

ORIGINAL ARTICLE

Genetic diversity of *Caryocar brasiliense* Cambess. (Caryocaraceae: Malpighiales) among genotypes producing fruits with and without thorns in the endocarp

Diversidade genética de *Caryocar brasiliense* Cambess. (Caryocaraceae: Malpighiales) entre genótipos produtores de frutos com e sem espinhos no endocarpo

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Abstract

The aim of this research was to evaluate genetic diversity among genotypes of “pequi”, *Caryocar brasiliense*, producing fruits with and without thorns in the endocarp, which is one the biometric characteristics of the fruits. The variance components associated with the effects of the model and estimates of the proportions of the total phenotypic variation were estimated due to the difference between groups, the difference between genotypes within each group, the difference between fruits within genotypes and within of groups. The genetic diversity within each group was verified, mainly in the group of plants producing fruit without thorns. In this study, H^2 varied from 0.0 to 88.40% in the group of fruits with thorns and from 0.0 to 96.32% in the group of fruits without thorns. Biometric evaluations demonstrate that the genotypes studied presented statistically significant differences; which shows that the population has a high genetic potential for germplasm conservation and breeding.

Keywords: Genetic diversity; Genotypes; Caryocaraceae; Conservation.

Resumo

O objetivo desta pesquisa foi avaliar a diversidade genética entre genótipos de *Caryocar brasiliense* produtores de frutos com e sem espinhos no endocarpo a partir de caracteres biométricos dos frutos. Os componentes de variância associados aos efeitos do modelo e estimativas das proporções da variação fenotípica total foram estimados devido à diferença entre os grupos, a diferença entre os genótipos dentro de cada grupo, a diferença entre os frutos dentro dos genótipos e dentro dos grupos. A diversidade genética dentro de cada grupo foi verificada, principalmente, no grupo de plantas produtoras de frutos sem espinhos. Neste estudo, a H^2 variou de 0,0 a 88,40% no grupo dos frutos com espinhos e de 0,0 a 96,32% no grupo dos frutos sem espinhos. Avaliações biométricas demonstraram que os genótipos estudados apresentaram diferença estatisticamente significativa, o que mostra que a população possui alto potencial genético para conservação e melhoramento da espécie.

Palavras-chave: Diversidade genética; Genótipos; Caryocaraceae; Conservação.

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INTRODUCTION

Currently, there is a worsening of environmental problems, such as deforestation and forest fires, the increase of carbon dioxide in the atmosphere, and the degradation of natural ecological areas has generated major concerns of the scientific community since little is known of the economic potential of Brazilian biodiversity. Among the most promising biomes in terms of the biodiversity of fruit trees is the Cerrado (Brazilian Savanna). The Brazilian Savanna is considered the most diverse savanna in the world, presenting a flora with more than 11.627 vascular species, which accounts for approximately 30% of the Brazilian biodiversity and 5% of the world (Silveira, 2010; Lehmann et al., 2014). Many species of plants of the Cerrado stand out because they have a food value, being extracted by the local communities, and later commercialized and consumed *in natura* or used by the industries in the most diverse economic activities.

The pequi (*Caryocar brasiliense* Cambess.) belonging to the family Caryocaraceae, stands out in this biome for its great economic value (Souza et al., 2007). The species is explored in an extractive way and deserves special attention due to the peculiar characteristics of its fruits such as flavor, color, and aroma, greatly appreciated by the regional population (Nascimento & Coccozza, 2015; Gomes et al., 2019). Typically, the fruits (pequis) of the *C. brasiliense* have thorns attached to the endocarp (Figure 1), however, a plant has been found that produces fruits without thorns (Kerr et al., 2007). The fruit has a green skin, the epicarp (Figure 1A) and inside it, a white-yellowish layer called the inner mesocarp, where the pyrenes (internal mesocarp) are found, which is the edible part of the fruit (Figure 1B). Each fruit can have from 1 to 4 pyrenes, but on rare occasions, there are fruits with 5 pyrenes. Visually, fruits without thorns in the endocarp have a greater pulp thickness (internal mesocarp) when compared to fruits with thorns (Figure 1C). Inside the pyrenes there is an almond, which is the biological seed where the embryo is present.

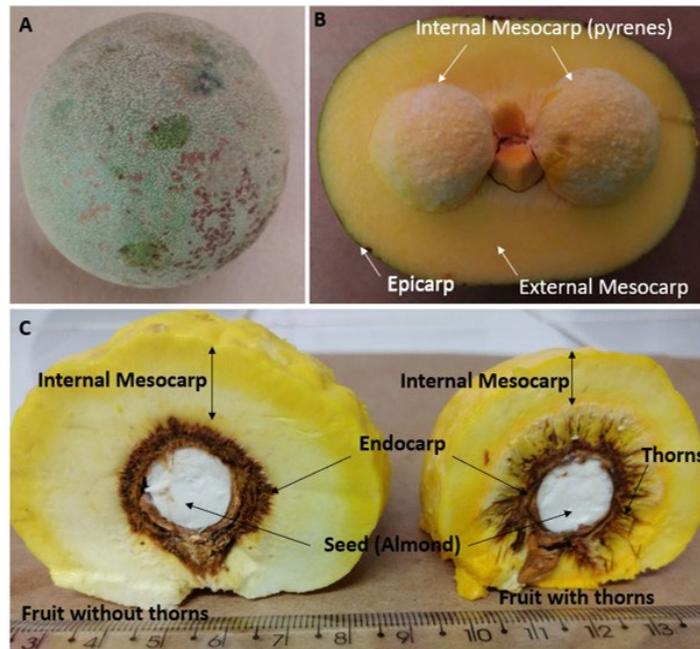


Figure 1- Pequi morphology. A: fruit, B: open fruit showing the pyrenes, and C: details of the pyrenes with and without thorns at the endocarp

The *Caryocar brasiliense* is native to different regions in the Cerrado (Almeida et al., 1998). It occurs in regions of good luminosity and less natural soil fertility (Silva, 1993), subtropical or typically tropical climate, with a well-defined dry season (Andersen & Andersen, 1988). Plants of *C. brasiliense* occurs in the North (Pará and Tocantins), Midwest (Federal District, Goiás and Mato Grosso), Southeast (Minas Gerais and São Paulo) and South (Paraná) (Medeiros & Amorim, 2015).

Distinct characteristics are common in native plants of the Cerrado indicating that the region of occurrence is an important factor in the variability of the evaluated characters (Corrêa et al., 2000; Silva et al., 2001). The differences found are influenced by environmental factors and, when a species has a large geographical distribution, such as is the case in *C. brasiliense*, these differences occur due to adaptation to the climate of these regions (Ribeiro & Rodrigues, 2006). The wild populations exhibit extensive morphological diversity, especially in the fruits. Many methods are employed to evaluate the genetic diversity of plants such as genetic, cytological, biochemistry, and morphological markers (Govindaraj et al., 2015; Bhandari et al., 2017; Kaur et al., 2018; Dar et al., 2019). Morphological characters measurement are much used since they provide a simple technique of quantifying genetic variation under a growing environment (Sharif-Raihan & Jahan, 2019; Gupta et al., 2020).

The knowledge of the levels and distribution of genetic diversity within and among populations of a species is the basis for the development and selection of plant genotypes in breeding programs and increases the understanding of the historical processes underlying the genetic diversity; thus, providing information for the management and preservation of endangered and geographically restricted species (Escudero et al., 2003). The biometric analysis of pequi fruits allows the researcher to obtain useful information for the conservation, breeder, and exploitation of natural resources in a rational way (Gusmão et al., 2006); detection of genetic diversity within and between populations of the same species; and relate genetic variability with environmental variability (Carvalho et al., 2003), which in turn permits the identification of the best parents in order to produce segregate populations (Cruz et al., 2012).

Multivariate techniques used to estimate genetic divergence permit the simultaneous evaluation of many characteristics (Wang et al., 2006; Fu et al., 2007; Shi et al., 2010). These approaches promote important information for genetic resources maintenance, germplasm bank simplification, and core collection generation as well as to assist in choosing descriptors that best represent the population diversity. Despite the high economic and environmental importance of *C. brasiliense* in the literature, there are still no studies on the variety that produces fruits without thorns in the endocarp. Thus, the aim of this study was to evaluate the genetic diversity among plants of *C. brasiliense* through biometric characteristics of the fruits with and without thorns at the endocarp, from a germplasm bank of the Federal University of Uberlândia, MG, Brazil.

MATERIAL AND METHODS

Plant material and climatic conditions

The genotypes selected for this study comprise plants cultivated in a germplasm bank of *C. brasiliense* consisting of plants that produce fruits with and without thorns in the endocarp in the experimental farm "Água Limpa" (19°6'16,49"S and 48°20'54,38"W), belonging to the Federal University of Uberlândia (UFU), Uberlândia, MG, Brazil. The different genotypes originated from seeds, and the genotypes that produce fruits without thorns in the endocarp (atypical characteristic of the fruits) were obtained from seeds of mother plants from the region of São José do Xingu, MT, Brazil, by Warwick Estevam Kerr, in the year 2007 (Kerr et al., 2007). The genotypes were selected according to the availability of fruits; therefore, the study comprised 17 mother trees with 10 fruits per tree, totaling 170 fruits, originating from open pollination. The genotypes in the collection included 8 plants producing fruit with thorns (Group 1 - A8, B7, D14, B3, B25, B6, B13, and D6) and 9 plants producing fruit without thorns (Group 2 - C10, C9, B20, A14, B26, C6, A17, B29, and D8), with 10 fruits per plant in each group.

The climate of Uberlândia is characterized as tropical, with a decrease in rains in the winter and average compensated annual temperature around 22 °C. Autumn and spring are transition seasons. The pluviometry index is little more than 1600 mm per annum, concentrated in the summer months. The precipitation is rain, and on some occasions, hail may occur. The precipitation and temperature data from the experimental station are shown in Figure 2, which correspond to the period from April 2017 to March 2018.

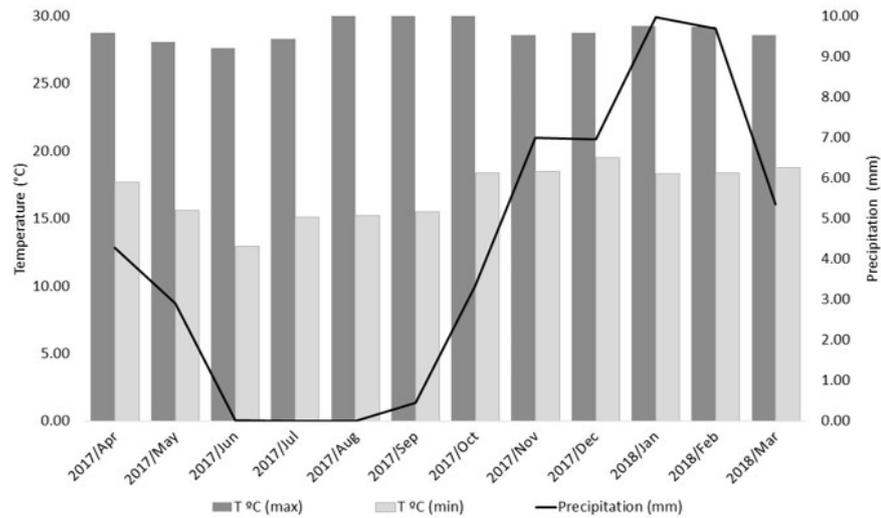


Figure 2 - Maximum and minimum temperature and average precipitation at the Experimental Station Fazenda Água Limpa - UFU, Uberlândia-MG, April 2017 to March 2018. Data provided by the Environmental Climatology Laboratory of the Federal University of Uberlândia (CLIMA - UFU).

Morphological study

Quantitative measurements were carried out on 10 fruits per plant. Twelve morphological traits for fruits were evaluated to examine the phenotypic diversity. The morphological traits were as follows: Fruit Weight (g); Fruit Height (mm); Fruit Length (mm); Fruit Width (mm); Pyrene Height (mm); Pyrene Length (mm); Pyrene Diameter (mm); Pyrene Weight (g); Peel Weight (g); Peel Thickness (mm); Yield of Fresh Pulp and Pyrene Yield (Figure 3). The Pyrenes' Yield (PY) was obtained from the relationship between the Pyrenes Weight and the Fruit Weight (PW/FW). For the analysis of Fresh Pulp Yield (FPY), the pyrenes with and without thorns were weighed in a semi-analytical balance to obtain the Total Mass (TM). After weighing, the internal mesocarp was removed and weighed again, obtaining the Fresh Mass (FM). The FPY was obtained by the ratio between Fresh Mass (FM) and the Total Mass (TM), with subsequent conversion to percentage (%), as expressed:

$$FPY = \left(\frac{FM}{TM} \right) * 100$$

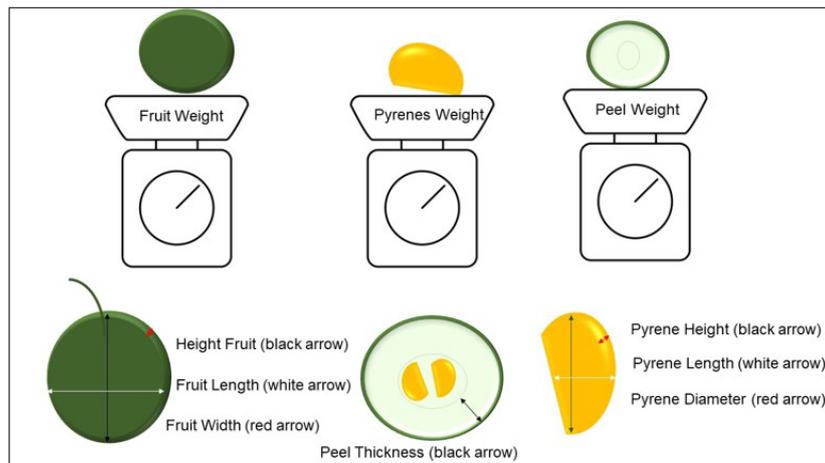


Figure 3 - Measurements performed on *C. brasiliense* (pequizeiro) fruits with and without thorns at the endocarp.

Statistical analyses

Initially, the descriptive statistical analysis of the data, such as media, maximum and minimum value, was performed using the Excel Software 2016, for each of the data sets. The obtained data were submitted to statistical analysis. To assess the genetic diversity among genotypes a variance analysis was performed, using the 5% probability level of significance. Subsequently, the averages were grouped using the Tukey test, at a 5% probability level. The analyses followed a hierarchical classification based on the model:

$$y_{ij} = \mu + G_i + m_j / G_i + e_{ij} ,$$

where y_{ij} : is the phenotypic value of the trait of genotype in block j ; μ : is the overall average; G_i : is the fixed effect of genotype i ; m_j / G_i : effect of the i -th plant within the group; and e_{ij} : error.

Broad-sense heritability on an entry-mean basis (h^2) was expressed as the ratio of the genetic variance component to the phenotypic variance. The mean of the fruits from each mother tree was used for the multivariate analysis. The variance components associated with the effects of the model and estimates of the proportions of the total phenotypic variation were estimated due to the difference between groups (with and without thorns), the difference between genotypes within each group, the difference between fruits within genotypes, and within of groups. Computational Program in Genetics and Statistics software GENES (Cruz, 2016) performed all steps of the described assessment.

RESULTS AND DISCUSSION

Morphological data showed that there were significant differences among the 12 characters and that the individuals were phenotypically diverse. These results showed that *C. brasiliense* had a high phenotypic variation in fruit morphology. The characteristics of fruits without thorns at the endocarp were predominantly higher than fruit characteristics with thorns in the endocarp, except for pyrene diameter and pyrene yield (Table 1). The pyrene yield per fruit for the group without thorns had an average of 17%, and for the group with thorns one of 20%, showing a predominance of peel as related to the mass of the fruit (Table 1); that is: 80% and 83% of the total mass of fruits with and without thorns respectively, corresponds to peel. A wide variation for the minimum and maximum in all the characters in both groups of species was observed, evidencing the high diversity among the fruits. In relation to fruit mass, there was a variation of 161.15 g 1215.70 g with a mean of 504.61 g for fruit with endocarp without thorns and 394.50 g for fruits with no thorns in the endocarp (Table 1).

Table 1 - Mean, minimum and maximum for the phenotypic characters of *C. brasiliense* fruits with and without thorns at the endocarp. Universidade Federal de Uberlândia, Uberlândia – MG, 2017/2018.

Characters	With thorns				Without thorns			
	N.	Mean	Minimum	Maximum	N.	Mean	Minimum	Maximum
FW (g)	80	394.50	161.15	1212.65	90	504.61	162.55	1215.70
HF (mm)	80	77.42	63.00	103.00	90	85.55	64.00	135.00
FL (mm)	80	98.48	65.00	140.00	90	104.62	71.50	135.00
FW (mm)	80	78.40	35.00	135.00	90	87.92	67.00	119.00
PH (mm)	80	57.55	45.50	82.00	90	63.60	48.00	80.00
PL (mm)	80	45.61	35.17	61.00	90	46.75	33.50	60.00
PD (mm)	80	41.00	33.75	53.50	90	39.17	30.00	47.50
P1W (mm)	80	59.52	32.70	156.80	90	71.41	29.10	117.75
P2W (g)	80	277.66	108.05	892.10	90	382.62	86.20	1068.25
PT (mm)	80	13.70	80.00	24.00	90	18.66	11.00	36.50
YP	80	0.20	0.09	0.38	90	0.17	0.06	0.51

FW – Fruit Weight; HF – Height Fruit; FL – Fruit Length; FW – Fruit Width; PH – Pyrene Height; PL – Pyrene Length; PD – Pyrene Diameter; P1W – Pyrenes Weight; P2W – Peel Weight; PT – Peel Thickness; YP – Yield Pyrenes

Morphological markers are used to study the variation that occurs in the morphology among different populations of a species in different environmental conditions, and generally reflect the interaction between genetic and environmental factors (Fang et al., 2018). Environmental fluctuations of rainfall and temperature (Figure 2) influence fruit production. Many works report the production of flower buds and flowering at the end of the dry season (Leite et al., 2006; Vilela et al., 2008; Françoso et al., 2014). The maturation of fruits throughout the rainy season ensures that they remain attractive to foragers for long periods, thus increasing the chances of dispersion (Batalha & Mantovani, 2000).

The pequi tree has a complex mating system that, despite being considered a self-compatible species, the action of pollinators plays an important role in the reproduction of the species, increasing the production of flowers and fruits by up to four times (Gribel & Hay, 1993). Thus, the morphological characterization of fruits can provide information on cultivation and management, besides allowing for the genetic evaluation of the mother trees for commercial planting (Battilani et al., 2011). The weight of the fruits, for example, is an important characteristic for commercialization, since the fruits of larger size have more pulp and, therefore, are of more interest economically. Therefore, the evaluation of genetic diversity aims to identify suitable parents to obtain hybrids with greater heterotic effect (Zhao et al., 2015), which can be considered a great approach when studying native species, such as *C. brasiliense*. In this way, the base population is sought for selection that combines wide genetic variability with a high mean for the character to be selected (Figueiredo et al., 2016).

There was a wide variation in the weight of pequi fruits with and without thorns in the endocarp (Table 1), as reported by Gulias et al. (2008) in a study of fruits with thorns at the endocarp, variations of 126.0 to 512.0 g. The values found by these authors were below the maximum value found for fruits with and without thorns in the endocarp in our research. Vera et al. (2007) observed that the mean length of pequi fruits with thorns in the endocarp was 5.80 cm and that of the width of 6.50 cm. Almeida et al. (1998) showed that the length of the fruits ranged from 4.20 cm to 6.40 cm and the width of 6.50 cm to 7.80 cm. In both studies, fruit measurements were lower than those found in our study, in which we obtained a mean of 10.46 cm in length and 8.79 cm in width for fruits with endocarp without thorns and 9.85 cm in length, and 7.84 cm wide for fruits with thorny endocarp (Table 1). In this research, we observed higher values for fruit weight. Soares-Júnior et al. (2010) obtained values for fruit mass varying from 81.59 g to 198.13 g, with a mean of 142.50 g, in fruits with thorns in the endocarp. In studies with *Caryocar coriaceum* from the states of Maranhão and Piauí, Ramos & Souza (2011) observed a high variability among the physical characters studied.

Fruit length and width were higher than those reported by Luz et al. (2011), who reported a variation of 4.30 cm to 5.40 cm and width of 5.70 cm to 6.90 cm in pequis with thorns coming from three northern regions of Minas Gerais. The averages for the length and width of the pyrenes in our analysis were 4.67 cm and 3.91 cm in pequi fruits without thorns and 4.45 cm and 4.10 cm for pequi fruits with thorns in the endocarp. These values were higher than the values obtained by Almeida et al. (1998), who obtained a variation range of 2.10 cm to 2.90 cm for the length and 2.80 cm to 3.80 cm for the width of the fruit pyrenes with thorns.

A significant difference was observed for the biometric fruit characters in the F test ($p \leq 0.01$) in relation to the group of plants producing fruits with and without thorns in the endocarp (Table 2). The existence of genetic diversity within each group, especially for the group of plants producing fruit without thorns was also verified.

Table 2- Summary of analysis of variance for phenotypic characters of *C. brasiliense* fruits with and without thorns at the endocarp. Universidade Federal de Uberlândia, Uberlândia – MG, 2017/2018.

Source of Variation	Mean Square					
	FW	HF	FL	FW	PH	YFP
Groups	513521.70**	2795.95**	2163.51**	3845.30**	1545.42**	14441.31**
Gen./G	187876.66**	1007.23 *	326.96 ^{NS}	370.97**	222.62**	374.48**
Gen./G1	75030.38*	156.06**	118.94 ^{NS}	151.01 ^{NS}	220.83**	691.18**
Gen./G2	286617.16**	1752.01**	508.97 ^{NS}	563.43**	224.17**	57.77**
Residue	34664.79	64.41	277.30	120.17	30.69	81.37
CV (%)	41.12	9.82	16.44	13.14	9.12	13.45
	PL	PD	P1W	P2W	PT	YP
Groups	54.57 ^{NS}	136.86**	151.36**	466764.54**	1047.62**	0.03*
Gen./G	163.37**	80.06**	1828.15 ^{NS}	159102.43**	106.18**	0.01 ^{NS}
Gen./G1	169.99**	88.04**	2519.29**	45414.33 ^{NS}	20.81 ^{NS}	0.010 ^{NS}
Gen./G2	157.59**	73.07**	1223.41**	258579.53**	180.88**	0.01 ^{NS}
Residue	19.71	12.03	358.95	23065.00	13.49	0.00
CV (%)	9.60	8.67	26.87	45.57	22.50	46.22

G: Groups; Gen.: genotypes; G1: With thorns; G2: Without thorns; CV: Coefficient of variation; ^{NS}: Not significant; * and **: Not significant at 5% and 1% probability by the F test, respectively. FW – Fruit Weight; HF – Height Fruit; FL – Fruit Length; FW – Fruit Width; PH – Pyrene Height; PL – Pyrene Length; PD – Pyrene Diameter; P1W – Pyrenes Weight; P2W – Peel Weight; PT – Peel Thickness; YP – Yield Pyrenes, YFP – Yield of Fresh Pulp

The coefficient of variation allows the comparison of variables of distinct nature and provides an idea of the accuracy of the data. The lower the coefficient of variation, the more homogeneous the data. High coefficients of variation were found for fruit weight (41.12%), peel weight (45.57%), and pyrene yield (46.22%) (Table 2). For all the characters, it was observed that the plants producing pequi fruits without thorns in the endocarp had averages higher than the group of trees which produced fruits with thorns; except for pyrene yield. These results evidenced the potential of pequi fruits producers without thorns for commercial cultivation, aiming both *in natura* consumption and industrial processing since the yield of fresh pulp was approximately 51% superior to that obtained in fruits with thorns in the endocarp.

Between the plants producing fruit without thorns in the endocarp, the genotype B29 was superior to the other genotypes as for all the characters except for fresh pulp yield and yield of pyrenes, which did not present significant differences by the t-Test ($p > 0.05$) (Table 3). A superiority of the genotype B7 (group of fruit-producing plants with thorns in the endocarp) was observed for most of the evaluated characters, with higher means for fruit mass and height; weight, length, diameter, and height of pyrenes and peel weight (Table 3).

In our study, the heritability (H^2) ranged from 0.0 to 88.40% in the group of fruits with thorns and 0.0 to 96% when compared to the group of fruits without thorns (Table 4). The characters with high heritability for fruits with thorns in the endocarp were the pyrenes height, pyrenes length, pyrenes diameter, pyrenes weight, and yield of fresh pulp.

In relation to the fruits of *C. brasiliense* without thorns at the endocarp, the characters that had high heritability were fruit weight, fruit height, fruit width, pyrene height, pyrene length, pyrene diameter, pyrene weight, peel weight, and peel thickness. The heritability (H^2) reflects the proportion of the phenotypic variance that is attributed to the genetic causes (Falconer & MacKay, 1996) and expresses the reliability of the phenotypic value as a guide to the genetic value. Heritability is the proportion of the phenotypic variance attributable to genetic variation that parents can pass on to their descendants (Frankham et al., 2012). High heritability expresses a high correlation between the phenotypic value and the genotypic

value. According to Cruz et al. (2012) heritability is of high magnitude when estimates are equal to or greater than 70%. The contribution of heritable genetic variance to total phenotypic variance is a critical parameter controlling the ability of a phenotype to respond to selection (Monteiro et al., 2002).

Table 3 - Means of the 17 accessions of *C. brasiliense* for phenotypic characters of fruits with and without thorns at the endocarp. Universidade Federal de Uberlândia, Uberlândia - MG, 2017/2018.

-----Pequi fruits with thorns -----												
Genotype	FW	HF	FL	FW	PH	PL	PD	P1W	P2W	PT	YP	YFP
B6	316.86b	75.95a	91.50a	75.64a	57.72b	45.95c	40.51b	69.76b	198.08b	11.50a	0.24a	57.45a
B7	553.52a	85.20a	102.35a	83.50a	65.50a	54.51a	45.53a	98.49a	395.42a	15.80a	0.19a	62.97a
A8	319.38b	74.70b	95.65a	74.40a	48.66c	37.08e	35.54c	41.10c	248.59b	14.80a	0.14a	58.28a
B13	344.89b	73.10b	99.60a	74.35a	57.06b	43.60d	42.54b	64.76b	234.24b	12.35a	0.21a	55.61a
B25	424.64a	79.40a	100.60a	81.70a	56.17b	45.88c	41.85b	65.69b	309.11a	14.60a	0.17a	41.01b
B3	372.93b	74.95b	97.40a	83.20a	56.17b	47.80b	38.40c	67.58b	362.87b	14.00a	0.20a	--
D6	337.38b	75.85b	95.00a	75.20a	59.57b	46.08c	41.33b	70.70b	225.27b	12.55a	0.23a	--
D14	486.65a	80.25a	97.70a	78.15a	59.59b	46.98b	42.03b	78.11b	347.71a	13.95a	0.21a	--
Mean	394.50B	77.42B	98.48B	78.40B	57.55B	45.61B	41.0A	69.52B	277.66B	13.70B	0.20A	55.06A
-----Pequi fruits without thorns -----												
B29	869.05a	114.25a	114.75a	101.10a	68.76a	44.25b	39.17b	73.92a	742.84a	27.25a	0.09a	78.20a
A14	400.15c	77.80c	99.50a	84.85b	57.89b	46.21b	38.90b	65.09a	288.55c	16.85b	0.08a	80.65a
C9	440.70c	80.30c	103.10a	85.65b	63.98a	50.74a	39.40b	76.72a	303.30c	17.71b	0.19a	85.26a
B26	273.83c	69.50d	89.85a	73.80c	53.79b	37.92c	33.31c	45.67b	200.91c	15.15b	0.17a	81.82a
B20	469.22c	80.80c	107.60a	85.90b	66.15a	47.69b	43.63a	81.45a	327.02c	16.05b	0.19a	77.49a
C10	405.42c	80.40c	103.20a	85.80b	64.60a	49.45a	39.92b	73.23a	284.83c	15.40b	0.21a	--
A17	531.10c	85.90c	108.45a	91.85a	66.77a	49.78a	40.69a	82.52a	400.10c	19.05a	0.19a	--
C6	520.10c	82.30c	104.85a	89.15a	64.99a	49.45a	38.86b	74.67a	379.20c	16.30b	0.16a	--
D8	631.84b	98.70b	110.30a	93.90a	65.72a	45.57b	38.25b	69.47b	512.01b	24.25a	0.15a	--
Mean	504.61A	85.55A	104.62A	87.92A	63.60A	46.75A	39.17B	71.41A	382.64A	18.66A	0.17B	80.68B

FW - Fruit Weight; HF - Height Fruit; FL - Fruit Length; FW - Fruit Width; PH - Pyrene Height; PL - Pyrene Length; PD - Pyrene Diameter; P1W - Pyrenes Weight; P2W - Peel Weight; PT - Peel Thickness; YP - Yield Pyrenes, YFP - Yield of Fresh Pulp. With thorns (A8, B7, D14, B3, B25, B6, B13 and D6) and without thorns (C10, C9, B20, A14, B26, C6, A17, B29 and D8). Means followed by the same lower-case letters in a column and capital letters between groups for the same character do not differ significantly at the 5% level of significance

Table 4 - Heritability (H^2) for phenotypic characters of *C. brasiliense* fruits with and without thorns at the endocarp. Universidade Federal de Uberlândia, Uberlândia - MG, 2017/2018.

Characters	Pequis with thorns	Pequis without thorns
	H^2 (%)	H^2 (%)
Fruit Weight	53.79	87.90
Fruit Height	58.72	96.32
Fruit Length	0.00	45.51
Fruit Width	20.41	78.67
Pyrenes Height	86.10	86.31
Pyrenes Length	88.40	87.49
Pyrenes Diameter	86.33	83.53
Pyrenes Weight	85.75	70.65
Peel Weight	49.21	91.08
Peel Thickness	35.15	92.53
Yield Pyrenes	28.15	38.66
Yield of Fresh Pulp	88.22	0.00

These predictions apply when considering the selection for processing of some phenotypes, mainly in the selection for the breeding of plants. The H^2 varied from 0.0 to

88.40% in the group of fruits with thorns and from 0.0 to 96.32% in the group of fruits without thorns. In the characters of pequi fruits with high heritability, like the characters for pyrene weight; pyrene length; pyrene diameter; pyrenes weight; peel weight, peel thickness in both groups there is a high selection response, indicating that the mother trees present high values for a character. When selecting only mother trees of *C. brasiliense* with values at a certain level above the population mean, which will be the parental trees, they will transmit to their offspring such alleles with high values. Heritability values should be specific for individual characters of each *C. brasiliense* population under unique biotic and abiotic conditions. The maintenance of genetic variation is a major objective within conservation planning for endangered species (Arponen, 2012). Information obtained in this study could contribute to the conservation planning of *C. brasiliense*.

CONCLUSION

Biometric evaluations demonstrate that the studied trees showed statistically significant differences mainly in relation to measures of weight and size, which shows that the population has a high genetic potential for conservation of germplasm and seed collection. Quantitative characteristics of the fruit are of fundamental importance to evaluate the agronomic potential and the best features for production. The identification of genetic materials and productivity are of top quality for industrial use; and fresh consumption is crucial for the formation of commercial plantations, breeding studies, and conservation of *Caryocar brasiliense*.

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