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ORIGINAL RESEARCH ARTICLE

Morphological and chemical characterization of cambucizeiro fruits

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ABSTRACT

The cambucizeiro (Campomanesia phaea), belonging to the Myrtaceae family, is a native plant of the Brazilian Atlantic Forest. The description of the characteristics of the cambucizeiro fruits is important to support new genetic improvement works and its commercial exploitation, especially regarding the processing of the fruit. The present work aimed to perform the morphological and chemical characterization of the cambucizeiro fruits. Fifty-eight accessions, from different locations in the Atlantic Forest and Serra do Mar in the state of São Paulo, were collected, propagated by seeds and one specimen of each accessory is at the Seedling Production Center in São Bento do Sapucaí (SP). Forty fruits from each access were collected in May and submitted to the following analyses: longitudinal and transversal diameter, total fruit fresh mass, number and mass of seeds, total soluble solids, % citric acid, ratio, firmness, vitamin C and coloration. Fruit conformation varies intensely among accessions. The number of seeds is not a good indicator for the relation with the fruit mass, but the mass of one thousand seeds. Some accessions have high soluble solids content, but, on the other hand, the vast majority have fruits with high acidity. Cambuci is an excellent source of vitamin C. The fruits of the accessions are green in color, persisting an opaque shade when ripe.

Keywords: Campomanesia Phaea; Carpometry; Chemical Characteristics

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1. Introduction

The species *Campomanesia phaea* (Berg) Landr. is popularly known as cambuci or cambucizeiro. The chemical composition of the fruit of the cambucizeiro is similar to that of other species of the Myrtaceae family, popularly known and used as food[1].

The cambucizeiro is naturally occurring in the states of São Paulo and Minas Gerais, on the slope of the Serra do Mar mountain range that faces the Paulista plateau and at the beginning of the plateau towards the interior, an area called Atlantic Coastal Forest, one of the vegetation types at risk of extinction[2].

Cambuci presents limitations to natural consumption due to its low carbohydrate content and high acidity. Despite not showing uniformity in its shape, it presents potential for industrialization due to its quality attributes, such as high yield in pulp, high acidity and reasonable concentrations of ascorbic acid[1].

There is a great variation in the size of the fruit of the Cambucizeiro, due to the fact that its occurrence extends from mountainous regions to areas near sea level, which can cause not only a morphological variation, but also a variation in the chemical constitution of these fruits.

Morphological studies of fruits, seeds, and chemical characterization of the pulp are frequent for several species. In general, they are performed to assist in pre-improvement programs for non-domesticated species[3] and to detect genetic variability among individuals or accessions in a population[4]. Biometrics is an important tool to detect genetic variability within populations of the same species and the relationships with environmental factors[5]. Silva *et al.*[6] conducted a study of biometric characterization of cagaita (*Eugenia dysenterica*) fruits in the southwest of the State of Goiás, a fruit tree also belonging to the Myrtaceae family, and found that there are variations in the morphometric characters of the fruits between subpopulations and between plants of the same subpopulation. According to Barbosa *et al.*[7], the population differentiation occurs due to regional patterns that influence the variability between populations or accessions of native cagaita plants.

The description of the characteristics of the fruits of cambucizeiro, from different areas of natural occurrence, is important to support its commercial exploitation, especially with regard to fruit processing for the preparation of fermented beverages and sweets. Due to the fact that there is no domestication or genetic improvement of this fruit, the present work aimed to perform the morphological and chemical characterization of the fruits of cambucizeiro accessions, aiming to select superior individuals, in order to enable the initiation of a program to encourage the production and consumption of cambuci, as well as the production of clonal seedlings.

2. Materials and methods

Ten mature fruits, absent of defects or spots and necrosis, were collected from the median part of the external projection of the crown of native cambucize trees from different locations in the Atlantic Forest and Serra do Mar in the states of São Paulo, Minas Gerais and Rio de Janeiro. After collection, the seeds were extracted and identified. Each plant was numbered.

The seeds, after being dried, were sown separately in 3 L plastic bags filled with substrate composed of organic matter. After eight months, each plant received a number, which became an access, and were taken to the field in 2006, at 5 × 4 m spacing, in an area belonging to the Seedling Production Center of São Bento do Sapucaí (SP; altitude of 874 m, latitude 22°41' South and longitude 45°44' West). The climate of the region is of type Cwb, mesothermal or tropical altitude, with dry winter and rainy summer, with average annual precipitation of 1,600 to 1,800 mm and average annual temperature ranging from 12 to 18 °C[8].

A total of 120 accessions were obtained. Of these, 40 fruits in the physiological maturation stage of 58 accessions were harvested in May 2014, because only these were producing fruits in satisfactory quantities for analysis. The fruits were coupled in transparent plastic bags, placed inside expanded polypropylene box containing ice and were transported immediately after collection to the Federal University of Lavras (UFLA), located in the Municipality of Lavras (MG).

The experiment was arranged in entirely randomized blocks, with four blocks, and only one plant was used in each block. The plot consisted of ten fruits, randomly collected from each plant. The treatments consisted of 58 cambucizeiro accessions.

In the Pomology laboratory of UFLA's Fruticulture Sector, we measured the dimensions (longitudinal and transversal diameter), total average fresh mass of the fruits, number of seeds mass, total soluble solids content, percentage of ascorbic acid, ratio, firmness, vitamin C content and coloration.

The description of these analyses follows:

Average longitudinal and transversal diameter of the fruits: with the help of a 150 mm digital pachymeter, the longitudinal diameter (quantified in the direction of the peduncle) and transversal diameter of the fruits were measured, this dimension being quantified in the equatorial direction of the fruit;

Average fruit mass: determined by weighing each fruit individually with the aid of a semi-analytical balance;

Number of seeds: the seeds from each fruit in the plot were removed and counted;

Thousand seed weight: the count of the seeds from ten fruits was done, weighed on a

semi-analytical scale, and then the ratio was calculated for one thousand seeds;

Total soluble solid content (TSS): to determine the TSS content, samples of fruit pulp from each access were macerated in porcelain crucibles and two readings were taken per sample. The TSS content was determined with the aid of a portable refractometer, at 20 °C, with readings expressed in °Brix;

Percentage of citric acid (titratable acidity—TA): the mass of approximately 10 g was transferred to Erlenmeyers, making up to 100 mL with distilled water. Three drops of 1% phenolphthalein indicator were added to this solution and the titrations were performed, under manual stirring, with a 0.05 N NaOH solution, previously standardized with potassium biphthalate. The results were expressed in g of citric acid per 100 g of pulp;

Total soluble solids and titratable acidity ratio: obtained by the quotient TSS/TA;

Firmness: the force necessary for a 3 mm probe coupled to a digital penetrometer was measured. The determinations were made in two distinct points of the fruits, and the results were expressed in Newtons (N);

Vitamin C: The ascorbic acid content was determined by the colorimetric method, using 2,4 dinitrophenylhydrazine. The reading was performed in a Beckman 640 B spectrophotometer, with a computerized system, and the results were expressed in mg of ascorbic acid per 100 g of pulp;

Coloration: determined in two distinct points of the fruit, using a Minolta CR-400 colorimeter, with determination in the CIE L* a* b* mode. The L* coordinate refers to the luminosity level, representing how light or dark the sample is, with values ranging from 0 (totally black) to 100 (totally white). The a* coordinate, on the other hand, can assume values from -80 to +100, where the extremes correspond to green and red, respectively. Finally, the b* coordinate, with the intensity from blue to yellow, can vary from –50 (totally blue) to +70 (totally yellow). The measurements were obtained at two diametrically opposite points in the equatorial zone of the fruit, and the coloration was expressed by the luminosity (L*), which determines the brightness, by the chromaticity (chroma), which determines the intensity of the color, and by the hue angle (°hue), which determines the hue.

All analyzed parameters were submitted to statistical analysis and Scott-Knott grouping of means test at 5% probability, using the SISVAR program[9].

3. Results and discussion

Table 1. Longitudinal and transversal diameter (equatorial direction) of the fruit, fresh mass of the fruit, number of seeds and weight of one thousand seeds in fruits of different accessions of cambucizeiro

Accesses	Longitudinal diameter of the fruit (mm)(1)	Fruit transverse diameter (mm)	Fruit mass (g)	Number of seeds	Weight of one thousand seeds (g)
7201	34.33 e	51.81 c	37.47 e	13.10 b	20.53 g
7202	38.35 d	51.20 c	51.67 d	12.69 b	76.16 d
7203	40.39 c	50.29 c	48.67 d	9.38 c	87.22 c
7204	41.65 c	50.12 c	40.93 e	7.80 d	105.66 c
7205	40.40 c	50.40 c	48.20 d	14.50 b	97.10 c
7209	35.92 d	48.27 d	33.61 f	7.09 d	51.99 e
7210	40.30 c	55.95 b	53.87 d	6.60 d	79.92 d
7215	36.59 d	44.06 e	28.67 g	18.00 a	67.65 d
7217	36.45 d	49.60 d	37.07 e	13.41 b	23.59 f
7220	39.26 c	59.56 b	60.56 c	4.91 e	85.85 c
7224	36.52 d	49.65 d	39.47 e	17.10 a	86.58 c
7225	40.32 c	49.82 d	43.40 e	13.20 b	53.86 e
7226	38.00 d	46.57 d	39.47 e	10.99 c	96.64 c
7230	39.92 c	53.97 c	53.33 d	11.00 c	190.27 a
7233	39.20 c	58.04 b	58.33 d	9.71 c	93.71 c
7234	43.02 b	59.95 b	62.33 c	12.10 b	117.64 b
7236	36.01 d	49.24 d	35.20 f	8.60 d	82.29 c
7238	29.87 f	41.05 f	21.20 g	9.60 c	81.14 d
7240	38.17 d	52.70 c	42.00 e	10.29 c	76.22 d
7243	46.85 a	64.94 a	73.20 a	6.19 d	117.99 b
7244	38.86 c	56.93 b	51.33 d	12.39 b	180.80 a
7246	36.47 d	52.06 c	39.00 e	14.69 b	114.72 b

Table 1. Continued.

Accesses	Longitudinal diameter of the fruit (mm)[(1)]	Fruit transverse diameter (mm)	Fruit mass (g)	Number of seeds	Weight of one thousand seeds (g)
7248	35.33 d	47.75 d	32.53 f	8.00 d	123.95 b
7249	39.89 c	52.63 c	44.67 e	10.20 c	135.89 b
7253	36.66 d	57.60 b	55.47 d	13.50 b	64.68 d
7254	35.04 d	52.81 c	40.67 e	14.50 b	53.66 e
7256	36.11 d	51.02 c	47.67 d	17.89 a	43.46 e
7257	29.77 f	51.52 c	46.67 d	6.60 d	38.36 f
7261	30.29 f	45.06 e	31.07 f	15.30 a	34.39 f
7262	28.05 g	43.00 e	28.93 g	8.69 d	43.17 e
7265	30.99 f	41.85 f	28.47 g	15.70 a	104.41 c
7266	34.82 e	51.51 c	44.67 e	16.20 a	67.45 d
7267	31.31 e	45.62 e	36.40 e	14.30 b	87.87 c
7268	38.67 c	54.37 c	48.33 d	12.40 b	41.05 e
7269	33.78 e	44.75 e	33.78 f	17.00 a	46.95 e
7271	37.72 d	56.57 b	62.80 c	15.80 a	53.60 e
7272	31.05 f	43.44 e	29.73 g	16.80 a	61.74 d
7273	41.71 c	62.83 a	82.33 a	6.99 d	125.34 b
7274	36.59 d	60.62 b	65.83 b	12.70 b	95.90 c
7275	32.64 e	58.52 b	49.73 d	7.10 d	102.61 c
7276	31.87 e	43.84 e	29.67 g	12.41 b	40.63 f
7278	33.79 e	48.61 d	41.07 e	13.10 b	63.60 d
7279	32.19 e	51.00 c	39.33 e	14.80 b	37.20 f
7280	27.24 g	41.77 f	24.33 g	13.60 b	44.27 e
7282	28.78 g	44.89 e	27.61g	8.60 d	76.07 d
7283	30.58 f	44.23 e	34.13 f	16.80 a	55.35 e
7284	31.94 e	46.68 d	36.67 e	12.50 b	105.51 c
7286	32.94 e	47.46 d	33.33 f	14.80 b	52.39 e
7287	32.41 e	44.73 e	34.53 f	15.90 a	31.63 f
7288	33.16 e	53.57 c	42.83 e	13.29 b	53.76 e
7290	30.16 f	38.24 f	27.07 g	7.40 d	45.20 e
7291	28.08 g	41.22 f	23.73 g	9.60 c	46.67 e
7292	35.04 d	51.53 c	42.67 e	15.40 a	55.96 e
7294	32.23 e	44.23 e	33.00 f	12.70 b	39.54 f
7296	36.42 d	45.18 e	34.93 f	15.10 a	74.73 d
7297	39.72 c	53.76 c	60.13 c	15.60 a	58.68 e
7298	30.18 f	44.92 e	33.47 f	15.60 a	63.62 d
7299	38.74 c	52.80 c	43.33 e	17.50 a	52.51 e
CV (%)	4.76	4.88	12.34	5.11	5.52

[(1)] Means followed by equal letters in the column do not differ by the Scott-Knott grouping test at 5% probability. CV = Coefficient of variation.

Accession 7243 was the one with the largest fruit dimensions (longitudinal diameter of 46.85 mm and transverse diameter of 64.94 mm). Consequently, this was the one that recorded fruits with greater fresh masses (73.20 g). Accession 7273 also recorded fruits with greater masses (82.33 g) and presented fruits with greater transverse diameters (**Table 1**). From these results, it can be seen that the mass of the fruits of the cambucizeiro is directly proportional to the transverse diameter.

These results agree with Pio *et al.*[8], who also related the highest mass values of nut cultivars with the dimensions of the fruits. On the other hand, Penoni *et al.*[10], analyzing fruits and nuts of macadamia nut cultivars, concluded that there is no possibility of making a relationship between the dimensions of the nuts and the mass. According to them, this lack of synchrony between the dimensions and the mass may be related to the moisture content of the nuts and/or to the amount of oil present in the nuts. In the case of cambucizeiro, because it is a fruit with a high moisture content, this relationship is possible, in agreement with Maro *et al.*[11], who also observed this relationship between raspberry cultivars. Silva *et al.*[6], who worked with the morphometric characterization of cagaita accessions native to the southwest of Goiás State, concluded that fruits of greater weight or size are preferred for industrialization because they have a higher processing yield.

An interesting fact is when the relationship between the number of seeds and the dimensions and mass of the fruit of the cambucizeiro accessions is observed. The accessions 7243 and 7273

stood out in the quantification of dimensions and mass, but, on the other hand, presented the lowest number of seeds per fruit. The opposite occurred with the accessions 7215, 7265 and 7272, which recorded higher values of the number of seeds and lower values of fruit mass (**Table 1**). According to Figueiredo *et al.*[12], the number of seeds is not an indication of greater fruit mass, because the authors observed that some blackberry cultivars have higher numbers of seeds, but lower fruit mass.

This result was not expected, since seeds synthesize gibberellic acid (GA_3), which in turn influences cell elongation and growth[13]. Berry enlargement in apyremic grapes is directly related to the use of plant regulators, in particular, the effect of GA_3 on cell activity and changes in the source-drain relationship of metabolites[14]. The GA_3 acts on the production of α-amylase, promoting the increase in sugar contents and, consequently, the osmotic pressure of the cell content, influxing a greater amount of water into the cell and propitiating its elongation[15].

If observed the weight of one thousand seeds, the cambucizeiro accessions 7243 and 7273, which presented higher values of fruit mass, stood out for this analyzed variable. Therefore, the number of seeds is not a good indicator for the relationship with the fruit mass, but rather the mass of one thousand seeds. According to Pio *et al.*[8], some seeds have pollination problems and do not develop perfectly, which reflects on the fruit mass and, possibly, on seedling germination and emergence. According to Figueiredo *et al.*[12], the blackberry cultivars "Brazos" and "Choctaw" recorded the highest number of seeds per fruit, but, on the other hand, the emergence of seedlings of "Brazos" was 76.6% and of "Choctaw", only 3.3%, possibly because the latter cultivar presents problems in pollination and seed formation.

The contents of soluble solids varied significantly in the fruits among the accessions. While the fruits from accessions 7209, 7256, 7261, 7262, 7269 and 7276 recorded the highest values (between 12.50 and 13.30 °Brix), other accessions such as 7210, 7220, 7226 and 7240 recorded only 7.30 to 7.95 °Brix (**Table 2**). The same was observed in the citric acid content of the fruits of the cambucizeiro accessions. Accessions 7209, 7226, 7243, 7244, 7246, 7253, 7274, 7288, 7292 and 7299 showed the most acidic fruits (between 3.02 and 3.48%), while access 7298 showed fruits with low acidity (0.65%) (**Table 2**). According to Vallilo *et al.*[1], in a comparative analysis of various fruits of the Myrtaceae family, fruits of the cambucizeiro presented 3.0% of citric acid, which exceeds the levels of other species of the Myrtaceae family.

Due to the high acidity of the fruits of the cambucizeiro accesses, it is believed that their destination is the processing of the fruit, agreeing with the results found by Vallilo *et al.*[1], except for access 7298, which showed the highest ratio (ratio of 16) (**Table 2**), being the access an option for the fresh fruit market. According to Campagnolo and Pio[16], the ratio of total soluble solids and titratable acidity is the ideal parameter to classify acidic fruits, such as blackberries, as to their destination (fresh fruit market or processing).

Regarding the firmness of the fruits, access 7288 showed the highest resistance, being considered the firmest (**Table 2**). It was observed during the evaluations that the fruits softened very quickly, presenting, in general, a considerable decrease in firmness 48 h after harvest. For vitamin C contents, accessions 7204, 7225, 7240, 7278 and 7292 presented the highest values, with a variation between 112.53 and 127.40 mg of vitamin C/100 g of fruit. According to Maro *et al.*[17], fruits grown in subtropical regions, such as raspberries, have higher concentrations of vitamin C compared to fruits grown in colder regions. This may be one of the reasons for this variation in vitamin C because, although the fruits were collected from the same location, the accessions had different origins.

Regarding the color of the fruits of the cambucizeiro accessions, the chromaticity had little variation, occurring only the separation of all accessions into two distinct groups, indicating that the fruits tended to present intensity of the predominant color (**Table 3**). The same occurred for fruit brightness, represented by L*, and for fruit hue, represented by the hue angle. The fruits of the cambucizeiro accessions are green, losing some of

their brightness as they reach the point of physiological maturity, i.e., persisting an opaque shade.

Table 2. Total soluble solids, percentage of citric acid, TSS/TA ratio (ratio), firmness and vitamin C in fruits from different cambucizeiro accessions

Accesses	Soluble solids (°Brix)[1]	% citric acid (TA)	Relationship SST/TA	Firmness (N)	Vitamin C (mg/100 g)
7201	11.10 b	2.72 b	4.08 e	10.43 d	77.67 c
7202	10.78 c	1.95 c	5.54 c	4.87 f	74.44 c
7203	8.74 d	1.80 d	4.85 c	7.53 e	61.91 d
7204	8.80 d	2.01 c	4.38 d	6.45 f	124.51 a
7205	9.00 d	2.06 c	4.37 d	4.56 f	86.83 c
7209	13.30 a	3.41 a	3.90 f	11.47 d	83.36 c
7210	7.95 f	2.02 c	3.93 f	7.76 e	98.60 b
7215	8.71 d	2.86 b	3.04 f	9.48 e	71.99 c
7217	9.70 d	2.31 c	4.19 e	5.82 f	100.03 b
7220	7.30 f	1.76 d	4.14 e	6.85 f	108.80 b
7224	9.80 d	2.14 c	4.57 d	5.44 f	83.23 c
7225	11.03 c	2.66 b	4.15 e	5.70 f	118.96 a
7226	7.85 f	3.02 a	2.60 g	5.77 f	74.65 c
7230	9.20 d	1.42 e	6.48 b	7.68 e	64.08 d
7233	8.85 d	2.25 c	3.93 f	6.93 f	48.13 e
7234	9.35 d	2.99 b	3.13 f	9.60 e	59.30 d
7236	9.35 d	1.90 d	4.93 c	10.20 d	62.72 d
7238	11.20 b	2.02 c	5.53 c	6.70 f	50.12 e
7240	7.60 f	1.88 d	4.03 e	8.19 e	112.53 a
7243	10.45 c	3.02 a	3.46 f	6.31 b	60.20 d
7244	8.65 e	3.35 a	2.58 g	5.86 f	60.11 d
7246	10.64 c	3.35 a	5.29 c	12.85 c	83.80 c
7248	9.89 d	1.92 d	5.15 c	6.25 f	108.92 b
7249	10.14 c	1.67 d	6.08 b	6.63 f	77.63 c
7253	9.52 d	3.06 a	3.11 f	9.48 e	60.86 d
7254	11.36 b	1.97 d	5.76 c	7.63 e	59.55 d
7256	12.51 a	2.54 b	4.94 c	5.80 f	61.51 d
7257	10.87 c	2.60 b	4.18 e	9.31 e	80.44 c
7261	12.70 a	2.19 c	5.79 c	6.34 f	51.08 e
7262	12.43 a	21.2 c	5.56 c	8.58 e	97.45 b
7265	10.18 c	2.48 c	4.10 e	11.45 d	87.08 c
7266	10.78 c	2.38 c	4.53 d	8.42 e	104.20 b
7267	10.68 c	1.40 e	7.63 b	3.31 g	60.51 d
7268	10.63 c	1.91 c	5.56 c	8.64 e	94.82 b
7269	13.05 a	2.98 b	4.37 d	9.67 e	80.65 c
7271	10.53 c	2.56 b	4.12 e	5.61 f	88.50 c
7272	11.77 b	2.85 b	4.13 e	5.61 f	89.90 c
7273	10.67 c	2.14 c	4.98 c	6.45 f	80.00 c
7274	8.82 d	3.21 a	2.75 g	16.00 b	109.75 b
7275	9.47 d	2.58 b	3.67 f	13.17 c	73.63 c
7276	12.50 a	1.92 b	6.50 b	5.16 f	68.12 d
7278	11.52 b	1.77 b	6.50 b	6.42 f	127.40 a
7279	11.00 c	2.37 b	4.65 c	5.08 f	25.62 f
7280	11.05 c	2.60 b	4.25 e	6.34 f	105.70 b
7282	10.60 c	2.32 b	4.58 d	11.10 d	87.00 c
7283	10.92 c	2.38 c	4.59 d	5.49 f	47.58 e
7284	11.27 b	1.77 d	6.38 b	5.75 f	65.61 d
7286	9.17 d	2.39 c	3.84 f	5.11 f	91.30 b
7287	11.42 b	2.19 c	5.21 c	9.22 e	80.02 c
7288	10.00 b	3.48 a	2.89 g	19.54 a	48.22 e
7290	11.12 b	2.84 b	3.91 f	7.32 e	70.43 c
7291	10.70 b	2.71 b	3.96 f	5.55 f	67.84 d
7292	11.10 c	3.23 a	3.44 f	9.34 e	112.72 a
7294	12.20 b	1.82 d	6.69 b	8.66 e	64.69 d
7296	12.01 b	2.53 b	4.74 c	10.94 d	86.64 c
7297	8.70 e	2.28 c	3.82 f	6.85 f	66.03 d
7298	10.40 c	0.65 f	16.0 a	5.77 f	80.72 c
7299	11.78 b	3.03 a	3.89 f	6.35 f	76.02 c
CV (%)	7.15	8.32	8.03	9.17	9.02

Table 3. Chroma, luminosity and hue angle in fruits from different cambucizeiro accessions

Accesses	Chroma[(1)]	Luminosity (L*)	Hue angle (°hue)
7201	17.95 a	50.92 a	100.93 b
7202	17.66 b	50.94 a	107.40 a
7203	15.96 b	48.81 b	104.56 a
7204	18.39 a	53.63 a	101.26 b
7205	20.09 a	50.39 b	104.55 a
7209	15.13 b	49.15 b	99.28 b
7210	19.48 a	52.16 a	107.11 a
7215	17.30 b	49.18 b	103.83 a
7217	16.09 b	46.87 b	110.97 a
7220	14.90 b	4783 b	107.82 a
7224	16.32 b	48.30 b	101.38 b
7225	19.79 a	55.38 a	99.22 b
7226	14.30 b	46.91 b	103.02 a
7230	15.85 b	48.78 b	99.09 b
7233	18.92 a	52.03 a	107.42 a
7234	16.27 b	47.47 b	93.16 c
7236	15.17 b	47.20 b	94.13 c
7238	14.08 b	46.93 b	95.10 c
7240	16.73 b	50.05 b	104.85 a
7243	21.97 a	55.65 a	107.04 a
7244	14.67 b	47.77 b	107.05 a
7246	15.08 b	48.31 b	105.43 a
7248	16.03 b	50.30 b	100.25 b
7249	12.93 b	46.01 b	101.09 b
7253	23.77 a	48.46 b	104.95 a
7254	17.99 a	50.57 b	105.20 a
7256	16.94 b	50.13 b	105.28 a
7257	19.10 a	51.86 a	101.88 b
7261	18.76 a	51.65 a	102.76 a
7262	14.72 b	46.69 b	102.75 a
7265	17.09 b	49.51 b	102.22 a
7266	19.35 a	52.85 a	101.94 b
7267	14.51 b	48.83 b	106.85 a
7268	17.85 a	49.38 b	103.10 a
7269	19.44 a	53.56 a	100.12 b
7271	17.36 b	50.15 b	107.71 a
7272	16.87 b	49.94 b	102.94 a
7273	20.02 a	51.81 a	107.68 a
7274	18.50 a	52.94 a	102.87 a
7275	21.15 a	54.65 a	103.73 a
7276	20.47 a	52.02 a	93.36 c
7278	14.80 b	47.95 b	103.72 a
7279	18.39 a	50.25 b	103.13 a
7280	16.59 b	48.91 b	102.04 b
7282	17.38 b	51.07 a	102.63 a
7283	17.03 b	49.10 b	100.31 b
7284	16.78 b	49.65 b	100.28 b
7286	15.32 b	46.81 b	101.11 b
7287	14.10 b	48.04 b	102.68 a
7288	14.80 b	47.17 b	105.36 a
7290	20.61 a	52.95 a	99.10 b
7291	16.90 b	49.83 b	106.33 a
7292	15.72 b	48.48 b	96.87 c
7294	18.39 a	53.53 a	101.71 b
7296	17.15 b	48.72 b	90.21 c
7297	19.99 a	50.17 b	106.73 a
7298	14.04 b	47.73 b	105.01 a
7299	20.25 a	53.61 a	101.54 b
CV (%)	13.14	5.23	4.52

[(1)] Averages followed by equal letters in the column do not differ by the Scott-Knott grouping of means test at 5% probability. CV = coefficient of variation.

4. Conclusion

The conformity of the fruits varies greatly among the accessions, with masses varying between

30 and 80 g. The number of seeds is not a good indicator for the relation with the fruit mass, but the mass of one thousand seeds. Some accessions have high total soluble solids content, but on the other hand, the vast majority have fruits with high acidity. Cambucizeiro fruits are an excellent source of vitamin C, and the fruits of the cambucizeiro accessions are green in color, persisting an opaque shade when ripe.

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Conflict of interest

The authors declared no conflict of interest.

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