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Original Article

Cariogenic and Erosive Potential of Industrialized Cashew Juice

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Abstract

Objective: To evaluate the cariogenic and erosive potential of industrialized cashew juice. **Methods:** Twenty-seven cashew juice samples of three different brands (n = 9) were analyzed for the following physicochemical parameters: pH, titratable acidity (TA), ascorbic acid, total soluble solids (TSS), TSS/TA ratio and reducing, non-reducing and total sugars. Assays were performed in triplicate and data were processed using ANOVA and Tukey test, considering $\alpha = 5\%$. **Results:** All samples showed pH values below 5.5, highlighting Da Fruta® brand, with mean value of 3.6 ($p < 0.001$). Although juices contain, on average, 34% of total titratable acidity ($p > 0.05$), there was no difference among groups for the amount of ascorbic acid (19.41 ± 3.46 g / 100 mL, $p > 0.05$), and TSS / TA ratio (35.05 ± 7.10, $p > 0.05$). Carrefour juices showed higher amounts of TSS (12.52 ± 0.31 g / 100 mL). For reducing, non-reducing and total sugars, mean values of 9.31 ± 0.97, 1.28 ± 1.01 and 10.59 ± 1.73 g / 100 mL, respectively, were found, with no differences among groups ($p > 0.05$). **Conclusion:** The industrialized cashew juices evaluated had low pH and considerable amount of sugars and acids, providing them cariogenic and erosive potential.

Keywords: Dental caries; Tooth erosion; Dietary sucrose..

Introduction

The increasing consumption of processed foods, either in developed [1] or developing countries [2], has led to concerns related to consequences on human health, especially metabolic disorders [3,4] and hypertension [5], as well as consequences for oral health that can affect dental elements, such as pain, decreased masticatory efficiency and aesthetic changes [6].

Among the most commonly consumed processed foods, juices stand out because they have great acceptability related to the high palatability, they are ready to use and are full of commercial information that enhance their nutritional components associated with health maintenance such as vitamins, minerals, fibers and other chemical constituents [7,8].

However, to achieve such characteristics, food industries need to add preservatives and other substances that ensure longer shelf life and palatability to products, making them more acidic and sweet [9]. These characteristics are potentially harmful to tooth structures by interfering in the development of erosion [10] and dental caries [11].

Given the great variability of industrialized juices produced in Brazil with tropical fruits, cashew juice deserves special attention because they are widely consumed, since its peduncle (pseudofruit) has the appearance of fruit, is juicy, fibrous and rich in vitamin C, and is part of many tropical fruit widely accepted in the international market [12, 13]. The aim of this study was to evaluate the physicochemical parameters of processed cashew juices related to their erosive and cariogenic potential.

Material and Methods

Endogenous pH, total soluble solids (TSS), titratable acidity (TA), TSS / TA ratio, ascorbic acid and sugar levels were determined in 27 industrialized fruit juice samples of different commercial brands (n = 9): Carrefour® (São Paulo, São Paulo, Brazil), Palmeiron® (Salvador, Bahia, Brazil) and Da Fruta® (São Paulo, São Paulo, Brazil), marketed in the city of Joao Pessoa, PB, Brazil. Products were selected according to their availability in market. Each analysis was performed in triplicate. Data were collected by a single calibrated examiner, recorded on study-specific charts.

Total Soluble Solids (TSS)

Total soluble solids, measured in degrees Brix (oBx), were analyzed by refractometry using an Abbe refractometer (PZO-RL1, Warsaw, Poland). As the refractive index of a sugar-containing solution is temperature dependent, refractometers are typically calibrated at 20oC [14]. The equipment was calibrated with deionized water (refraction index = 1.3330 and 0º Brix at 20ºC) and the readings of samples were performed (oBrix or g/100mL).

pH Measurement

The pH of each juice was determined using a pH meter (TEC-2 pH meter; Tecnal, São Paulo, SP, Brazil) placed directly into each solution. The pH meter accurate to 0.1 was first calibrated

according to the manufacturer's instructions, employing buffer standards of pH 7 and pH 4. Twenty milliliters of each pure beverage was placed in a beaker and the pH meter electrode was immersed in the juice and the reading was recorded [15]. Between readings, the electrode was rinsed in distilled water to ensure that no cross-contamination occurred.

Titratable Acidity (TA)

TA was measured according to the method adopted by the Association of Official Analytical Chemists [16], that is, the amount of 0.1 N KOH solution needed for the product to reach a neutral pH or a pH value above it. A 10 mL aliquot of the diluted product was titrated (10% solution of the sample) with the 0.1 N KOH solution until the substance reached a pH value between 8.2-8.4, corresponding to the endpoint of the phenolphthalein. Readings were done with a pH meter (TEC-2R; Tecnal, São Paulo, SP, Brazil). When this value was reached, the spent KOH volume was recorded and the acidic percentage of the substance was calculated using the following equation, with the result being expressed as percentage of citric acid.

$$\text{Acidity (\%citric acid)} = \frac{V \times Nap \times F \times \text{meq-g(citric acid)} \times 100}{\text{Sample}}$$

Where: V = KOH volume; Nap = Normal concentration of the KOH base; F = Normality correction factor; meq-g = miliequivalent per gram of citric acid; Sample= volume of the medicine.

Vitamin C (Ascorbic Acid)

Vitamin C extraction was performed using 5 ml of juice, which were added of 50 ml of oxalic acid 0.5 g.100 ml-1. Titration of the amount of Vitamin C (ascorbic acid) in samples was performed using 2,6-diclobenzenoindofenol as indicator [17].

Statistical Analysis

Data were analyzed using descriptive and inferential statistics with analysis of variance (ANOVA) and Tukey tests, considering $\alpha = 5\%$ and SPSS software v. 21.

Results

Physicochemical parameters related to cariogenic potential are described in table 1. Carrefour juice showed higher amount of TSS (oBrix), with mean value of 12.52 ($p < 0.001$), although no differences related to the amount of reducing, non-reducing and total sugars among groups were observed.

All juices showed hydrogen-ion potential (pH) below 5.5, especially Da Fruta®, with mean value of 3.6 ($p < 0.001$). No significant differences were observed among groups for parameters titratable acidity (TA), TSS (° Brix) / TA and vitamin C, as shown in Table 2.

Table 1. Mean and standard deviation of the physicochemical analyses of juices evaluated related to their cariogenic potential.

	TSS (°Brix)	Reducing sugars (g/100mL)	Non-reducing sugars (g/100mL)	Total sugars (g/100mL)
Carrefour®	12.52±0.31[a]	9.41±0,79[a]	1.27±0,69[a]	10,69±1.25[a]
Da fruta®	11.43±0.40[b]	9.01±0.99[a]	1.02±0.98[a]	10,03±1.81[a]
Palmeiron®	10.34±0.55[c]	9.47±1.14[a]	1.56±1.31[a]	11,04±2.07[a]
	p=0.0000	p=0.5983	p=0.5533	p=0.5209

Different letters on the same column indicate significant differences. ANOVA and Tukey tests (α = 5%).

Table 2. Mean and standard deviation of physicochemical analysis of juices evaluated related to the erosive potential on the tooth structure.

	pH	Titratable Acidity	Vitamin C	TSS (º Brix) / TA
Carrefour®	4.04±0.15[a]	0.34±0.11[a]	19.99±2.79[a]	33.34±10.53[a]
Da fruta®	3.60±0.02[b]	0.30±0.02[a]	20.03±2.96[a]	38.07±4.55[a]
Palmeiron®	4.04±0.15[a]	0.34±0.11[a]	18.20±4.48[a]	33.34±10.53[a]
	p=0.0003*	p=0.6315	p=0,5373	p=0.8309

Different letters on the same column indicate significant differences. ANOVA and Tukey tests (α = 5%).

Discussion

Considering that dental caries results from the fermentation of sugars by oral microorganisms, especially streptococci, the frequent intake of foods containing significant amounts of these substances is an important risk factor for developing the disease [18]. Similarly, the regular consumption of acidic foods is associated with erosion of dental tissues, triggering painful sensations, pulp damage and aesthetic changes [19].

In this sense, knowing the physicochemical parameters of industrialized beverages, including fruit juices, is relevant for contributing to a better nutritional counseling by health professionals, as they provide important information in detecting risk of oral problems, and this problematic has been incorporated as an object of interest of some studies described in literature [19, 20], although only few studies on industrialized cashew juice have been identified. Parameters determined for fresh fruit juices are considered reference and contribute to the analysis of data presented in this study.

The amount of TSS (oBx) is directly associated with food viscosity due to its direct relationship with the amount of sugars, especially glucose, fructose and sucrose, varying according to species, facilitating their retention on tooth surfaces and contributing to dental biofilm maturation [13,22]. TSS values ranging from 10.34 to 12.52 were observed, especially for Carrefour® juice ($p \leq 0.001$), which corroborate studies that found a range from 8 to 12.6° Brix in fresh cashew juice [12, 21]. These values are similar to those observed for other fruit juices [19, 22].

Significant amount of sugars, especially reducing sugars (mean = 9:31 g / 100mL), was found in the juices evaluated, with no difference between brands. Analyses performed in fresh cashew juices showed mean value of 3.2 g / 100mL of these sugars [20]. This difference may have occurred due to the addition of sugars to industrialized juices to improve palatability, consequently, increasing their acceptability by consumers but also increasing their cariogenic potential, since the frequent

consumption of sugar-sweetened beverages is associated with increased incidence of dental caries [23].

Mean pH value of 3.74 was observed, and Da Fruta® juices showed the lowest value (3.60 p <0.001). Mean titratable acidity of 0.32% was observed, with no difference between brands. These values are similar to those found in other studies, since pH values between 4.10 and 4.4 and titratable acidity values between 0.30 to 0.34% have been reported [12, 21]. These parameters reflect the erosive potential of juices evaluated, since the apatite crystals of the tooth enamel undergo dissolution at pH below 5.5 [24].

The amount of vitamin C (ascorbic acid) present in cashew juices was also measured [12,25], since cashew presents considerable amounts of this substance [26], which is associated with beneficial effects on human health and is considered a dietary supplement with antioxidant effects [27]. In this study, a mean value of 19.41 g / 100 ml was found, with no difference among groups. In fresh cashew juices, this value is, on average, 139.75 mg / 100mL [12]. In citrus fruits such as oranges, the vitamin C content can vary depending on the cultivar, location, harvest and degree of ripeness, and may present values up to 84.03 mg / 100mL [28]. Even though presenting vitamin C contents lower than those found in fresh juices, industrialized products overvalue information regarding the presence of this substance. It is noteworthy that for good utilization of vitamin C for health, intake of 75-100 mg / day, on average, is recommended [29].

The TSS / TA ratio is an indicator used to determine the sweet: acid taste, which is important for improving the palatability of products [28], and the range of this ratio preferred by consumers is from 15 to 18 [30], although there is a positive correlation between this ratio and sensory analysis. In juices evaluated in this study, TSS / TA ratio values are higher than recommended, probably due to the addition of acids and sugars by manufacturers, ensuring greater acceptability by the consumer market. Furthermore, these data indicate the cariogenic and erosive properties of these products.

The results of this study point to the need to consider the production of industrialized foods, especially juices, with physicochemical and nutritional properties beneficial to health maintenance and preservation of dental structures, and further laboratory studies aiming at evaluating the effect of these substances on dental structures, as well as clinical trials seeking to show the consumption of such beverages as a risk factor for the development of dental caries and dental erosion, should be carried out.

Conclusion

The industrialized cashew juices analyzed exhibit physicochemical parameters favorable to the development of erosion and dental caries, highlighting their low pH values and presence of considerable amounts of sugars.

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