

## Different 'umbu-cajá' clones fruit quality

### Qualidade de frutos de diferentes clones de umbu-cajazeira<sup>1</sup>

Wallace Edelky de Souza FREITAS<sup>2</sup>; Maria Lucilania Bezerra ALMEIDA<sup>3</sup>;  
Patrícia Lígia Dantas de MORAIS<sup>4</sup>; José Robson da SILVA<sup>5</sup>

<sup>1</sup> Parte do projeto de pesquisa da Empresa de Pesquisa Agropecuária do Rio Grande do Norte (EMPARN)

<sup>2</sup> Autor para correspondência, Engenheiro Agrônomo, doutorando em Fitotecnia pela Universidade Federal do Ceará (UFC); Programa de Pós-Graduação em Agronomia/Fitotecnia, Departamento de Fitotecnia/CCA/UFC, Av. Mister Hull, 2977 - Campus do Pici - Bloco 805 - Sala 206, CEP: 60.356-000 – Fortaleza – Ceará; wallacedelke@hotmail.com

<sup>3</sup> Engenheira Agrônoma, doutoranda em Fitotecnia pela Universidade Federal do Ceará (UFC); Programa de Pós-Graduação em Agronomia/Fitotecnia, Departamento de Fitotecnia – Fortaleza – Ceará; lucilanielmeida@hotmail.com

<sup>4</sup> Engenheira Agrônoma, D.Sc. professora adjunta da Universidade Federal Rural do Semi-Árido; Departamento de Ciências Vegetais; Mossoró-RN; plmorais@hotmail.com

<sup>5</sup> Engenheiro Agrônomo, D.Sc. pesquisador da Empresa de Pesquisa Agropecuária do Rio Grande do Norte; Mossoró-RN; jrobson@oi.com.br

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#### Abstract

This study aimed at evaluating the fruits quality of different clones of umbu-cajazeira. The fruits were harvested from clones of umbu-cajazeira cultivated in the Experimental Station of the Empresa de Pesquisa Agropecuária do Rio Grande do Norte (EMPARN) located in Ipangaçu-RN. Completely randomized design was used with six treatments (different clones) and six replications of 30 fruits per clone. Clones evaluated were: Alto do Rodrigues, Serra do Mel, Carnaubais, Assu, Dué, Ipangaçu. The ripe fruit were evaluated as for fresh mass, longitudinal and transversal diameter, pulp yield, vitamin C, soluble solids (SS), soluble sugars, titratable acidity (TA), pH, SS/TA ratio, anthocyanins total and yellow flavonoids. There is a reasonable phenotypic variability among clones, making it possible to indicate the Ipangaçu and Serra do Mel clones, which produce fruits that gather quality traits favorable (fresh mass, pulp yield, fruit shape, titratable acidity, soluble solids, SS/TA ratio) for the composition of commercial orchards, both for in natura consumption and for industrial processing.

**Additional keywords:** bioactive compounds; post-harvest; *Spondias* sp; vitamin C.

#### Resumo

Este trabalho teve como objetivo avaliar a qualidade de frutos de diferentes clones de umbu-cajazeira. Os mesmos foram obtidos de clones de umbu-cajazeira cultivados na Estação Experimental da Empresa de Pesquisa Agropecuária do Rio Grande do Norte (EMPARN), localizada no município de Ipangaçu-RN. Foi utilizado um delineamento inteiramente casualizado, com seis tratamentos (diferentes clones) e seis repetições de 30 frutos por clone. Os clones avaliados foram: Alto do Rodrigues, Serra do Mel, Carnaubais, Assu, Dué e Ipangaçu. Os frutos maduros foram avaliados quanto à massa fresca, ao diâmetro longitudinal e transversal, ao rendimento de polpa, ao conteúdo de vitamina C, aos sólidos solúveis (SS), aos açúcares solúveis, à acidez titulável (AT), ao pH, à relação sólidos solúveis e acidez titulável (SS/AT), às antocianinas totais e aos flavonoides amarelos. Existe variabilidade fenotípica entre os clones, sendo possível indicar os clones Ipangaçu e Serra do Mel, que produzem frutos que reúnem características qualitativas favoráveis (massa fresca, rendimento de polpa, formato do fruto, acidez titulável, sólidos solúveis, relação sólidos solúveis e acidez titulável) para a formação de pomares comerciais, tanto para consumo *in natura* como para o processamento industrial.

**Palavras-chave adicionais:** compostos bioativos; pós-colheita; *Spondias* sp; vitamina C.

#### Introduction

'Umbu-cajá' (*Spondias* sp) belongs to the Anacardiaceae family. It is an interspecific hybrid of 'cajazeira' (*Spondias mombin* L.) with 'umbu tree' (*Spondias tuberosa* Arruda), which is typical of Brazilian Northeast region semi-arid (Silva Junior et al., 2004; Lira Júnior et al., 2005). Despite the great economic importance in pulp and processed juices production, it is an underutilized species, although having high potential

for success in employment and income generation in the Brazilian Northeast. This species is exploited in several manners, among which extraction stands out, which is the most common form of getting its fruits, mainly in the Brazilian semiarid region.

The 'umbu-cajá' plant has potential for cultivation due to expected growth in its fruits marketing, which have attractive appearance and pleasant taste. These are sold in street markets, greengrocers and supermarkets, and in some cases are sold in poor

condition, due to fermentation and insect attacks (Silva et al., 2009).

The fruits have increased participation in the Northeast region agribusiness, mainly in commerce, through fresh fruit and pulp processing, with great acceptance in the market because of its taste, aroma, excellent quality and good agro-industrial features, such as pulp yield above 60% and soluble solids of around 10 °Brix, being used as raw material in juices, popsicles, ice cream, nectars and jams preparation (Lima et al., 2002).

Despite 'umbu-cajá' having high potential in the Northeast, where there is predominance of these fruits, there are few commercial plantations. Fruits are mainly eaten in the planting area, and the rest is then sold to other country regions in pulp form, a niche in which there is already assured consumers (Brito et al., 2009). Thus, fruit demand has increased due to this large pulp consumer market in Brazil, thus arousing interest for the species cultivation, which is still in domestication stage, with little available information about this culture management.

Several factors influence fruits physical and physicochemical characteristics, among which stand out genetic constitution, climatic and soil conditions, cultivation and post-harvest treatment (Rodrigues et al., 2012).

In breeding programs, genotypes characterization is one of the main process stages, as it allows identifying, selecting and indicating better materials, especially when it comes to perennial species.

However, the generation of new and more productive cultivars with higher quality characteristics, such as fruit color, flavor, texture, sugar content, acidity, transportation resistance, among others, has been the researchers' challenge in this fruit genetic improvement. Thus, this study aimed to assess different 'umbu-cajá' fruit clones physicochemical characterization.

## Material and methods

Fruits were obtained from 'umbu-cajá' clones grown at Rio Grande do Norte Agricultural Research Company Experimental Station (EMPARN), located in the municipality of Ipangaçu-RN. The crop was harvested in 2011 directly from the crown, when fruits were ripe. Subsequently, they were placed in Styrofoam boxes and taken to the Federal Rural University of the Semi-arid Postharvest Laboratory, UFERSA, Mossoró, RN, where fruits were selected, and deformed or pest and disease attacked fruits were discarded. Then, they were cleaned with water and mild soap, to be afterwards processed, in order to perform analyzes.

A completely randomized design with six treatments (Alto Rodrigues, Serra do Mel, Carnaubais, Açú, Dué and Ipangaçu clones) and six replications of 30 fruits per clone was used. Physical and physicochemical analyzes were carried out for fruit characterization. For physical analysis, 30 fruits were

used, which were individually examined as for fresh matter (g), with the aid of an analytical balance; longitudinal diameter (mm), measuring with a digital caliper from the apex to the fruit base; transverse diameter (mm), measured with a digital caliper in the equatorial region, perpendicular to the longitudinal diameter; and pulp yield, for which fruits were individually weighed on an analytical balance and subsequently had the peel, pulp and seed separated, with results being expressed as a percentage (%). As for physicochemical analyzes, the 30 fruits pulp and peel were processed, in order to get a single sample for determining: vitamin C (ascorbic acid 100 g<sup>-1</sup> pulp), quantified according to Strohecker & Henning (1967); soluble solids (SS; °Brix), directly determined from the juice with a digital refractometer, PR-100 Pallete model, Atago brand, according to AOAC (2005); soluble sugars (%), analyzed by anthrone method, according to Yemn & Willis (1954); titratable acidity (TA% citric acid), obtained through sample titration with NaOH 0.1M solution, according to AOAC (2005); pH, determined with the aid of a digital potentiometer directly in the pulp, as recommended by AOAC (2005); SS/TA ratio, determined through the relation between soluble solids (SS) and titratable acidity (TA); and total anthocyanins (AnT) and yellow flavonoids (YF), quantified according to Francis (1982).

Results were submitted to analysis of variance (ANOVA) using the 4.6 Sisvar software, and means were compared using Tukey's test ( $p < 0.05$ ).

## Results and discussion

For fruit fresh matter, there was a significant difference between clones (Table 1). The highest matter fruits were obtained from Serra do Mel, Alto Rodrigues and Ipangaçu clones, and the lowest in Dué clone. On average, fruits weighed 13.1 g, which was lower value than that found for 'umbu-cajá' fruits by Lira Júnior et al. (2005) and Silva Junior et al. (2004) in Pernambuco, i.e., 20.69 and 23.18 g, respectively. Carvalho et al. (2008), in their study with the same fruit tree in several regions of Bahia state, found considerable genetic diversity between researched genotypes, showing that this heterogeneity can be caused with emphasis on genotypes from other environments introduction, or perhaps through natural breeding introgression. It is known that the average fruit matter is an important characteristic for fresh fruit market, since heavier fruits are also the larger ones.

When assessing pulp yield, values ranging from 64.9%, for Dué clone, to 74.5%, for Ipangaçu (Table 1) were observed. Mean values equal to 68.1% were found, what is similar to the results found by Santos et al. (2010), 69.70%. The pulp yield rate shows great fruit potential for food industry, mainly with pulp and juices, being considered the main factor for raw material acquisition. According to Lira Júnior et al. (2005), it is also considered a quality attribute,

especially for fruit intended for products production, whose minimum value required by the processing industry is of 40% pulp yield. In agribusiness, fruits with high potential are those from genotypes with above

average yield, with some chemical properties to be improved to meet market requirements (Pinto et al., 2003).

**Table 1** - Different ‘umbu-cajá’ clone fruit fresh matter (FM), pulp yield (PY), longitudinal diameter (LD), transversal diameter (TD) and LD/TD ratio mean values.

Clone	(*)FM (g)	(*)PY (%)	(*)LD (mm)	(*)TD (mm)	(*)LD/TD
Alto Rodrigues	13.9 a	66.9 c	35.2 a	29.0 a	1.12 ab
Serra do Mel	14.3 a	70.2 b	32.5 a	29.0 a	1.12 ab
Carnaubais	12.5 ab	65.4 c	32.0 a	28.1 ab	1.14 a
Açu	13.1 ab	67.0 c	30.9 ab	27.4 ab	1.13 ab
Dué	11.0 b	64.9 c	29.0 b	26.7 b	1.08 b
Ipangaçu	13.8 a	74.5 a	31.8 a	27.5 ab	1.16 a
Overall mean	13.1	68.2	31.9	27.9	1.12
LSD	2.40	2.88	1.95	1.96	0.04
CV (%)	8.18	1.89	2.77	3.13	1.71

(\*)Means followed by the same letter in the column do not differ by Tukey’s test at 5% probability; LSD – least significant difference; CV – coefficient of variation.

For longitudinal and transversal diameters, a slight variation with Alto Rodrigues and Serra do Mel clone fruits was observed, showing superiority over the others, while Dué clone had the lowest values for these variables (Table 1). Similar results were observed by Soares et al. (2008), while performing correlations between ‘cajazeira’ morphological and agronomic characters, where an average of 33.4 and 24.0 mm for the longitudinal and transversal diameters, respectively, was obtained.

LD/TD ratio indicates the fruit shape, that is, the closer to 1, more rounded is the fruit. Dué clone fruits were the most rounded, with the values of 1.08 for LD/TD ratio, the closest to 1, while Carnaubais and Ipangaçu clones had the most pear-shaped format,

with average values of 1.14 and 1.16, respectively (Table 1).

With respect to titratable acidity, it can be observed in Table 2 that there was a significant difference between clones, with large variation between 0.94% and 1.95%. Carnaubais clone had the highest acidity percentage, not differing from Alto Rodrigues and Serra do Mel clones. Overall, titratable acidity mean obtained for clones was equivalent to 1.66% of citric acid. Compared to other ‘umbu-cajá’ pulp characterization studies, Silva Júnior et al. (2004) found a total acidity percentage similar to that found in the present study, with an average of 1.66% citric acid. Canuto et al. (2010) had 1.3% mean values, what was lower than results obtained in this study.

**Table 2** - Different ‘umbu-cajá’ clone fruit titratable acidity (TA), soluble solids (SS), pH and SS/TA ratio mean values.

Clone	(*)TA (% of citric acid)	(*)SS (°Brix)	(*)pH	(*)SS/TA
Alto Rodrigues	1.87 ab	12.8 ab	2.60 bc	6.82 c
Serra do Mel	1.88 ab	13.2 a	2.72 ab	6.97 bc
Carnaubais	1.95 a	13.4 a	2.67 abc	6.87 c
Açu	1.77 b	12.9 ab	2.75 ab	7.30 bc
Dué	1.53 c	12.1 b	2.53 c	7.93 b
Ipangaçu	0.94 d	12.7 ab	2.82 a	13.53 a
Overall mean	1.66	12.80	2.68	8.30
LSD	0.16	0.80	0.16	0.96
CV (%)	4.50	2.80	2.69	5.21

(\*)Means followed by the same letter in the column do not differ by Tukey’s test at 5% probability; LSD – least significant difference; CV – coefficient of variation.

According to Lima et al. (2002) and Pinto et al. (2003) genotypes with acidity above 1.0% citric acid can be considered as the most interesting for agricultural industry, since there is no need of citric acid addition for pulp conservation, resource used to minimize microorganism development. All clones had citric acid percentages above the minimum value required for ‘umbu-cajá’ (0.9%) by the Identity and Quality Standard (BRASIL 1999), with Ipangaçu

having the lowest value.

Soluble solids content had a significant difference between clones (Table 2). Soluble solids results were lower than those reported by Tiburski et al. (2011), who reported mean values of 14.9 °Brix, which were higher than those reported by Lira Júnior et al. (2005) and Santos et al. (2010), 10.14 and 10.0 °Brix, respectively. Considering this variable, all clones fruits are suitable for juice production, as Lima et al. (2002)

reported that fruit intended for this technological purpose should have soluble solids values higher than 8 °Brix.

The pH values had little variation, with a minimum of 2.53 in Due clone and a maximum of 2.82 in Ipanguaçu. In these fruits processing, pH values, along with acidity values, indicate the possibility of using 'umbu-cajá' without the need for acid addition in pulp conservation (Carvalho et al., 2008).

For SS/TA ratio, there was high variation between clones. Ipanguaçu clone had the highest value, 13.53, differing from the other genotypes (Table 2). Comparing to other studies, such as Silva Júnior et al. (2004), who obtained values ranging from 7.14 to 10.94 while studying 'umbu-cajá', with a mean value of 9.05, it was similar to the results found in the present study. For Pinto et al. (2003), SS/TA ratio provides a good fruit flavor assessment, being more representative than sugars and acidity isolated measurement. It is also

known that high SS/TA ratio is preferable for fresh and/or processed fruits consumer market (Silva et al., 2011). In this context, the Ipanguaçu clone is highlighted, which had a value of 13.53.

Vitamin C content showed a significant difference between clones (Table 3). A mean of 15.2 mg 100 g<sup>-1</sup> fruit pulp was obtained, standing out among Ipanguaçu and Dué clones, which had means of 19.3 and 16.0 mg 100 g<sup>-1</sup>, respectively. The minimum total vitamin C value was observed in Serra do Mel clone (13.4 mg 100 g<sup>-1</sup>). It is noteworthy that vitamin C content in 'umbu-cajá' pulp is low compared with other fruits, such as cashew, which reaches 273 mg 100 g<sup>-1</sup> (Almeida et al., 2011). Vitamin C results found in this study were higher than those reported by Carvalho et al. (2008), who found levels from 3.8 to 16.4 mg 100 g<sup>-1</sup> in fruits coming from 'umbu-cajá' populations in the state of Bahia.

**Table 3** - Different 'umbu-cajá' clone fruit vitamin C (Vit. C), soluble sugars (SS), yellow flavonoids (YF) and total anthocyanins (AnT) mean values.

Clone	(*)Vit. C (mg 100 g <sup>-1</sup> )	(*)SS (%)	(*)YF (mg 100 g <sup>-1</sup> )	(*)AnT (mg 100 g <sup>-1</sup> )
Alto Rodrigues	13.6 b	7.9 b	28.6 bcd	2.6 a
Serra do Mel	13.4 b	7.7 b	34.9 b	2.6 a
Carnaubais	14.3 b	8.5 ab	30.1 bc	2.5 a
Açu	14.7 b	8.4 ab	21.8 d	2.5 a
Dué	16.0 ab	7.9 b	22.6 cd	2.2 a
Ipanguaçu	19.3 a	8.8 a	46.5 a	2.6 a
Overall mean	15.20	8.20	30.80	2.50
LSD	4.17	0.83	7.95	0.43
CV (%)	12.20	4.53	11.51	7.74

(\*)Means followed by the same letter in the column do not differ by Tukey's test at 5% probability; LSD – least significant difference; CV – coefficient of variation.

With respect to soluble sugars, there was variation between clones (7.7 to 8.8%) (Table 3). Ipanguaçu, Carnaubais and Açu clones had the highest soluble sugar levels. Silva et al. (2011) found large amplitude for soluble sugars content, 4.09 to 10.80% in fruits harvested in the city of Iguatu - CE.

As for yellow flavonoids, Ipanguaçu clone had the highest content, and Açu and Dué clones the lowest (Table 3). To anthocyanins, there was no significant difference between clones. 'Umbu-cajá' fruits had high values for these two variables when compared to fruits of the same family, such as the Brazil plum, which have 6.9 and 0.3 mg 100 g<sup>-1</sup> flavonoids and anthocyanins, respectively (Rufino et al., 2010). Flavonoids and anthocyanins have attracted high interest because of their ability to react with free radicals and, therefore, contribute to cardiovascular, circulatory, neurological and cancer diseases prevention (Jacques et al., 2010).

## Conclusion

There is a reasonable phenotypic variability among umbu-cajá clone fruits from EMPARN Experimental Station, in the municipality of Ipanguaçu-RN.

Ipanguaçu and Serra do Mel clones produce fruits that have favorable qualitative characteristics (fresh matter, pulp yield, fruit shape, titratable acidity, soluble solids and soluble solids ratio) for commercial orchards formation, both for *in natura* consumption and industrial processing.

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