content (10.21 to 14.78%) in the blended pulps F2 and F3 is lower than the content of reducing sugars in the whole pulp (F1).

Santos Filho et al. [23], when applying pineapple pulp residue in the preparation of a dairy beverage, quantified non-reducing sugars (10.49%) that corroborate the results of formulations with the addition of milk.

Water activities resulted in high values, increasing with the proportion of milk. Carneiro et al. [24] determined water-soluble babassu extract water activity values of 0.97-0.98. Sandri et al. [25] in buriti pulp found water activity of 0.980.

Table 3 shows the color parameters (L*, a* and b*) of the formulations.

Color is a very important attribute and is a parameter that can influence the sensory acceptance of products. Considering the chromatic characteristics of the formulations, it was found that the higher the proportion of milk in the formulation, the higher the luminosity due to the fact that the closer to the white color, the greater the value of L*. At the same time, the intensities of yellow (+b*) and red (+a*) decreased, suggesting dilution of the carotenoid pigments responsible for the yellowing of the catholic pulp.

Castro et al. [26], working with frozen it pulp of different flavors and brands, observed results for L* of 50.86 and for +b* of 33.04, in passion fruit pulp. Ribeiro et al. [27] detected L* value of 47.98 in pasteurized umbu juice under the effect of storage at 6℃. Mgaya-Kilima et al. [28] reported a range of +a* from 5.4 to 7.3 in mixtures of mango, papaya and guava juices with *Hibiscus sabdariffa* L.

4. CONCLUSION

The mixture of catole coconut pulp and milk (F3) gave the product better nutritional characteristics, mainly of the protein content and reduction of lipids. The catole coconut pulp without mixtures (whole) presented the highest contents of titratable total acidity, TSS/TTA ratio, ascorbic acid, ashes and lipids, besides the higher intensity of yellow color.

The addition of milk to the coconut pulp resulted in lighter samples and the increased proportion of milk statistically influenced the results.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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