

Quality characteristics of papaya fruit commercialized in São Luís city, Maranhão - Brazil

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Abstract: The good quality of fruit should remain from production to reach the final consumer. This study aimed to evaluate the biometric characteristics, physical and chemical properties of the papaya cultivar Sunrise solo', commercialized in supermarket chain in five different districts from São Luís city - Maranhão, as following, Cohama, Operária, Downtown, São Cristóvão e Renascença. The experimental design was completely randomized with five treatments. Each treatment consisted of one supermarket from same company per district. The follow analysis were performed: fruit, peel and pulp weight (WP); pulp yield (PY); fruit length; diameters of fruits and of the internal cavities and thickness of pulps. It was also evaluated the pulp firmness, total titratable acidity (TTA), total soluble solids (TSS) and ratio (TSS / TTA). The evaluated fruits did not present significant difference for WP. The fruits commercialized in Cohama presented the greatest firmness (6.26 Kgf.cm⁻²) and larger size, both for weight (648.00g) as for length (14.35cm) and diameter (10.05cm). However, the PY were lower (52.71%). Regarding the chemical composition, although the fruits of Cohama presented the highest SST content (11.80 °Brix), the fruits commercialized in the Center and in the Renaissance district presented the highest ratio content, 119.17 and 118.79, respectively.

Keywords: Characterization, quality, 'Sunrise solo', Carica papaya L.

Date of Submission: 07-12-2017

Date of acceptance: 18-12-2017

I. Introduction

In Brazil, the papaya cultivation has been highlighted significantly, being one of the most cultivated fruit and consumed in the country [1]. Papaya has a pleasant taste and aroma. The pulp has sensory and nutritional characteristics that make it a healthy food for all ages. Its chemical composition changes according to cultivar, climate, crop practices, location, cultivate period and maturity stage [2]. According GODOY *et al.* (2010) [3] papaya presents postharvest life relatively short, at ambient conditions, and reach complete maturation in about a week, promoting quantitative and qualitative fruit losses. Fruit marketing structure is still inadequate in Brazil, since the producer depends to the wholesaler, most of time, and this affect both prices and product quality [4]. The chain marketing of fruit has several components of the internal market involved such as producers, wholesalers, supply Centers, market traders and retailers (supermarkets, grocery stores and others), which complete the distribution to consumers [5].

It is extremely important the fruits reach the final consumer with the highest quality possible, requiring the control of post-harvest factors and appropriate care throughout the production chain. In Brazil is a regular practice allocate the products with higher qualities for markets with higher purchasing power in detriment of lower income in order to add value to the product and get a higher return. This practice occurred frequently for products intended for export, compared to those sent to the domestic market. Papaya consumers are accustomed to the characteristics related to sensory profile of papaya fruits belonging to varieties Solo and Formosa [6]. In order to characterize the papaya fruit available to consumers in districts belonging to regions with different levels of development indices in São Luís city - MA, the objective of this study was evaluate the biometric characteristics, physical and chemical properties of the papaya cultivar 'solo Sunrise' commercialized in the same supermarket chain located in the different districts.

II. Material And Methods

'Sunrise solo' papaya fruits were collected in November 2015 in five districts, belonging to five different districts with different development levels in São Luís city (Fig 1): Cidade Operária (T1 – Operária district), Forquilha (T2 – São Cristóvão district), Centro (T3 – Downtown district), São Francisco/ Renascença (T4 - Renascença district) and Cohama (T5 - Cohama district). The district characteristics and some development indexes (DI) can be seen in TABLE 1. The fruits were purchased in the same supermarket chain. This supermarket chain is supplied by Wholesale market from São Louis city, known by Ceasa. The fruits were then transported to a warehouse where they were temporarily stored in refrigeration chamber. After, the fruits were sent to market stores in plastic boxes. In this study, twenty-five customers present in this supermarket selected the fruits. Five consumers in each supermarket were responsible for the selection of three fruits. All fruits were sent to Postharvest Laboratory (LAPOC) of the Maranhão State University (UEMA) to perform the analyzes. The papaya fruits were individually assessed for biometric and physical analysis, 15 fruits per treatment totalizing 75 fruits. The biometrics analysis performed were: fruit weight (FW), peel weight (PW) and pulp weight (PW), in grams; pulp yield (%); length of fruits (LF); diameters of the fruits (DF); inner cavities (IC); and thickness of pulps. To perform those analyses it was used a semi-analytical balance Balmak - MP25 and digital pachymeter Stainless Hardened 150mm.

For fruit firmness, two readings per fruit were performed, in the lengthwise middle part. The analysis was accomplished in two points transversely opposite, with prior removal of the epidermis. The equipment used was the analog penetrometer Fruit Pressure Tester FT-327, equipped with nozzle 7.9 mm of diameter and the unit force was kilograms per square centimeter (Kgf.cm^{-2}). The chemistry analysis in fruit pulp was performed. Three fruits composed each sample. The total soluble solids content (TSS) was performed using a hand held refractometer ISO 2173 [7]. The total titratable acidity (TTA) was performed according to ISO 759 (1998) [8] using the pH meter, MS TECNOPON Instrumentation (MPa - 210), by titration with sodium hydroxide (NaOH 0.1N) until endpoint reach 8.10 to 8.19. Finally, the ratio was evaluated by TSS/TA.

The statistical design was completely randomized with five treatments. Each treatment consisted of supermarkets (from the same network) of different districts, with five replicates and three fruits per repetition. The results were submitted to analysis of variance by F test and Scott & Knott test with 5% probability ($P < 0.05$). All statistical analysis were accomplished using the Assisat software version 7.7 beta.

III. Results And Discussion

The results showed significant difference for the weight of fruits and peels, as well as the pulp yield, fruit length, fruit diameter, the diameter of the inner cavity, thickness of the pulp (TABLE 2), firmness, total soluble solids, total titratable acidity and ratio (TABLE 3). The results of the weight pulps indicated no significant differences among the fruit marketed on the different districts (TABLE 2). The Cohama district (T5) presented the best DI (TABLE 1). The fruits commercialized in this district presented the largest weight of fruits and peels, 45.29% and 287.27%, respectively higher than the lowest values found. However, this same district presented the fruits with the lowest pulp yield. The Operária district presented the second best development index and the highest pulp yield, around 31% higher than the others did. The fruits commercialized on Operária were those also presented the lowest fruit weight and did not showed significant difference from fruits commercialized on Renascença district, whose presented the worst development index.

VIANA *et al.* (2015) [6], evaluated different genotypes of papaya and found fruit weights for Sunrise Solo 'around 471,00g. This value is very close to the smallest masses found in the Cidade Operária and Renascença districts. The pulp yields found by these authors, around 52.55% are near the lowest values found in Cohama district. DANTAS *et al.* (2015) [9] evaluated different hybrids and found weight fruit close to 491.90g. This weight fruit is higher than found by the previous authors, but still close to those found in the Operária and Renascença districts.

FAGUNDES & YAMANISHI (2001) [10] evaluated the commercialization of 'solo' papaya fruit in Brasília over a year and found fruit weights ranging from 372.20 g to 537.10 g. However, these values are still lower than those found on Cohama district. The same authors also verified that the fruits weight are lower in November than in June.

The fruits commercialized in Cohama district were those with the greatest lengths, fruit diameter, internal cavity and pulp thickness. The values were 9.63%, 17.96%, 13.13% and 26 97%, respectively higher than the lowest values found. The fruits commercialized in other districts did not presented significant difference among them for fruit length, fruit diameter, inner cavity and pulp thickness.

The fruits commercialized in Cohama district presented the lower pulp yield due they had the greatest amount of seeds and peels weight. This indicates that consumers of this district are purchasing larger fruits, but with less final yield, because the pulp weight showed no significant differences among the evaluated districts.

The fruit length of cultivar 'Sunrise Solo' from Cohama district was significant higher than other districts. However, all districts presented similar fruit length results than reported by VIANA *et al.* (2015) [6]

and DANTAS *et al.* (2015) [9]. The hybrid 'H54.78' studied by VIANA *et al.* (2015) [6] presented 14.12 cm fruit length. This value is close of value found in Cohama district for cultivar 'Sunrise Solo'.

It was observed that the highest fruit diameter, 10.05 cm, was found on Cohama district. This value was statistically different, $F = 10.83$ ($p < 0.05$) to those values found from the other districts. The fruit diameter found in the other districts were similar to those reported by VIANA *et al.* (2015) [6] and DANTAS *et al.* (2015) [9], ranging from 8.52 to 8.93 cm. Regarding the diameters of the inner cavities found in the present work, it can be observed they were higher than found by VIANA *et al.* (2015) [6] and DANTAS *et al.* (2015) [9]. These authors reported inner cavities ranging from 3.82 to 5.10 cm. The inner cavity average found in Cohama district was 7.67 cm and in the other districts, the values ranged from 6.78 to 7.04 cm. The inner cavity from Cohama district was significant higher than the other districts, where $F = 9.99$ ($p < 0.05$). Regarding the thickness of the pulp, DANTAS *et al.* (2015) [9], found mean values of 2,34cm to 'Sunrise Solo', which were only lower than the thickness found in fruits of Cohama district.

Cohama district also had the firmest pulps (6.26 Kgf.cm⁻²). The fruits commercialized in Operária, São Cristóvão, Downtown e Renascença districts showed no significant differences, where the firmness averages were 2.73, 2.33, 2.74 and 2.14 Kgf.cm⁻², respectively. The fruits from all districts presented good firmness. It was possible to note that all values were higher than found, for 'Sunrise Solo' variety, by VIANA *et al.* (2015) [6] and YAMANISHI & FAGUNDES (2001) [10], where the firmness of the fruits ranged from 0.56 to 1.55 Kgf.cm⁻². This increased firmness may be due to difference in maturity among the fruits. It is known that the most mature fruits have lower firmness.

Regarding to quality analyses, the fruits commercialized in Operária district were those with the lowest TSS values and higher values of AT. Therefore, the ratio of these fruits from this district were lowest. It can be noted that fruits from Operária district presented low appearance quality during commercialization. The Downtown and Renascença districts, present intermediate and low ID, respectively (TABLE 1). The fruits commercialized on these districts presented high total soluble solids, low total titratable acidity and high ratio values. The ratio average of these districts were respectively 130.33% and 129.59% higher than Cohama district.

FAGUNDES & YAMANISHI (2001) [10] evaluated the papaya fruits from 'Solo' variety during one year. They found SST values ranging from 9.0 to 12.5 ° Brix, the ATT from 0.04 to 0.16 grams of citric acid per 100g pulp and the TSS / TA ranging from 74.70 to 275.70. These values were close to those found in this work. However, the values found by these authors in November, the same month of this study, were 12.3 ° Brix (SST), 0.11 grams of citric acid per 100g of pulp (TTA) and 110.8 (TSS / TTA). These results are close to those found for Downtown and Renascença districts.

VIANA *et al.* (2015) [6] and DANTAS *et al.* (2015) [9] evaluated the 'Sunrise Solo' variety and found higher SST values, 14.17 °Brix and 13.3 °Brix, respectively. However, VIANA *et al.* (2015) [6] found ATT values close to the lowest values found in this study (0.09 grams of citric acid per 100g of pulp) and DANTAS *et al.* (2015) [9] found much higher values of ATT (0.72 grams of citric acid per 100 g of pulp) than those were found in this study.

The results obtained from this study indicate that the fruits with best appearance (size, weight and strength) may have been sent to be commercialized in the district with higher ID. However, despite having the better appearance, these fruits do not have the best yields and the best or quality characteristics.

IV. Figures and Tables

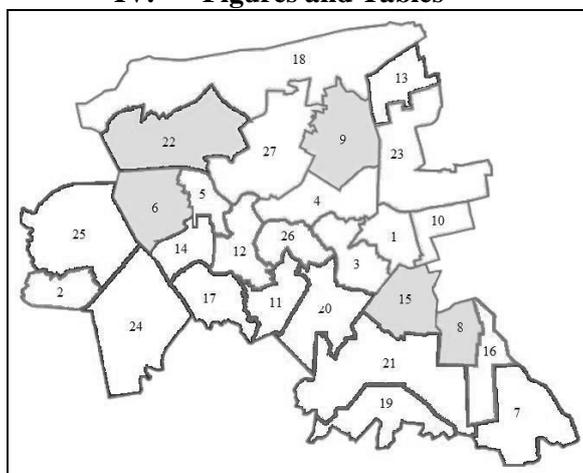


Figure 1. São Luís city map including delimiting regions. Districts evaluated belonging to the following regions: 9 – Cohama; 8 – Cidade Operária; 6 – Centro; 15 – São Cristóvão; and 22 – São Francisco/Renascença. Modified from site Observatorio Social de São Luis (2016).

Table 1. Characteristics of districts and the São Luís city, from website

http://nossasaoluis.org.br/slz2014/area_00_.html

	São Luís	Districts				
		Cohama (T1)	Cidade Operária (T2)	Centro (T3)	Forquilha (T4)	São Francisco/Renascença (T5)
Illiteracy (15 years or more)	4,67%	2,12% c	1,78% c	2,77% b	3,48% b	3,65% a
People in extreme poverty	5,95%	2,56% c	1,83% c	3,30% b	3,97% b	4,17% a
People with per capita income up to ¼ minimum wage	15,75%	9,06% c	9,16% b	9,02% c	9,66% b	21,89% a
People with per capita income of up to ½ minimum wage	37,74%	16,19% c	27,86% b	25,30% b	31,71% b	41,85% a

According to the site, with percentages lower case letters followed by the same letter on the line do not differ. The assets belonging to the city of St. Louis were not compared with the regions. Districts where the fruits were purchased: T1 – Cohama; T2 – Cidade Operária; T3 – Centro; T4 – São Cristóvão; T5 – Renascença.

TABLE 2. Biometric Characteristics of papaya fruits 'Sunrise solo' acquired from the same network supermarket in different districts of São Luis city - MA.

	Districts					CV%	F
	Cohama	Cidade Operária	Centro	São Cristóvão	Renascença		
Fruit weight (g)	648,00 a	446,00 c	517,00 b	507,00 b	453,00 c	12,22	24,93**
Peel weight (g)	213,00 a	55,00 c	119,00 b	113,00 b	103,00 b	26,25	49,35**
Pulp weight das polpas (g)	342,00 a	308,00 a	314,00 a	309,00 a	287,00 a	18,13	1,72 ^{ns}
Pulp Income (%)	52,71 c	68,98 a	60,58 b	61,07 b	62,50 b	10,70	11,79**
Length of fruits (cm)	14,35 a	13,09 b	13,11 b	13,13 b	13,24 b	6,54	5,73**
Fruit diameter (cm)	10,05 a	8,55 b	8,58 b	8,93 b	8,52 b	8,53	10,83**
Diameter of internal cavities (cm)	7,67 a	6,81 b	7,04 b	6,91 b	6,78 b	6,39	9,99**
Thickness of the pulps (cm)	2,74 a	2,25 b	2,22 b	2,26 b	2,16 b	12,65	9,60*

Means followed by the same letter on the line do not differ by the Scott & Knott test at 5% significance level.

TABLE 3. Average concentrations of total soluble solids (TSS in Brix), titratable acidity (TTA in g of citric acid per 100g pulp) and ratio (TSS / TTA), fruit papaya 'Sunrise solo' acquired the same network supermarket in different districts of the São Luis city - MA.

	Districts					CV%	F
	Cohama	Cidade Operária	Centro	São Cristóvão	Renascença		
SST	11,80 a	10,68 b	12,40 a	12,16 a	12,22 a	4,94	6,96**
ATT	0,12 c	0,21 a	0,10 d	0,17 b	0,10 d	13,86	91,17**
SST/ATT	99,67 b	51,74 d	119,17 a	73,20 c	118,79 a	8,56	69,56**

Means followed by the same letter on the line do not differ by the Scott & Knott test at 5% significance level.

V. Conclusion

The Cohama, which is the district with the best social indicators, presented the larger fruits for marketing in both weight, length and diameter. However, the yield of pulps were the lowest one. All evaluated fruits showed good firmness, especially the fruits commercialized in the Cohama district. The fruits commercialized in the Downtown and Renascença districts were those with the best quality characteristics. The fruits commercialized in the Operária district were the ones that showed the lowest quality characteristics.

Acknowledgements

To Coordination for the Improvement of Higher Education Personnel (CAPES) by the financial support throughout the National Postdoctoral Program (PNPD).

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Carlos Augusto Rocha de Moraes Rego "Quality characteristics of papaya fruit commercialized in São Luís city, Maranhão - Brazil." *IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)* 10.12 (2017): 22-26.