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PHYSICOCHEMICAL AND SENSORY EVALUATION OF YELLOW MOMBIN (*Spondias mombin L.*) ATOMIZED POWDER[1]

LUÍS GOMES DE MOURA NETO[2*], ÉRICA MILO DE FREITAS FELIPE ROCHA[3], MARCOS RODRIGUES AMORIM AFONSO[4], SUELI RODRIGUES[4], JOSÉ MARIA CORREIRA DA COSTA[4]

ABSTRACT - Dehydration is an important alternative to making the most of the use the surplus of production and take advantage of the seasonality of tropical fruits. Thus, this study aimed to evaluate the physicochemical composition of the yellow mombin pulp (*Spondia mombin* L.) powder, obtained by spray drying, and evaluate its sensory acceptance in the form of reconstituted juice. The physicochemical analyzes of the yellow mombin powder were: pH, soluble solids, titratable acidity, ascorbic acid and moisture, with all results in accordance with the current legislation. The addition of maltodextrin in the process reduced the sensory analysis values (color, appearance, and taste). The tested formulations, (powders with 25 and 27.05% maltodextrin) preserved, and even favored the aroma. These formulations had the following values (7.66 and 7.68) higher than the values found for integral juice (6.60).

Keywords: Food Preservation. Maltodextrin. Spray-dryer. Tropical fruit.

AVALIAÇÃO FÍSICO-QUÍMICA E A SENSORIAL DE PÓ DE CAJÁ ATOMIZADO (*Spondias mombin* L.)

RESUMO - A desidratação mostra-se como uma alternativa importante para aproveitar o excedente de produção e sazonalidade das frutas tropicais. Neste contexto, o objetivo desta pesquisa foi avaliar a composição físico-química da polpa de cajá (*Spondia mombin* L.) em pó, obtido por spray-dryer, e avaliar a sua aceitação sensorial em forma de suco reconstituído. As análises físico-químicas realizadas nos pós de cajá foram: pH, sólidos solúveis, acidez titulável, ácido ascórbico e umidade, apresentando todos os resultados dentro da legislação vigente. A adição da maltodextrina no processo indicou redução das notas dos atributos cor, aparência e sabor na análise sensorial. As formulações testadas, pós com 25 e 27,05% de maltodextrina conservaram, e até favoreceram, o atributo aroma, obtendo notas de valor superior (7,66 e 7,68) ao observado para o suco integral (6,60).

Palavras-chaves: Conservação de alimentos. Maltodextrina. Spray-dryer. Frutas tropicais.

*Corresponding Author.
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Part of the first Author's Dissertation Thesis in the program of Post graduation in Food Science and Thecnology .
[2]Federal Institute of Education, Science and Thecnology of Pernambuco, College of Afogados da Ingazeira, Edson Barbosa Street, S/N. Neighborhood: Manoela Valadares, Zip code: 56800-000, City of Afogados da Ingazeira, PE; luis.neto@afogados.ifpe.edu.br.
[3]Federal Institute of Education, Science and Technology of Rio Grande do Norte, College of Pau dos Ferros, Highway 405, KM 154, Neighborhood: Chico Cajá, Zip code: 59900-000, City of Pau dos Ferros, RN.
[4]Federal University of Ceará, College of Pici, Block 852, Zip code: 60455-900, Fortaleza, CE.

INTRODUCTION

The Northeast of Brazil stands out for its climate and soil, which are favorable for the production of tropical fruits. Such production and the processing of these fruits are important economic activities in this region. The taste and aroma of the exotic tropical fruits, produced in a large variety, become an attractive characteristic, which is responsible for their good acceptance by a diversified public (TIBURSKI et al., 2011).

The yellow mombin (*Spondia mombin* L.) belongs to the Anacardiaceae family; this fruit is found in the tropical areas of America, Asia, Africa and in Brazil, especially in the North and Northeast regions of this country, where it is known as "cajá verdadeiro", "cajá-mirim" and "taperebá" (SOARES et al., 2006). It is a highly appreciated fruit, presenting good characteristics for industrialization (OLIVEIRA et al., 2014).

Despite the increasing production and attempts at cultivation of yellow mombin in recent years, Brazil has no commercial orchards, thus all the fruits are collected from wild plants, and because it is a seasonal fruit its consumption is very low (OLIVEIRA et al., 2014; MATA et al., 2005).

Aiming the offer of the fruit and its components, reducing the dependence on seasonal conditions, wastage and losses, it is necessary to apply processing technologies for conservation, in order to make this fruit available for longer periods.

The dehydration of fruit is an important technique that adds value to the final product, and increases its subsequent application and useful life, facilitating its commercialization. This technique promotes the reduction of the water activity, preventing microbiological contamination and undesirable biochemical reactions in the food (MARQUES et al., 2009).

Among the drying techniques, spray drying is widely used in the food industry. It consists of processing solutions, suspensions, emulsions, pastes, or in this case, the pulp or fruit juice powder; this process when properly conducted generates a versatile product with stable nutritional value (PEDRO et al., 2010; ANSELMO et al., 2006).

The quality of reconstituted powder products depends on the characteristics of the product *in natura*, operating conditions of drying (dryer air inlet temperature, drying air flow, feed flow rate, atomization rate or atomizer nozzle pressure) and type of dryer (KING et al., 1994; MASTERS, 1991). These variables can affect the color, aroma and physical properties related to reconstitution (SITU; LAWAL, 2007).

Within this context, this study aimed to evaluate the effect of atomization on chemical and physicochemical characteristics of the yellow mombin pulp powder, obtained by spray drying, and sensory acceptance of reconstituted yellow mombin powder.

MATERIAL AND METHODS

Collecting, storage of raw materials and drying process

The yellow mombin (*S. mombin* L.) pulp was obtained from a processing industry in the city of Fortaleza (Ceará State, Northeast Brazil), in consumer packages (transparent polyethylene bags) with capacity of 100g. Then the pulp was taken, under cooling conditions, to the Laboratory of Food Quality Control and Drying of the Food Technology Department of the Federal University of Ceará, and it was stored in an upright freezer at -18 °C, and thawed in its original package, under refrigeration (2 – 5 °C) for 18 hours.

Thereafter, we added different concentrations of maltodextrin 20DE in the pulp, which was dehydrated in spray-dryer (model MSD 1.0, "Labmaq do Brasil") equipped with a spray nozzle of 1.2 mm diameter, air flow of 3.0 L/min and atomizing pressure of 100 psi. The concentrations and drying temperatures were established according to the design below (Table 01).

Table 01. Yield of the experimental design for dehydration in spray-dryer.

Test	Air temperature (ºC)	Maltodextrin (%)	Yield (%)
A	160	25	26.46
B	160	15	20.81
C	120	25	18.05
D	120	15	18.18
E	140	20	19.77
F	140	20	21.36
G	140	20	20.60
H	140	12.95	23.60
I	140	27.05	24.64
J	112	20	21.38
K	170	20	17.99

By the variance analysis at 95% of the confidence interval, we observed that the adjusted model was not significant, with a correlation coefficient of 0.53. From this result, we decided to choose the trials that showed the best yields (trials A and I), continuing with the chemical, physicochemical and sensory evaluations.

Analytical determinations

All physical and physicochemical analyses of the powders A and I were performed in triplicate, as follows: moisture content (using a vacuum oven at 70 °C under reduced pressure until constant weight); pH (using a pH meter periodically calibrated with buffer solutions of pH 4.0 and 7.0); titratable acidity (using titration with NaOH 0.1 N, and the results expressed as percentage of citric acid); and soluble solids content (using a refractometer at 20 °C, with scale ranging from 0 to 90 °Brix); all procedures were performed according to the methodology of the Adolfo Lutz Institute (2008).

The vitamin C content was determined by the titration meter method based on the reduction of 2,6-dichlorophenolindophenol indicator by the ascorbic acid, and the results expressed in mg of ascorbic acid per 100 g of sample (AOAC, 1984).

Preparation of the reconstituted juice

In performing the sensory tests, the reconstitution of the juice powder was based on the solid content of the original juice and on the most appropriate proportion of sugar, through preliminary tests using the proportion of 1/2 (p/p) of powder/sugar. The dilution was made with fresh water until 11 ºBrix. The standards used for sensory comparison were the concentrated (commercial) juices utilized to get the powder products, which were diluted until 11 ºBrix, according to Normative Instruction N. 12, dated September 4, 2003 (BRAZIL, 2003), which sets standards of identity and general quality of tropical juices. The standard juice in this study was produced with yellow mombin pulp, potable water, and sugar until the same value of soluble solids required by the legislation.

After preparation, glass containers were filled with juice, sealed thermically and then stored under refrigeration.

Sensory analysis

Sensory acceptance tests were carried out in individual booths with 50 untrained panelists (52% female and 48% male) in the Federal Institute of Education, Science and Technology of Pernambuco State, *Campus* Afogados da Ingazeira.

Initially, a recruitment questionnaire was delivered to consumers. In this questionnaire, evaluation was related to age of respondents, gender, education level, how much they like or do not like yellow mombin juice, and the frequency and pattern of consumption of yellow mombin juice.

The samples were served in plastic glasses in a standard amount (30 ml) under cooling temperature and coded with randomized three-digit numbers. Water at room temperature was provided for cleaning the taste.

We used a nine-point hedonic scale (1 = dislike extremely, 9 = like extremely) to evaluate the color, aroma, appearance and flavor parameters (DUTCOSKY, 2011).

Statistical analysis

The results of the sensory acceptance were evaluated by ANOVA of two factors (sample and untrained panelists) with interaction for each attribute. The Tukey’s test was used to compare the means of the samples, and the results were presented in the tabular and graphical form. For the physical and physicochemical characteristics, we also used ANOVA and Tukey's test at 5% probability to test for significant differences between samples, using the Statistica software, version 7.0 (STATSOFT CO., 2007).

RESULTS AND DISCUSSION

The chemical and physicochemical results as to the moisture, pH, acidity, ºBrix and vitamin C for the powders A and I are shown in Table 02.

Table 02. Average values of physicochemical parameters for each sample (n = 3).

Physicochemical analyses	Sample	
	A	I
Ph	2.79a±0.05	2.83a±0.01
Soluble Solids (ºBrix)	95.67a±1.85	97.00a±1.15
Titratable Acidity (TA)	4.19a±0.07	3.65b±0.03
SS/AT Ratio	22.81a±0.04	26.60a±0.39
Ascorbic Acid (mg/100g)	52.76a±0.00	58.08a±5.80
Moisture (%)	3.33a±0.07	3.57a±0.06

Samples: Yellow mombin atomized powder A (160 °C, 25% maltodextrin) and yellow mombin atomized powder I (140 °C and 27.05% maltodextrin). *Different superscripts within lines and attributes indicate significant differences (p<0.05).

The pH values for the powders A and I did not show significant differences in pH, ºBrix, SS/TA, ascorbic acid and moisture. Only acidity presented differences at 5% probability ($p<0.05$).

Silva (2005) reported average values of 2.88 for pH of powders with concentration of 15% maltodextrin; this author also studied the atomized pulp of yellow mombin and presented values close to this study that ranged from 2.79 to 2.83. Silva et al. (2005) in studying the stability of golden apple (*S. cytherea*) powder found values around 3.03 at the beginning of the experiments. The variety of the plant, the processing temperature, as well as the concentration of the compounds in the powders can explain the pH differences.

Chitarra and Chitarra (2005) reported that the soluble solids are made up of water soluble compounds, including especially sugars, organic acids and other ones. The values of total soluble solids of the powders A and I were 95.67 and 97.00 ºBrix. When comparing these values with those obtained for fresh pulp (9.78), an increase of nearly 100% is observed and can be justified by the addition of maltodextrin and by the dehydration of raw material. Oliveira et al. (2006) studied the comparative analysis of integral surinam cherry pulp (*Eugenia uniflora* L.), formulated and powder, with maltodextrin in its composition and stated that values of total soluble solids of the integral pulp rose from 7.00 to 15.33 ºBrix with the addition of maltodextrin.

Silva (2005) when working with atomized yellow mombin with maltodextrin concentrations of 7.5, 10 and 15% found values of 24.50 and 21.25 and 18 ºBrix, respectively, well below those observed in this study.

The total titratable acidity of the powders varied from 3.65 to 4.19; this behavior was expected because the temperature handles the pH increase, which leads to acidity reduction. This same behavior was also observed by Santos et al. (2014) while studying guava powder obtained in spray-dryer.

Silva (2005) obtained a reduction in the percentage of titratable acidity with fresh pulp presenting 2.15 $mg.100g^{-1}$ and powder giving values between 1.79 and 1.88 $mg. 100g^{-1}$. Souto (2008) also reported the same behavior in the study on drying of yellow mombin bagasse, as do Oliveira (2006) in qualifying the surinam cherry powder, with average values of 0.73 $mg.100g^{-1}$ and 0.74 $mg.100g^{-1}$, representing a reduction of 67% in the total titratable acidity presented by the fresh pulp.

The relationship between soluble solids and total titratable acidity is one of the best ways to evaluate the flavor of a fruit, being more representative than the single measurement of sugar content and acidity and giving a good sense of balance between these two components, which is directly related to the quality of the fruit (CHITARRA; CHITARRA, 2005). These same authors reported that soluble sugars in fruits are responsible for the sweetness and taste through the balance.

The SS/TA ratio among all atomized powders of yellow mombin showed no significant difference at 5%, with values of 22.81 for sample A and 26.60 for sample I. This relationship expresses the attractiveness of the product; the higher it is the more preferred it becomes (MELO et al., 2015). Pinto (2003), studying the yellow mombin fruit, observed the average value of 11.03 and Tavares Filho (2010) in a study on the conservation of yellow mombin pulp by combined methods found the value of 11.30. The values found in this study were substantially higher because our study is on yellow mombin powder and the authors cited earlier evaluated fresh fruit.

The amount of ascorbic acid showed no statistically significant differences at 5% probability level between the powders A and I. The atomization process caused loss of this constituent in all tests, mainly due to high temperatures, with a reduction of about 45.54% of the initial content (fresh pulp). This reduction can also be explained by the partial pressure of oxygen, pH and temperature, which produce large losses of ascorbic acid, as well as by exposure to air, light and heat during the trials.

Despite the reduction of ascorbic acid during the storage, the yellow mombin powder still has a considerable amount of the vitamin C. In Brazil, the Recommended Dietary Allowances for vitamin C is 45 mg for adults in accordance with Resolution RDC N. 269 of 09/22/2005 (BRASIL, 2005). However, the magnitude of the standard deviation observed for integral yellow mombin pulp and in some assays indicates that variation in ascorbic acid concentration is relatively high.

Behavior similar to this research was reported by Silva (2005) when analyzed atomized powder of yellow mombin at different concentrations; these powders showed values 25% lower than the fresh pulp. Silva et al. (2005) in their studies on storage of golden apple powder found initial values of 91.60 mg/100g, reducing the initial content in about 35%.

Tanaka (2007) in the study about the influence of spray drying on the content of ascorbic acid in acerola cherry (*Malphigia emarginata*) juice reported that after the process the presence of the compound was of 17.8%, reducing in nearly 50% the initial amount (33.5%).

The values of moisture ranged between 3.33 and 3.57, indicating that the yellow mombin powder lost an average of 96.69% of water in relation to the integral pulp. These results suggest that atomized powders of yellow mombin are in agreement with the parameters established by law for dehydrated products. The RDC N. 272 of 09/22/2005 from National Health Vigilance Agency (ANVISA) recommends that products from dried or dehydrated fruits must submit to a maximum of 25% of moisture, which is a protective factor against the development of spoiling and pathogenic microorganisms

(BRAZIL, 2005).

A value similar to that of this study was reported by Silva (2005) studying the physicochemical characterization of yellow mombin atomized powder. This author reported the value of 2.34% for the powder with 15% maltodextrin at a temperature of 150 °C. Higher values were found by Oliveira et al. (2006) when studying the comparative analysis of surinam cherry pulp (formulated and powder), in which formulated surinam cherry powder with 15% maltodextrin obtained moisture value of 8.12% while formulated powder with 30% maltodextrin presented 7.64% of moisture.

The evaluation results of the samples of reconstituted yellow mombin juice about the powders A and I, regarding the acceptance of appearance, color, aroma and flavor are shown in Figures 1 to 4.

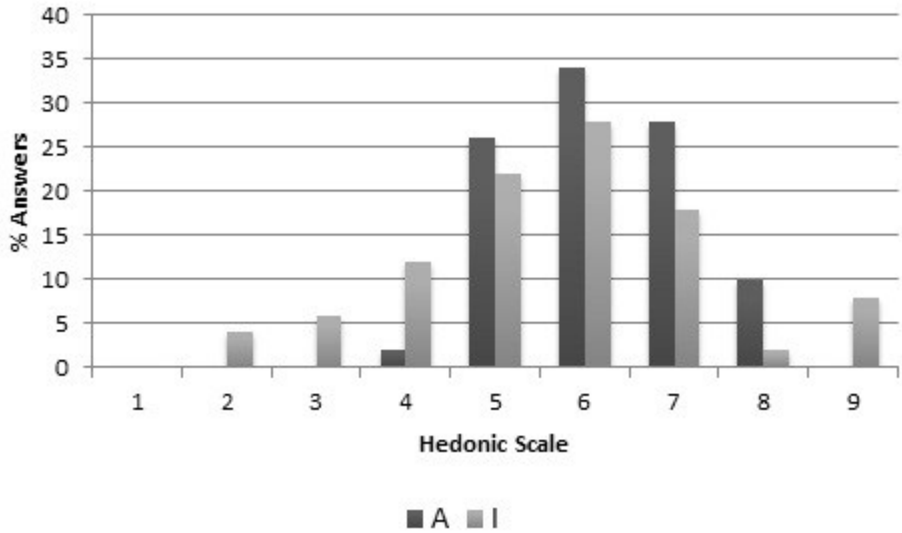

Figure 1. Frequency distribution of tasters in evaluating the acceptance of the appearance attribute for four samples of reconstituted juice of yellow mombin (A and I).

Looking at the percentage of responses for the attribute appearance, it is noted that the samples showed a low level of acceptance, as the highest frequency is located in the category ‘do not like’(2-4). In addition, most scores focused on the category 5, which is "not like nor dislike", with percentages of 30% and 34% for samples A and B, respectively (Figure 1).

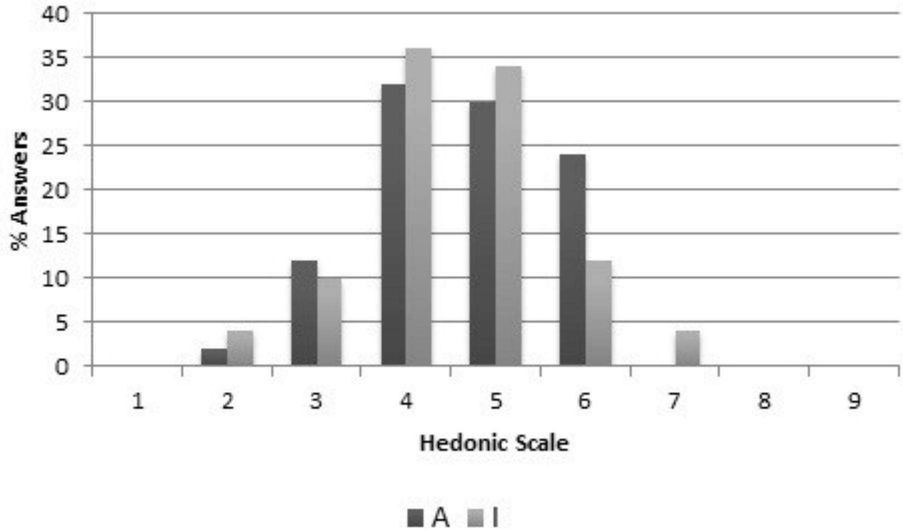

Figure 2. Frequency distribution of tasters in evaluating the acceptance of the aroma attribute for four samples of reconstituted juice of yellow mombin (trials A and I).

According to the percentage of responses to the acceptance of the attribute aroma, as shown in Figure 2, one can observe that the two samples showed good level of acceptance, given that the highest frequency of responses is located in the categories 6-9. Each sample had the highest frequency of responses in different categories of the scale. Sample A received the highest score in the category 6 (34%), corresponding to "like slightly". The sample I also reached higher frequency response in category 6 (28%), but it stands out for having received a score in category 9 (8%), which corresponds to "like extremely".

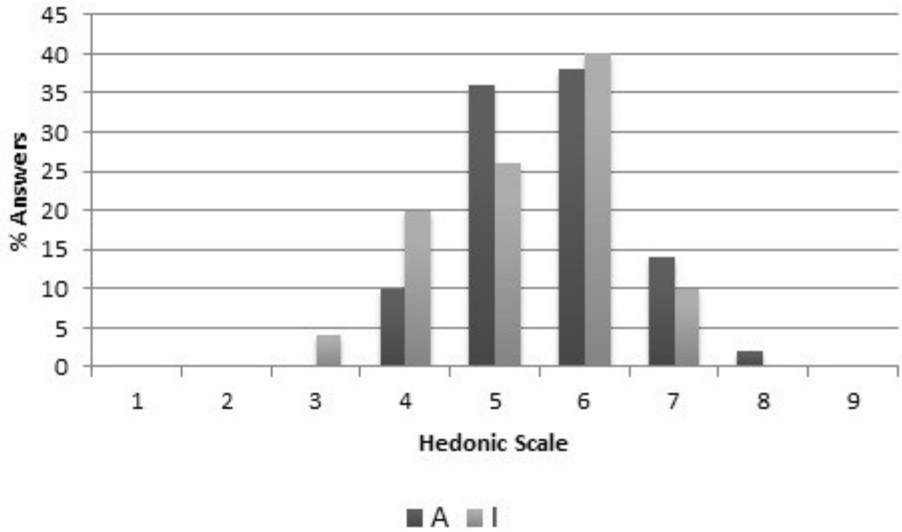

Figure 3. Frequency distribution of tasters in evaluating the acceptance of the color attribute for four samples of reconstituted juice of yellow mombin (A and I).

Assessing the frequency of hedonic responses to color attribute, there is a distribution of responses among all categories of the scale with greater number of categories related to like (6-9), representing a good level of acceptance (Figure 3).

Sample A obtained 38% in category 6, taking notes until the category 8 (3%). The sample I received the greatest number of responses in scale 6 (40%), but when related to the others, it obtained the category dislike (1-4), representing 50%, a significant number for consumer acceptance.

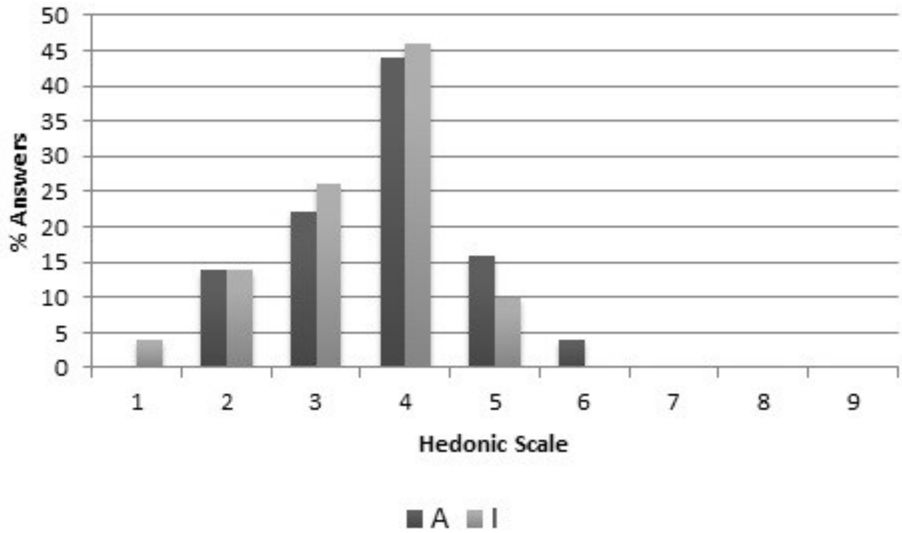

Figure 4. Frequency distribution of tasters in evaluating the acceptance of the flavor attribute for four samples of reconstituted juice of yellow mombin (A and I).

The answers for the attribute Flavor were distributed among all levels of scale 'do not like' (1-4), given that the highest percentage of responses lies between these scores. The only sample that had a note in the class considered 'like' was the sample A, which scored 6, even in a small percentage (4%). The sample I got notes on any scale of 'do not like', getting the most expressive score in category 4 (46%) (Figure 4).

Mean values, in the same column, followed by different lower-case letters show the statistically significant difference ($p<0.05$).

Among the samples of reconstituted yellow mombin juice, there was no statistical difference in the level of 5%.

According to Table 3, it is observed that the notes of the standard sample were higher for the attributes color, appearance and flavor, showing differences statistically significant ($p<0.05$).

Table 03. Average of sensory attributes for each sample of reconstituted juice of yellow mombin

Sensory characteristics	Reconstituted juice		Standard
	A	I	
Color	5.64b	5.32b	7.60^{a}
Aroma	7.68a	7.66a	6.60b
Appearance	4.62b	4.52b	6.80^{a}
Flavor	3.68b	3.44b	7.40^{a}

*Different superscripts within lines and attributes indicate significant differences ($p<0.05$).

The reconstituted yellow mombin juice presented a high loss of the characteristic flavor of the fruit; a detail observed when compared to that of the standard sample. This fact can be explained by the high concentration of maltodextrin used in the two trials (25 and 27.05%).

About the characteristic aroma, the reconstituted juices of yellow mombin had higher values, differing to the standard sample ($p<0.05$). The addition of maltodextrin as a "protection component" of volatile compounds and its concentration in the dehydration should have favored a higher value for this feature.

The reconstituted juice presented a similar aspect to a clarified juice, which can justify the value obtained by the color and appearance attributes. Silva (1998) reported lower scores to those in this study when studying the stability of clarified yellow mombin juice (3.56 and 3.60, respectively for color and appearance). The color reduction is due to production of smaller particles, increasing flow of oxygen during atomization, with consequent oxidation of pigments (DESOBRY, et al. 1997), and this has been observed in different studies (CAI; CORKE, 2000; FRANCISCONI et al., 2003).

CONCLUSION

The results of chemical and physicochemical analysis remain in accordance with the limits established by law and were considered satisfactory in relation to overall quality; the nutrient losses due to processing is not meaningful to depreciate the product quality.

This investigation has demonstrated that the conditions of this study promoted significant differences between dehydrated juices and standard about the sensory characteristics. And the attribute aroma was the only parameter showing a greater value for reconstituted juices than that of the standard.

About reconstituted juices, one can observe that the increasing concentration of maltodextrin favored the reduction of all attributes.

Based on this study, it is suggested that other maltodextrin concentrations and processing temperatures be evaluated through consumer trials, as well as studies on the application of atomized powder of yellow mombin in manufacturing of other products, not only of juice, as production of cakes, jellies and ice cream.

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