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Productivity and juice quality of different passion fruit cultivars grown in northwest region of Rio de Janeiro

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ABSTRACT

Brazil is the major world producer of passion fruits. This culture is an alternative for small farms due to the fast economic gain and monetary income distributed throughout the year. The intense occurrence of plant diseases in commercial orchards forced the development of new cultivars. The objective of this work was to characterize the fruit productivity, the pulp yield and the juice quality of improved passion fruit cultivars: BRS Gigante amarelo (GA), BRS Ouro vermelho (OV) and BRS Sol do Cerrado (SC), comparing to the Common Yellow (CY) passion fruit normally grown in the orchards. Juice quality was evaluated by titratable acidity (TA), pH, total soluble solids (TSS), ratio TSS/TA, total soluble sugars (SS), reducing sugars (RS) and ascorbic acid (AA) contents. BRS GA presented the higher fruit productivity and juice yield, but the lower rind thickness. Its content of TA was similar to the CY passion fruit. The three cultivars presented higher contents of RS and TSS than CY passion fruit, with higher value of SS for the BRS GA. The content of AA was similar among the different cultivars. BRS GA was considered as more productive and with better juice quality.

KEYWORDS: *Passiflora edulis*. Chemical characterization. BRS Gigante Amarelo. BRS Ouro Vermelho. BRS Sol do Cerrado.

INTRODUCTION

Among the species of the genus Passiflora, 150 to 200 are nature from Brazil. The species *Passiflora edulis* Sims (yellow passion fruit) represents 95% of Brazilian crops (BERNACCI; MELETTI; SOARES-SCOTT, 2003). Brazil is the major worldwide producer of passion fruit; however, its average productivity is low considering the potential of the culture. Fungal, bacterial and viral pathogens are among the factors limiting the productivity of passion fruit (CERQUEIRA-SILVA *et al*., 2015).

Although Brazil has excellent growing conditions, the passion fruit productivity is low due to lack of technical and scientific information, the low technological level of farmers for the crop management and the use of inadequate cultivars (MAIA *et al*., 2009).

The passion fruit cultivation is an agricultural alternative for small farms due to the fast economic gain and monetary income distributed throughout the year (MELETTI, 2011). According to IBGE (2021) Brazil produced more than 690,000 t. in 2020, with an average yield of 14.87 t ha^{-1}.

Before the 2000s most orchards were planted with seeds selected by producers. The availability of cultivars with high productivity and good fruit quality for two market segments (fresh consumption and industry) introduced new options for the producers. However, the orchards have been affected by many diseases, turning necessary to obtain more resistant cultivars (MELETTI, 2011). Thus, three new hybrids (BRS Gigante Amarelo, BRS Sol do Cerrado e BRS Ouro Vermelho) were launched in 2008 after researches at Embrapa Cerrados in Brazil, with high productivity and tolerance to diseases (FALEIRO *et al*., 2008).

The quality of passion fruit is evaluated by physical and chemical characteristics of the fruits, which can be influenced by the season and the harvest point (DANTAS *et al*., 2018). Vianna-Silva *et al.* (2008) found that the yellow passion fruits produced at the summer season in the northern Rio de Janeiro region can be harvested with 65% of yellow peel color. However, in the winter season the fruits can be harvested earlier, as was also observed by Coelho *et al*. (2010), noting that the passion fruit in the winter crop can be harvested with 30% of yellow peel color.

In the studies with the new passion fruit hybrids (BRS Gigante Amarelo, BRS Sol do Cerrado e BRS Ouro Vermelho), Santos *et al.* (2013) found that fruits of these different cultivars harvested in the summer season at the northwest region of Rio de Janeiro must present at least 55% of yellow peel color to render the lower mass loss, the best quality of juice and higher storage time.

In general, the quality of passion fruit is influenced by the following factors: climate, soil, cultivation techniques, maturity stage, harvest season and genetic variation of passion fruit (FISCHER; MELGAREJO; CUTLER, 2018). Maia *et al*. (2009) pointed the phenotypic variability of these materials that leads to marked differences in productivity, fruit mass, number of fruits and peel color.

The genotype x environment conditions affect deeply the yield and fruit quality traits of the passion fruit, influencing the performance of the different genotypes in the distinct locations. The interaction of cultivars with environmental factors is of great importance for farmers and in plant breeding programs. Differences in productivity among cultivars will depend on the environment in which they are being cultivated (VIERA *et al*., 2020)

In this sense, little is known about the output of different cultivars under the climatic conditions and soil characteristics extant in the northwest region of Rio de Janeiro. This study aimed to evaluate the productivity of fruits and determine the pulp yield and juice quality of BRS Gigante Amarelo, BRS Ouro Vermelho e BRS Sol do Cerrado compared to the Common Yellow passion fruit normally cultivated in the north and northwest regions of Rio de Janeiro (Brazil), which are leading fruit production hubs in this state.

MATERIAL AND METHODS

EXPERIMENTAL DESIGN

The passion fruit were planted between January and February/2009 in an orchard located at Miracema (Rio de Janeiro, Brazil, coordinates 21°24'44'' S, 42°11'48'' W). The terrain is characterized by a red-yellow latosol soil, with clayey texture, dystrophic, with strongly wavy relief. The climate is characterized by dry season from April to September, with rainfall of 10-15 mm on average; and a rainy season which usually starts in October, reaching a peak in December, declining gradually in the months of January, February and March. On average the wettest months can reach more than 200 mm. The experimental crop was established in a randomized block design, repeated three times, with four treatments: BRS Gigante Amarelo, BRS Ouro Vermelho e BRS Sol do Cerrado, and Common Yellow passion fruit normally grown in North and Northwest Rio de Janeiro regions, consisting of crossing between varieties Maguary and Praça João Pessoa. Each experimental parcel having 14 plants in espalier system with spacing 3 x 3 m, in which were applied conventional cultivation techniques and irrigation by hose. In support of espaliers were used alive stakes of *Gliricidia sepium* and treated eucalyptus stakes, with 6 m spacing. Irrigation was performed weekly during the dry season. It was applied the usual cultural treatments and crop management described by Costa *et al.* (2008).

PRODUCTIVITY AND PHYSICAL CHARACTERIZATION OF FRUITS

In assessing the productivity of each cultivar, it was performed the count of fruits and measurements of the size and total weight of the fruits of each weekly harvest taken in the period from October/2009 to May/2010. Randomly sampling of 10 fruits for each weekly harvest was used to measure the longitudinal length and equatorial width of the fruit during the whole production period.

In evaluating pulp yield, rind thickness and quality of the juice, the samples were collected between April to May, with samples of 20 fruits per treatment, according to Coelho *et al.* (2011a), maintaining the same standard size and format of fruits harvested at ripe stage (totally yellow peel). The BRS Ouro Vermelho was evaluated with two types of fruit (red peel and yellow peel), considering that about 20% of its production have red peel color (COHEN *et al*., 2008).

In the laboratory, the passion fruits were washed in tap water and kept in cold storage (13 °C and 90% RH) until processing. Measurements of the longitudinal length, equatorial width and skin color were performed. Fruit were weighed on analytical balance and half-cut at the equatorial region for removal of the pulp with a spatula. The rind thickness was measured with a caliper in four equidistant points, and the juice yield was measured according to Silva *et al*. (2008). The juice was filtered through cotton and frozen at -18 °C.

The peel color was measured by the Hunter colorimeter (MiniScan XE Plus, USA), calibrated to black and white reflective plates with light pattern D65 and angle 10°, and the results were expressed by the parameters Hunter L, a, b. The color measurements were made in two midpoints of the upper and lower parts of the fruit, at the clearer and greener side face, according to Silva *et al*. (2008).

The raw pulp was processed in a homogenizer (Britain®, Brazil) and filtered through a previously weighed synthetic fabric (mesh 1 mm), adapted in a manual pressing tool, which allowed the accounting of the pulp residue mass. The amount of juice was obtained by the difference between the mass of raw pulp and the final residue mass, with results expressed in percentage of the fruit mass, normalized to 100 g.

CHEMICAL CHARACTERIZATION OF JUICE

The chemical characterizations of the juice were evaluated by total soluble solids content (TSS) with digital refractometer (ATAGO, PR-201, Italy) expressed in °Brix. Measurements of the pH were made with a WTW potentiometer (Model 330/SET, German) calibrated with a standard solution pH 4.0 and 7.0. The total titratable acidity (TA) was measured in 2 mL of dilute juice in 50 mL of distilled water after titration with 0.1N NaOH and phenolphthalein indicator (AOAC, 1995), with results in g L^{-1} citric acid. Also it was obtained the calculation of TSS/TA ratio, representing TA in 0.1 L of juice.

The content of reducing sugars (RS) was measured by the method of Lane and Eynon, according to AOAC (1995), using 5 mL juice diluted in 50 ml of distilled water. The total soluble sugars (SS) were measured by the same method after acid hydrolysis (70 °C / 5 min) using 4 mL of juice and 2 mL of 2 N HCl, with subsequent cooling and pH correction (3 mL of 1 N NaOH diluted in 60 mL distilled water). The results of RS and SS were expressed in g L^{-1}. Ascorbic acid content (AA) was measured by titration with 2,6-dichloroindophenol, using 2 mL of juice and 5 mL of oxalic acid (AOAC, 1995). The results were expressed in g L^{-1}.

STATISTICAL ANALYSIS

Data were evaluated considering a simple random sampling, with 5% significance and deviation of 10% around the middle of an infinite fruit population. The results of 20 replicates of fruits per treatment were compared by Student 't' Test using the software Sistema de Análises Estatísticas e Genéticas (SAEG, 2007).

RESULTS AND DISCUSSIONS

PRODUCTIVITY OF THE CULTIVARS

Physical characterizations of fruits and average data on productivity of crop from October to May revealed high production yield, even in this case of a dry land experiment without systematic artificial irrigation, but only with sporadic irrigation by hose (Table 1). The productivity of BRS Ouro Vermelho was lower than the Common Yellow, but BRS Gigante Amarelo showed the highest productivity. It is also noteworthy the bigger fruits of BRS Gigante Amarelo.

Table 1 - Determination of the total number of fruits (TNF), average weight of fruit (AWF), fruit average per plant (FAP), fruit weight per plant (FWP), average length of fruit (ALF), average diameter of fruit (ADF) and productivity (Prod) of passion fruit cultivars: Common Yellow (CY), BRS Sol do Cerrado (SC), BRS Gigante Amarelo (GA) e BRS Ouro Vermelho (OV), grown in experimental farming at Miracema-RJ (Brazil), during the first cycle production from Oct/2009 to May/2010

Cultivars	TNF (unit)	AWF (10^{-3} kg)	FAP (unit)	FWP (kg)	ALF (10^{-2} m)	ADF (10^{-2} m)	Prod (t ha^{-1})
CY	3778	192.6	107.9	20.78	9.12	7.48	22.87
BRS SC	4268	212.6	101.6	21.6	9.05	7.42	23.70
BRS GA	4385	235.3	104.4	24.53	9.18	8.19	26.98
BRS OV	3520	186.1	99.87	15.59	8.86	7.60	17.16

Source: Authors (2022).

In the evaluation of one cycle of 12 month of production, the overall productivities of the cultivars BRS Gigante Amarelo, BRS Rubi do Cerrado, with the exception of BRS Sol do Cerrado, were between 2.6- and 3.1-times higher than the national average (13.5 t ha^{-1}) and between 2.2- and 2.6-times greater than the average in Mato Grosso (15.8 t ha^{-1}) (RONCATTO *et al.,* 2021). In the present study, the overall productivity was evaluated for the first cycle of eight months ‘production, in which the BRS Gigante Amarelo yielded 26.98 t ha^{-1}, enabling a much good performance as compared to the same cultivar evaluated by Roncatto *et al*. (2021) in Cáceres (Mato Grosso). In another way, the cultivar BRS Sol do Cerrado also have good performance in the present work (23.7 t ha^{-1}), but differing from the worse performance noted by Roncatto *et al*. (2021) for this cultivar grown in Cáceres, which was considered as insufficiently adapted to the climatic and cultivation conditions extant in the experimental area. Aguiar *et al.* (2015) reported that the productivities, accumulated over two cultivation cycles, of 13 *P. edulis* hybrids varied between 34.5 and 43.6 t ha^{-1}.

The average fruit mass values recorded in this study ranged from 186.1 to 235.3 g and were compared to those (174.5 to 249.5 g) recorded by Roncatto *et al*. (2021) for similar cultivars, and with those (172.3 to 227.8 g) reported by Aguiar *et al*. (2015) for 13 hybrids of *P. edulis* cultivated in the southern state of Paraná.

PULP YIELD AND PHYSICAL CHARACTERIZATION OF FRUITS

The fruit standardization was confirmed by measures of size and fruit shape, as well as the same pattern of peel color in the ripe stage of the fruits in relation to brightness (Hunter L), greenness (Hunter a) and yellowness (Hunter b), except BRS Ouro Vermelho with red peel color (Table 2). According to Coelho *et al*. (2011b) and Oliveira *et al.* (2011), the standardization of fruit is important to carry out the comparative measures of juice yield and rind thickness.

Regarding the standardization of fruit mass (Figure 1), it is noted that only BRS Ouro Vermelho (red peel color) did show the higher mass (0.2309 kg) than BRS Ouro Vermelho with the yellow peel color (0.1996 kg). The other cultivars did show equal weight, with the following values: 0.2083 kg for BRS Gigante Amarelo; 0.2051 kg for BRS Sol do Cerrado; and 0.2121 kg for the Yellow Common passion fruit, confirming the standardization of fruit mass. Tupinambá *et al.* (2008) found average values of 0.2021 kg for BRS Gigante Amarelo; 0.1909 kg for BRS Sol do Cerrado and 0.1909 kg for BRS Ouro Vermelho. The Common Yellow Passion Fruit used in this experiment for analysis of juice yield is equivalent to fruits Extra 3A produced in Northern Rio de Janeiro region which were evaluated by Coelho *et al*. (2011b).

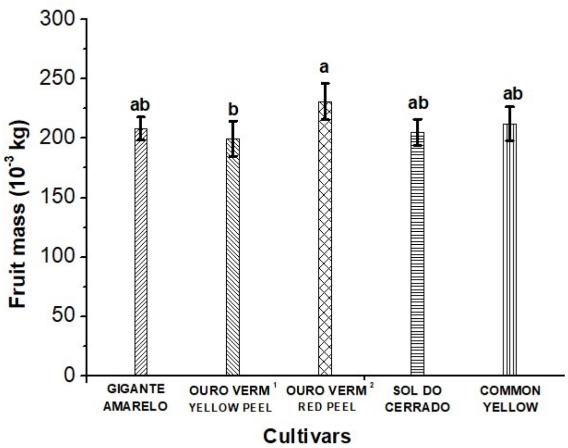
Table 2 - Measurements of color (Hunter L, a, b) size (Length-L and Width-W) and shape (ratio L/W) of the passion fruit cultivars: BRS Gigante Amarelo (GA), BRS Ouro Vermelho (OV) (yellow peel* and red peel color), BRS Sol do Cerrado (SC) and Common Yellow (CY) passion fruit, grown in experimental farming at Miracema-RJ (Brazil) and harvested in the end of the first cycle of production from April to May/2010**

Cultivars	Hunter L	Hunter *a*	Hunter *b*	Length-L (10^{-2} m)	Width-W (10^{-2} m)	Ratio L/W
BRS GA	73.20 ±1.8	1.29 ±1.7	36.12 ±0.9	9.26 ±0.1	7.49 ±0.1	1.24 ±0.02
BRS OV *	73.38 ±1.7	1.47 ±1.5	35.57 ±0.8	9.28 ±0.1	7.43 ±0.1	1.25 ±0.02
BRS OV **	43.91 ±2.9	2.70 ±1.6	14.35 ±2.1	9.27 ±0.1	7.51 ±0.1	1.23 ±0.02
BRS SC	70.02 ±1.8	1.29 ±1.0	33.23 ±0.7	9.38 ±0.1	7.51 ±0.1	1.25 ±0.02
CY	74.14 ±1.1	1.28 ±1.2	35.50 ±0.7	9.23 ±0.1	7.53 ±0.0	1.23 ±0.03

The averages are represented with confidence intervals at $p \leq 0.05$.

Source: Authors (2022).

Figure 1 - Average mass of the fruits of passion fruit cultivars: BRS Gigante Amarelo, BRS Ouro Vermelho (yellow peel[1] and red peel[2]), BRS Sol do Cerrado and Common Yellow passion fruit, grown in experimental farming at Miracema-RJ (Brazil) and harvested in the end of the first cycle of production from April to May/2010

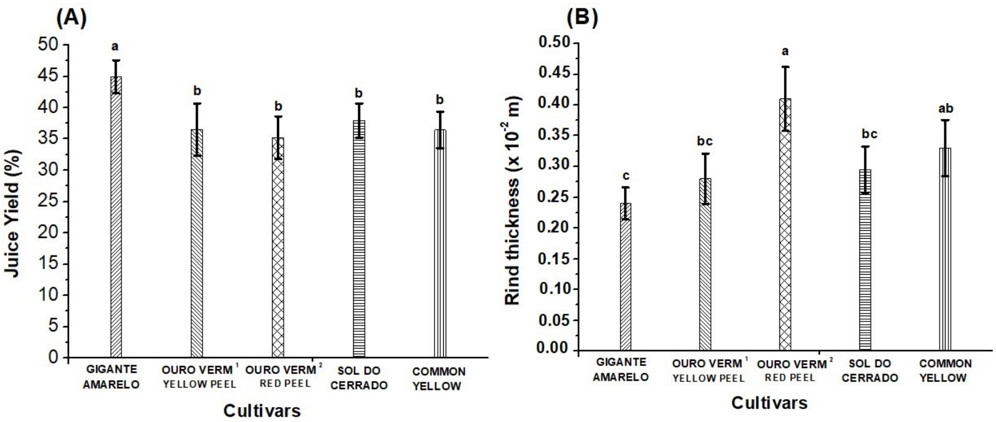


The bars are represented with confidence intervals at $p \leq 0.05$.

Source: Authors (2022).

Under the same pattern of physical characteristics, the cultivar BRS Gigante Amarelo has the highest juice yield (45%) (Figure 2.A). According to Dutra *et al*. (2010), BRS Gigante Amarelo shows linear increase of juice yield from 40.3% to 56% with increasing irrigation levels. These results are higher than those described by Tupinambás *et al.* (2008), who found average values of 34.5% for the BRS Gigante Amarelo, 33.4% for BRS Ouro Vermelho and 31.5% for the BRS Sol do Cerrado, working with different sizes of fruits.

Figure 2 - Juice yield (A) and rind thickness (B) of passion fruit cultivars: BRS Gigante Amarelo, BRS Ouro Vermelho (yellow peel[1] red peel[2]), BRS Sol do Cerrado and Common Yellow passion fruit, grown in experimental farming at Miracema-RJ (Brazil) and harvested in the end of the first cycle of production from April to May/2010



The bars are represented with confidence intervals at $p \leq 0.05$.

Source: Authors (2022).

The cultivars BRS Ouro Vermelho (yellow and red peel), BRS Sol do Cerrado and Common Yellow passion fruit showed similar juice yield, with 36.5% in average (Figure 2A), reaching the same magnitude of juice yield (36.6%) as found in the Common Yellow passion fruit studied by Oliveira *et al*. (2011). According to Silva *et al.* (2008), the juice yield of the Common Yellow passion fruit is influenced by the harvest season and fruit ripening stage, reaching 41.4% in the ripe fruit harvested in the summer season under irrigation by controlled drip.

The rind thickness of BRS Gigante Amarelo was lower than Common Yellow passion fruit and BRS Ouro Vermelho (red peel), justifying the higher juice yield (Figure 2B). However, the BRS Ouro Vermelho (red peel) stood out with a thicker rind (0.41×10^{-2} m), contributing to the lowest juice yield of this cultivar in relation to BRS Gigante Amarelo. According to Dutra *et al.* (2010), the rind thickness of BRS Gigante Amarelo reaches 0.85×10^{-2} m as irrigation levels is increased. According to Silva *et al.* (2008), Common Yellow passion fruit in summer season reduces the rind thickness from 0.79×10^{-2} m (onset of ripening) to 0.5×10^{-2} m (ripe fruit). In the winter season they reach 0.49×10^{-2} m in the ripe stage. Coelho *et al.* (2011b) have found average value of rind thickness with $0.53x10^{-2}$ m (large ripe fruit), and $0.32x10^{-2}$ m (small fruit) for Common Yellow passion fruit growing in the northern Rio de Janeiro region. Fortaleza *et al.* (2005) state that, the passion fruits are preferred by consumers when they have thinner rind, since they have higher content of pulp.

The pulp yield and rind thickness of passion fruit are strongly affected by the genotype x environment interaction. However, the variability of each quality trait can vary according to the evaluated population in the specific local of production. The variability achieved should be due to the degree of adaptation of the genotypes to the different locations, as well as the expression of the phenotype in relation to the edaphic and environmental conditions of each site (VIERA *et al*., 2020).

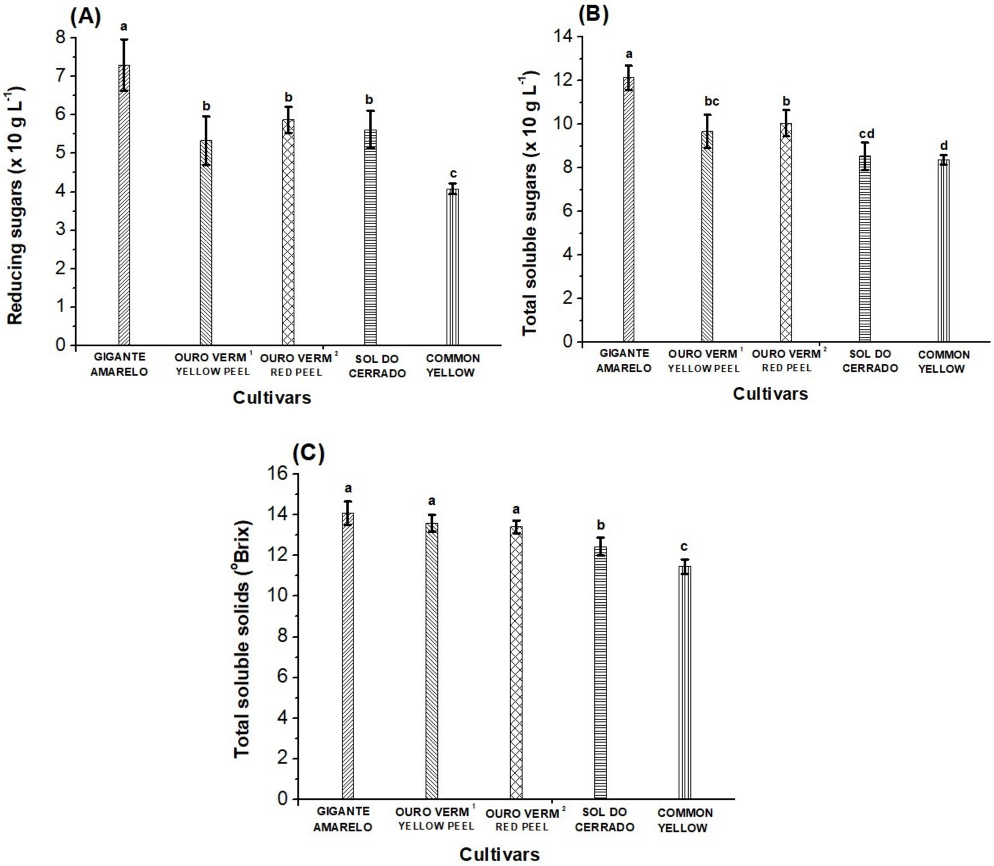
CHEMICAL CHARACTERIZATION OF JUICES

The BRS Gigante Amarelo has higher content of RS (73 g L^{-1}) compared to the other cultivars (Figure 3A). The Common Yellow passion fruit showed lower content of RS (41 g L^{-1}). Coelho *et al.* (2010) found an average RS of 49 g L^{-1} in Common Yellow passion fruit harvested at the Northern Rio de Janeiro region. The content of total soluble sugars (SS) was also higher in BRS Gigante Amarelo (121 g L^{-1}), but with lower values in BRS Sol do Cerrado and Common Yellow passion fruit, with 84 g L^{-1} (Figure 3B). Coelho *et al.* (2010) found 96 g L^{-1} for the Common Yellow passion fruit of the Northern Rio de Janeiro region.

In juice of BRS Gigante Amarelo the total soluble solids (TSS) content (14.1 °Brix) was also highlighted in relation to the lower content of TSS in BRS Sol do Cerrado and Common Yellow passion fruit, with the average of 11.4 °Brix (Figure 3C). According to Coelho *et al.* (2010), the Common Yellow passion fruit in the winter season at the Northern Rio de Janeiro region reaches 14.5 °Brix. However, higher value (16.2 °Brix) was observed by Vianna-Silva *et al.* (2008) in the ripe yellow passion fruit harvested in irrigated plantation. Mamede *et al*. (2011) found that BRS Gigante Amarelo harvested in the rainy summer at Cruz das Almas (Bahia, Brazil)) reached 15.4 °Brix, but the fruits of the dry spring season reached 12.1 °Brix. Tupinambá *et al.* (2008) encountered 16 °Brix for the BRS Sol do

Cerrado and 15 °Brix for BRS Ouro Vermelho and BRS Gigante Amarelo planted in Planaltina (DF, Brazil), highlighting the importance of high temperatures and sun light for increasing photosynthesis level and further accumulation of sugars in the fruit.

Figure 3 - Reducing sugars content (A), total soluble sugars (B) and total soluble solids (C) in juice of passion fruit cultivars: BRS Gigante Amarelo, BRS Ouro Vermelho (yellow peel[1] red peel[2]), BRS Sol do Cerrado and Common Yellow passion fruit, grown in experimental farming at Miracema-RJ (Brazil) and harvested in the end of the first cycle of production from April to May/2010



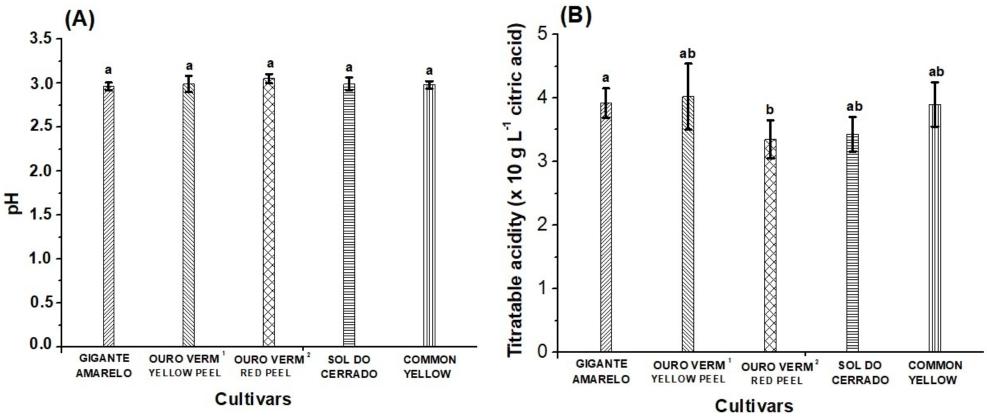
The bars are represented with confidence intervals at p ≤ 0.05.

Source: Authors (2022).

All the passion fruit cultivars reached total soluble solids (TSS) above the minimum required (11 °Brix) for the production of passion fruit pulp (*Passiflora edulis* Sims), according to the identity and quality standards of the Ministério da Agricultura, Pecuária e Abastecimento (MAPA) (Figure 3.C) (BRASIL, 2018).

Measurements of pH did not differentiate among the cultivars (Figure 4A), with an average pH 2.99, which is higher than the minimum level (2.7) required by the Ministério da Agricultura, Pecuária e Abastecimento (BRASIL, 2018). According to Silva *et al*. (2005) and Coelho *et al.* (2010), the pH of the Common Yellow passion fruit juice in the winter harvest is unchanged when the fruit presents more than 30% of yellow peel color, keeping average pH 2.92 in ripe fruit. This is in accordance to Tupinambá *et al.* (2008) that found similar values of pH for the BRS Sol do Cerrado, BRS Ouro Vermelho and BRS Gigante Amarelo produced in the Cerrado region (Planaltina - DF, Brazil), with the pH 2.9.

Figure 4 - Average values of pH (A) and titratable acidity (B) in juice of passion fruit cultivars: BRS Gigante Amarelo, BRS Ouro Vermelho (yellow peel[1] red peel[2]), BRS Sol do Cerrado and Common Yellow passion fruit, grown in experimental farming at Miracema-RJ (Brazil) and harvested in the end of the first cycle of production from April to May/2010



The bars are represented with confidence intervals at $p \leq 0.05$.

Source: Authors (2022).

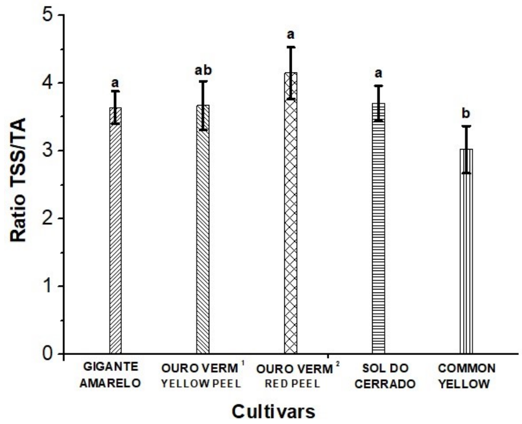
The change in pH is indirectly related to juice acidy. However, the pH is affected by the concentration of free H^+ ions and also by the buffering capacity of the juice or the pulp (SILVA *et al.,* 2016).

In juice of BRS Gigante Amarelo the total titratable acidity (TA) did not differ from the Common Yellow passion fruit, with the average 39.2 g L^{-1} (Figure 4B). The juice of BRS Ouro Vermelho (red peel) had lower acidity (33.5 g L^{-1}) than BRS Gigante Amarelo, but it had similar content to the other cultivars. According to the identity and quality standards of the Ministério da Agricultura, Pecuária e

Abastecimento (BRASIL, 2018), the minimum acidy level of the passion fruit juice must be 2,5 g 100 g^{-1}.

The high acidity in juice of passion fruit is interesting for fruits destined to the industry, while the low acidity is desirable for fruits destined to the *in natura* market. The yellow passion fruit destined to the *in natura* and industry market must have titratable acidity between 2.9% and 5.0%. According to the quality and identity standards required by MAPA, passion fruit pulp must contain at least 2.5% (2.5 g 100 g^{-1}) of total acidity (SILVA *et al.,* 2016). The high acidity in juice used by industry allows to reduce artificial acidifiers, which is an important parameter in the conservation of food products (NETO *et al*. 2015).

Figure 5 - Average values for the ratio TSS/TA in juice of passion fruit cultivars: BRS Gigante Amarelo, BRS Ouro Vermelho (yellow peel[1] red peel[2]), BRS Sol do Cerrado and Common Yellow passion fruit, grown in experimental farming at Miracema-RJ (Brazil) and harvested in the end of the first cycle of production from April to May/2010



The bars are represented with confidence intervals at $p \leq 0.05$.

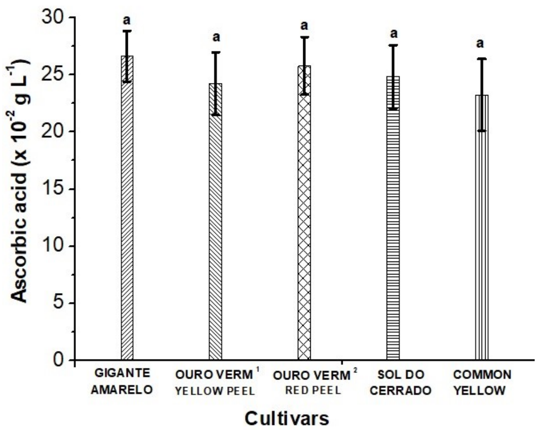
Source: Authors (2022).

All the cultivars showed higher values for the ratio TSS/TA compared to the Common Yellow passion fruit, with the exception of BRS Ouro Vermelho with yellow peel (Figure 5). The highest values of TSS/TA ratio can be attributed to the higher content of soluble solids, since the acid content was similar among the different varieties, with the exception of BRS Ouro Vermelho (red peel) that presented the lowest acidity.

The TSS/TA ratio is an important chemical characteristic to evaluate the quality of passion fruit, because it is related to the fruit flavor, that results of the contribution of the components responsible for the acidity and sweetness, which may contribute to a better palatability to the pulp. The TSS/TA ratio is more representative for the palatability than the TSS or TA measurement alone. In general, the higher the value of this ratio, the more palatable is the juice or fruit pulp, since the total soluble solids content is high and / or the acidity is low. In addition, values of TSS/TA between 3.4 and 4.5 indicate fruit with adequate quality, both for the *in natura* consumption or for fruit processing (NÓBREGA *et al.,* 2021).

Measurements of ascorbic acid contents in juices are presented in Figure 6.

Figure 6 - Ascorbic acid content in juice of passion fruit cultivars: BRS Gigante Amarelo, BRS Ouro Vermelho (yellow peel[1] red peel[2]), BRS Sol do Cerrado and Common Yellow passion fruit, grown in experimental farming at Miracema-RJ (Brazil) and harvested in the end of the first cycle of production from April to May/2010



The bars are represented with confidence intervals at $p \leq 0.05$.

Source: Authors (2022).

Ascorbic acid (AA) content was similar for the different cultivars, with the BRS Gigante Amarelo showing 0.266 g L^{-1} and the Common Yellow passion fruit with 0.232 g L^{-1} (Figure 6). Coelho *et al*. (2010) found 0.217 g L^{-1} in Common Yellow passion fruit harvested at the northern Rio de Janeiro region. According to Cohen *et al*. (2008), BRS Ouro Vermelho planted in Colônia Agrícola of Ipapety (DF, Brazil) presented an AA content from 0.115 to 0.159 g kg^{-1} for conventional production system, and from 0.117 to 0.129 g kg^{-1} for organic system. The AA content in BRS Sol do Cerrado varied from 0.115 to 0.151 g kg^{-1} for conventional production system, and from 0.122 to 0.140 g kg^{-1} for organic system. These results have smaller magnitudes, but indicate similarities between the two cultivars, as was verified in the present work.

CONCLUSIONS

Productivity and passion fruit size from BRS Gigante Amarelo are higher than the Common Yellow passion fruit, unlike BRS Ouro Vermelho which present lower productivity and smaller fruit size under field conditions at the northwest region of Rio de Janeiro. Furthermore, BRS Gigante Amarelo has higher juice yield compared to the others passion fruit cultivars. Its rind thickness is smaller than the Common Yellow passion fruit. In the chemical analysis of juice, the genotypes of Embrapa have higher contents of reducing sugars and total soluble solids in relation to Common Yellow passion fruit, highlighting the BRS Gigante Amarelo, but they do not differ with respect to juice acidity and ascorbic acid content.

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AUTHORS' CONTRIBUTIONS

J.L.V.S – Physical and chemical assays, E.D.R. – Conceptualization, Methodology, Writing, S.A.C – Project Coordinator by Embrapa, J.F.M.M – Implantation and Monitoring of the orchard.

CONFLICT OF INTEREST

The authors have no conflict of interest that would bias the collection, analysis, reporting or publishing of the manuscript.

Produtividade e qualidade do suco de diferentes cultivares de maracujás plantados na região noroeste do Rio de Janeiro

RESUMO

O Brasil é o maior produtor mundial de maracujá. Esta cultura é uma alternativa para os pequenos agricultores devido ao rápido ganho econômico e renda distribuída ao longo de todo o ano. Entretanto, um grande ataque de doenças forçou o desenvolvimento de novos cultivares. O objetivo deste trabalho foi caracterizar a produtividade, o rendimento de polpa e a qualidade do suco dos cultivares de maracujá: BRS Gigante Amarelo (GA), BRS Ouro Vermelho (OV), BRS Sol do Cerrado (SC), comparando com o maracujá Amarelo Comum (AC) normalmente plantado nos pomares comerciais. A qualidade do suco foi avaliada em termos de acidez titulável (AT), pH, sólidos solúveis totais (SST), razão SST/AT, açúcares solúveis totais (AST), açúcares redutores (AR) e conteúdo de ácido ascórbico (AA). O maracujá BRS GA apresentou a maior produtividade e rendimento de suco, mas a menor espessura de casca. O seu conteúdo de AT foi similar ao do maracujá AC. Os três cultivares apresentaram maiores conteúdos de AR e SST, em relação ao maracujá AC, com maior valor de TSS para o maracujá BRS GA. O conteúdo de AA foi similar entre os diferentes cultivares. O BRS GA foi considerado como de maior produtividade e de melhor qualidade do suco.

Palavras-chave: *Passiflora edulis*. Caracterização química. BRS Gigante Amarelo. BRS Ouro Vermelho. BRS Sol do Cerrado.

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