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Quality and postharvest conservation of sour passion fruit genotypes

James Maciel de Araújo[1]*, Romeu de Carvalho Andrade Neto[2], Leonardo Barreto Tavella[3], Hugo Mota Ferreira Leite[3], Marlon Lima de Araujo[4] Lauro Saraiva Lessa[2], Marcos Giovane Pedroza de Abreu[5], João Paulo Sebim Marim[3]

[1]Fundação de Amparo a Pesquisa do Acre, Cruzeiro do Sul-AC, Brasil
[2]Empresa Brasileira de Pesquisa Agropecuária, Rio Branco-AC, Brasil
[3]Universidade Federal do Acre, Cruzeiro do Sul-AC, Brasil
[4]Polícia Militar do Estado do Acre, Cruzeiro do Sul-AC, Brasil
[5]Universidade Estadual Paulista, Botucatu-SP, Brasil
*Corresponding author, e-mail: jamesagro3@gmail.com

Abstract

The postharvest phase is a limiting factor for climacteric fruits such as passion fruit due to rapid deterioration causing wilting and favoring the occurrence of pathogenic microorganisms. From this perspective, this study aimed to evaluate the postharvest quality of passion fruit genotypes cultivated in Mâncio Lima, Acre, as a function of the storage period after harvest. The experiment was set up and conducted at the Plant Science Laboratory of the Federal University of Acre, Campus Floresta. The experimental design was in randomized blocks, in a 10 x 5 factorial arrangement referring to 10 sour passion fruit genotypes and five postharvest evaluation periods, with three replications of six fruits. The fruits were evaluated for physical and chemical quality. Analysis of variance and polynomial regression were performed at 5% significance. The genotypes showed oscillations regarding the physical and chemical characteristics of the fruits depending on the storage time. All evaluated genotypes are recommended for cultivation. However, when harvested directly from the ground after detached from the plant, fruits must be stored for up to 10 days at room temperature.

Keywords: Juruá Valley, *Passiflora edulis Sims*, selection, storage

Introduction

Brazil accounts for the largest production and consumption of passion fruit and its by-products worldwide (Passiflora edulis Sims.) (Cerqueira-Silva et al., 2014). Native to South America, the species is widely cultivated in tropical and subtropical countries and is present in almost all Brazilian states (Silva et al., 2016).

Sour passion fruit has been increasingly cultivated in the Brazilian State of Acre, especially in the Juruá Valley Microregion. This region shows an outstanding agricultural potential for fruit farming and has offered a significant alternative for income generation for local producers (Andrade Neto et al., 2015). Even though, the rugged terrain of the region does not favor intensive cultivation of the main commercial crops, fruit species can still be grown in sloped areas due to their natural soil drainage, requiring minimum soil management.

Passion fruit is mainly marketed as fresh fruits and pulp, primarily for the agroindustry (Giovanaz et al., 2014). In the fresh form, the parameters used to determine passion fruit quality are related to fruit appearance, this attribute being the main one used by consumers, who opt for spotless fruits with smooth peels, yellowish color, and larger sizes (Giovanaz et al., 2014; Silva Filho et al., 2015).

The post-harvest stage is one of the main obstacles in the passion fruit production chain since fruits are subject to accelerated deterioration caused by wilting and pathogenic microorganisms that, associated with the lack of proper handling and conservation, cause enormous fruit quality losses (Rinaldi et al., 2017). In addition, passion fruit is classified as having climacteric respiration, which causes greater loss of water and mass (Pocasangre Enamorado et al., 1995; Vespucci et al., 2018). From this perspective, good fruit conservation during long storage periods is essential for commercialization, especially in

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the fresh fruit market (Favorito et al., 2017).

The fruit senescence process, which includes effects such as pericarp wrinkling, begins from three to seven days after fruit abscission, and passion fruit stands out as a highly perishable fruit with rapid pericarp dehydration and wilting (Silva, et al., 2009). The change in pericarp color is one of the main physiological transformations that fruits undergo during storage, with the potential to affect pulp quality (Vianna-Silva et al., 2008). According to these authors, this change in peel color is used to determine the moment of harvest and is related to the extension of the storage period.

From this perspective, this study aimed to evaluate the postharvest quality of passion fruit genotypes cultivated in Mâncio Lima, Acre, as a function of the storage period after harvest.

Material and Methods

The experiment was set up and conducted at the UFAC Plant Science Laboratory, Campus Floresta, using fruits harvested in the Nova Vida Grange, municipality of Mâncio Lima, State of Acre, Brazil, located at the geographic coordinates: 7°38'03.1" S and 72 °51'39.1" W. According to Alvares et al. (2013), based on the Köppen classification, the climate in the region is classified as *Af*, corresponding to a humid tropical climate. According to Inmet (2023), the mean annual precipitation in the region exceeds 2,000 mm, the mean temperature ranges from 24.5 °C to 32 °C, and the mean relative humidity exceeds 83%.

The experimental design was in randomized blocks, in a 5 x 10 factorial arrangement corresponding to five fruit evaluation periods (0, 5, 10, 15, and 20 days after harvest) and 10 sour passion fruit genotypes (Seleção Acre, BRS Gigante Amarelo, BRS Sol do Cerrado, BRS Rubi do Cerrado, Flora Brasil FB 200 "Yellow master", FB 300 "Araguari", CPAC 325 x VML, IAC 277, 275, and 273), with three replications of six fruits.

In the first week of May 2021, the fruits were harvested, packed in plastic bags, and taken to the Plant Science Laboratory of the Federal University of Acre (UFAC), Campus Floresta, located in the municipality of Cruzeiro do Sul, State of Acre, with the analyses beginning immediately after harvest (time 1 - 0 days). The fruits remained in plastic bowls at room temperature until they were evaluated from time 2 (five days after harvest) onwards (10, 15, and 20 days after harvest).

The physical characteristics evaluated were: fruit mass (g), obtained with a precision balance (0.01 g); seedless pulp mass (g), obtained after pulp extraction using a sieve and then by weighing on a digital scale; percentage of mass loss over time (%), obtained by the difference between the fresh mass on the day of weighing (%) in relation to the initial mass (time 1 - 0 day); fruit length (cm), determined by measuring the distance between the fruit's base (peduncle insertion) and its apex; fruit diameter (cm), measured perpendicular to the height of the fruit region with the largest dimension; shell thickness (epicarp + mesocarp, in mm), determined with a digital caliper accurate to 0.01 mm; and juice yield (RS %), obtained by the following equation:

$$\text{Juice yield (\%)} = \frac{\text{Gross pulp mass (g) - Residual mass (g)} \times 100}{\text{Total fruit mass (g)}}$$

The chemical analyses were performed according to methodologies described by the Adolfo Lutz Institute (IAL, 2008). The content of soluble solids (SS, in °Brix) was determined using a refractometer. Titratable acidity (TA, in % of citric acid) was measured by titration with 0.1M NaOH. The ratio of soluble solids to titratable acidity (RATIO) was obtained by the relationship between these two variables. The pH was obtained using a pH meter periodically calibrated with buffer solutions at pH 4 and 7.

The data were subjected to analysis of variance (F-test) at 5% significance. After checking the differences between treatments, the means were compared using the Scott-Knott clustering test at 5%, in the case of qualitative treatments (genotypes), and regression analysis for the quantitative treatments (days after harvest). The statistical software SISVAR was used in all statistical analyses (Ferreira, 2019).

Results and Discussion

There was a significant interaction between passion fruit genotypes and evaluation days. The fresh fruit mass decreased linearly with the passing of days after harvest for all passion fruit genotypes evaluated (**Figure 1**).

Regardless of the genotype, the mean losses in relation to time 0 were 21.12 g after 5 days, 38.24 g after 10 days, 48.87 g after 15 days, and 55.04 g at 20 days after harvest.

The loss of fresh mass during storage is due to the reduction in water volume as a result of transpiration and metabolic respiration (Venâncio et al., 2013). Perishable fruits, including passion fruit, tend to reduce their mass due to respiration and perspiration even when kept under ideal storage conditions (Chitarra & Chitarra 2005). An alternative used to avoid this scenario is to decrease the temperature in the storage environment since this practice slows the fruit metabolism and reduces the loss of fruit mass (Rinaldi et al., 2017).

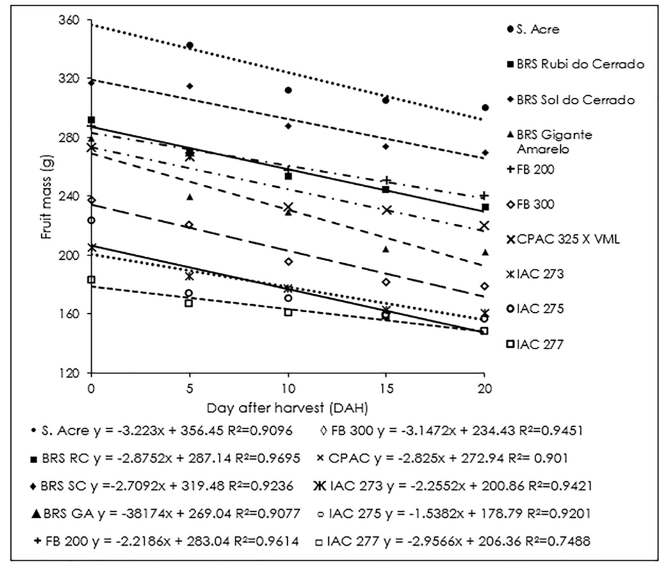

Figure 1 - Fruit mass (g) of sour passion fruit genotypes as a function of the evaluation time after harvest (days).

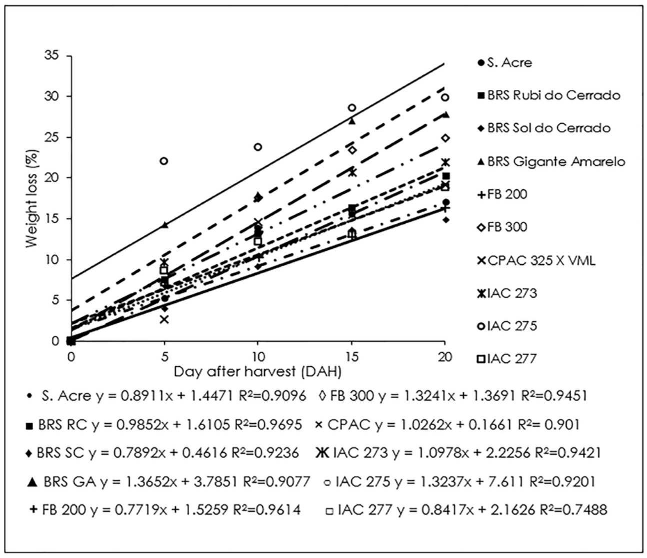

Figure 2. Fruit mass loss (%) of sour passion fruit genotypes as a function of the time after harvest (in days).

According to the classification of climacteric and non-climacteric fruits, the rate of mass and volume loss in fruits may be more pronounced over the storage period, depending on respiratory patterns (Chitarra & Chitarra, 2005). Climacteric fruits have greater respiratory intensity and ethylene production, which accelerates their maturation and causes them to lose more mass and volume. On the other hand, non-climacteric fruits need more time to complete the ripening process, lower respiratory intensity, low ethylene production, and show a slow loss of mass (Chitarra & Chitarra, 2005; Costa et al., 2011). Passion fruit is classified as a climacteric fruit that, during its physiological maturation, reaches a peak in ethylene production and respiratory rate, thus increasing the loss of fruit mass and volume (Vespucci et al., 2018).

In percentage terms, the loss of fruit mass during the post-harvest evaluations showed a linear adjustment for all sour passion fruit genotypes evaluated, with the cultivar IAC 275 showing the greatest loss (34.08%) of initial fruit mass and the cv. BRS Sol do Cerrado showing the lowest loss (16.24%) in relation to the initial fruit mass (**Figure 2**).

Silva et al. (2019) observed the same fruit mass loss effect in yellow passion fruit until the 10^{th} day of storage. In another study, Venancio et al. (2013) found a fruit mass loss of up to 42.8% until the 16^{th} of storage, whereas Botelho et al. (2019) found a mass loss of 20.8% in yellow passion fruit until the 9^{th} day after harvest.

According to the Agriculture Federation of the State of Paraná - FAEP (2015), in order for passion fruit to be considered withered, the loss of fresh mass should not exceed 8% of the initial mass because, when exceeding this value, the fruit appearance is affected and, therefore, the commercial value depreciates, especially for the fresh fruit market (Silva et al., 2015).

When this parameter is used as a standard to classify wilted fruits, according to FAEP (2015), only the genotypes BRS Gigante Amarelo, IAC 273, and IAC 275 exceeded this value. However, after 10 days of harvest, all fruits showed values above 8 %. These results can be explained by the fact that the fruits were picked from the ground. According to Botelho et al. (2019), fruits harvested at a more mature stage (100% of yellow peel) or from the ground tend to show rapid wilting and mass loss, with a consequent reduction in post-harvest shelf life.

According to Arjona et al. (1992), passion fruit can be stored for seven to ten days under normal temperature and environmental conditions. However, it is believed that, for better fresh fruit acceptance by consumers, fruits should have a good appearance, swollen pericarp, yellow peel color, and smooth surfaces without wrinkles, stains, or damage that could influence the pulp (Aguiar et al., 2015).

Fruit length showed a linear reduction in all genotypes throughout the evaluation period after harvest (**Figure 3**).

The reduction in fruit length is due to the fact that passion fruit is highly perishable since, after disconnected from the plant, the fruits showed rapid epicarp dehydration (withering), reducing fruit size and mass, which shortens the storage period (Pocasangre-Enamorado et al., 1995; Durigan et al., 2004).

Regardless of the genotypes studied, the data adjusted to a decreasing linear regression as a function of the evaluation periods after harvest for fruit diameter (**Figure 4**).

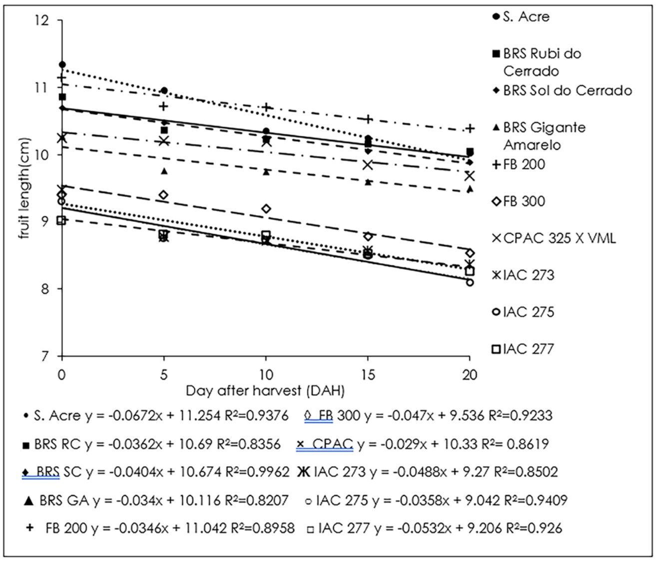

Figure 3 - Fruit length (cm) of sour passion fruit genotypes as a function of the evaluation time after harvest (days).

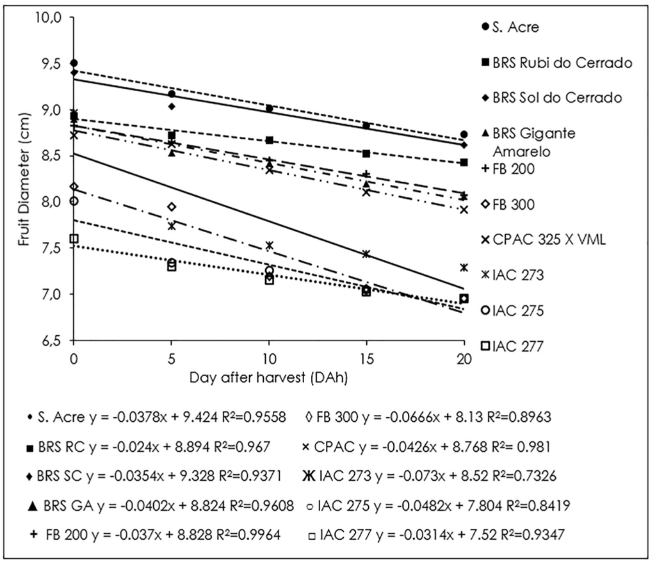

Figure 4 - Fruit diameter (cm) of sour passion fruit genotypes as a function of the evaluation time after harvest (days).

Between the 20th day and the initial evaluation period, the cultivar IAC 273 showed the greatest reduction in fruit diameter (1.67 cm), whereas the cultivar BRS Rubi do Cerrado had the smallest reduction (0.57 cm).

Peel thickness showed a linear reduction as a function of the evaluation days after harvest regardless of the genotype (**Figure 5**). The genotype Seleção Acre showed the greatest reduction in bark thickness, from an initial 11.16 mm to 7.42 mm 20 days after harvest. Genotype FB 200 showed a smaller reduction, from 7.66 mm at the beginning of evaluation to 6.64 mm 20 days after harvest (Figure 5).

The parameters of seedless pulp mass (**Figure 6** A) and juice yield (Figure 6 B) decreased over the storage days after harvest. The seedless pulp mass ranged from

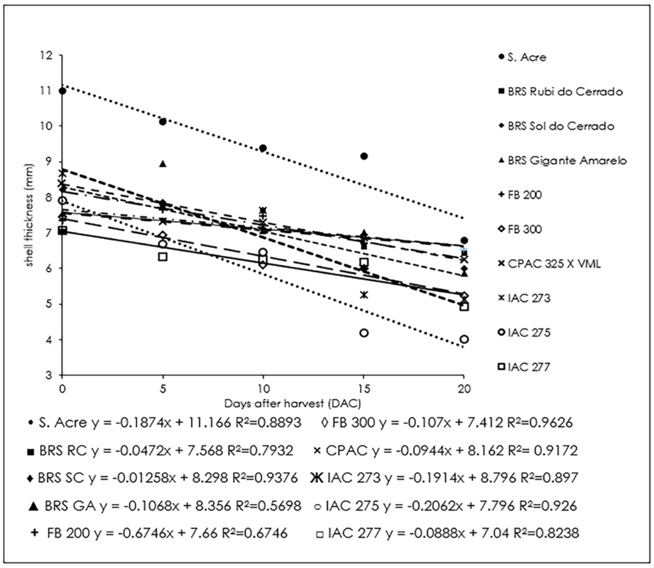

Figure 5 - Peel thickness (mm) of sour passion fruit genotypes as a function of the evaluation time after harvest (days).

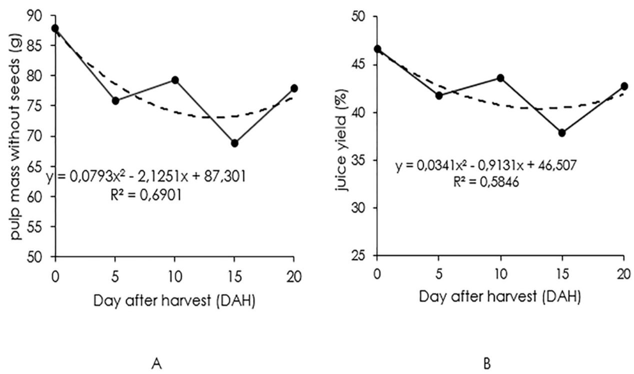

Figure 6 - Seedless pulp mass (A) in g and juice yield (B) in % of sour passion fruit genotypes as a function of the evaluation time after harvest (days).

87.78 g at the beginning of the evaluation to 73.06 g at 13 DAH. Juice yield decreased from 46.58% to 34.75% at 13 DAH.

The genotypes BRS Sol do Cerrado and FB 200 showed the highest means of seedless pulp mass and juice yield (**Table 1**).

Table 1 - Mean values of seedless pulp mass, juice yield (%), and SS/AT ratio (ratio) of sour passion fruit genotypes

Genotypes	Seedless pulp mass (g)	Juice Yield (%)
Seleção Acre	79.31 b	43.75 b
BRS Gigante Amarelo	79.01 b	43.41 b
BRS Rubi do Cerrado	85.71 b	47.09 b
BRS Sol do Cerrado	93.01 a	51.10 a
FB 200 Yellow Master	91.11 a	50.06 a
FB 300 Araguari	67.77 c	37.23 c
CPAC 325 x VML	85.49 b	46.97 b
IAC 273	67.86 c	37.28 c
IAC 275	64.38 c	35.37 c
IAC 277	59.92 c	32.92 c

Means followed by the same letter do not differ according to the Scott Knott test at 5% significance.

Silva et al. (2009) observed an increase of 1.9 g per day in fruit mass due to the increase in water volume resulting from the hydrolysis of carbohydrates in the respiration process, mainly through the osmotic movement of water from the epidermis to the pulp. In another study, Venancio et al. (2013) found an increasing linear effect of more than 12% on pulp yield from the initial evaluation (0 days) until 16 DAH.

There was a significant interaction between the evaluated genotypes and the evaluation time after harvest for soluble solids, pH, and titratable acidity. The ratio of soluble solids to titratable acidity was influenced separately by both factors.

The mean values of soluble solids fit the quadratic regression model for the cultivars BRS Rubi do Cerrado, FB 300, IAC 273, and IAC 277 (**Figure 7**). The first cultivar showed a maximum value of 13.75 °Brix up to the 6th day after harvest; the second showed 13.60°Brix until the 7th day after harvest; the third showed 12.78°Brix until the 7th day; and the fourth genotype showed 13.16°Brix until the 3rd day after harvest. The other genotypes showed a linear reduction in the soluble solids content over the storage period.

Venancio et al. (2013) and Cavichioli et al. (2014) found a gradual reduction in the soluble solids content of passion fruit during storage.

For Silva et al. (2009), the increase in sweetness during fruit maturation is due to the increase in simple sugars and the decrease in acidity and astringency, as well as the emanation of volatile compounds. For most genotypes, the reduction in soluble solids (Figure 7) can be explained by the fact that the fruits were picked ripe after being naturally released from the plants.

The fruit pH of genotypes IAC 273, IAC 275, IAC 277, and BRS Rubi do Cerrado adjusted to the quadratic regression model, whose maximum values were, respectively, 3.25 on the 15th day after harvest, 3.26 on the 14th day, 3.21 on the 17th day, and 3.20 on the 11th day after harvest (**Figure 8**). The other genotypes adjusted to the linear model with an increase in the pH value.

The pH oscillations during storage are related to the intrinsic characteristics of the environment and the fruit, e.g., the maturation stage (Rinaldi et al., 2017). According to the same author, the increase in pH during storage, especially in plant products, is linked to the natural reduction in acidity values since the acids present in fruits tend to be used in metabolic processes that occur in the plant.

There was a linear decline in the titratable acidity content until the 20th day of evaluation after harvest for all passion fruit genotypes (**Figure 9**). Genotype FB 300 showed the greatest AT reduction, i.e., from 3.47% initially to 2.21% at 20 DAH, whereas IAC 275 showed the smallest reduction, from 2.98% initially to 2.24% at 20 DAH.

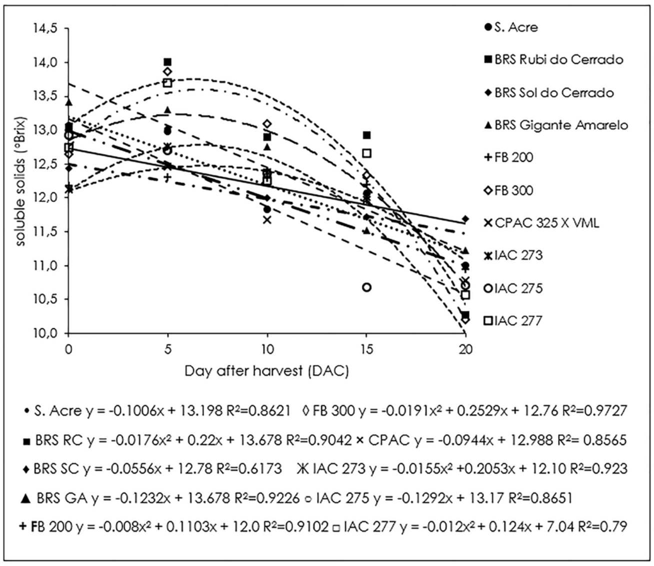

Figure 7 - Soluble solids (°Brix) of passion fruit genotypes as a function of the evaluation time after harvest (days).

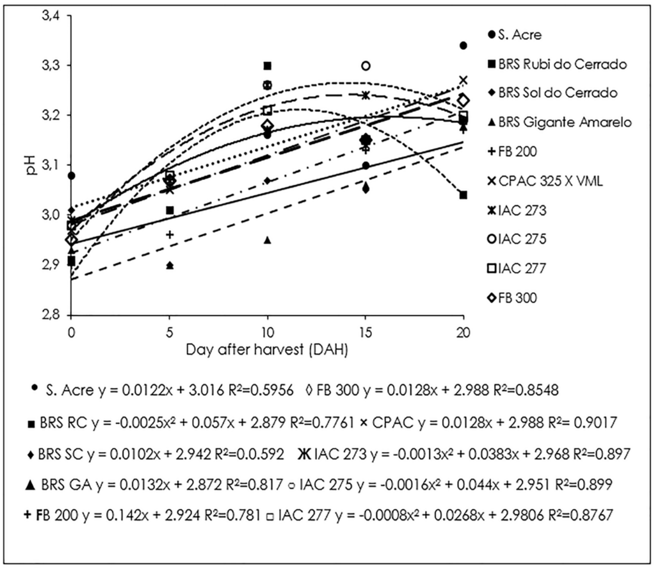

Figure 8 - Potential of hydrogen (pH) of passion fruit genotypes as a function of the evaluation time after harvest (days).

A linear reduction in fruit acidity occurs mainly when fruits are stored at higher temperatures (above 20°C) due to increased metabolic activity (Arruda et al., 2011).

According to Chitarra and Chitarra (2005), titratable acidity in fruits and plants originates, above all, from organic acids dissolved in cell vacuoles, both in free form and combined with salts, esters, and glycosides. In most cases, acidity decreases with fruit maturation due to its use in respiration or in its transformation into sugars during fruit storage (Silva et al., 2009; Moura et al., 2016).

Seymour et al. (1993) state that the gradual reduction in titratable acidity during fruit maturation and senescence is attributed to respiration.

Normative Instruction No. 1, of January 7, 2000, from MAPA, determines that the minimum values for unfermented and undiluted passion fruit pulp are 11°Brix of soluble solids and 2.50% of acidity. Thus, under the studied conditions, the fruits were within the values required for industrialization.

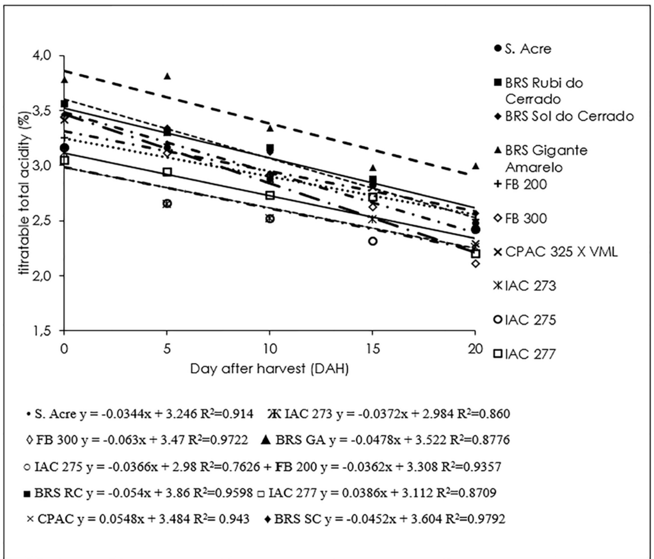

Figure 9 - Titratable acidity (%) of passion fruit genotypes as a function of the evaluation time after harvest (days).

There was a linear increase in the ratio of soluble solids to titratable acidity as a function of the storage period for the with a daily increase of 0.03 up to the 20th DAH (**Figure 10**). This behavior occurred due to the marked reduction in titratable acidity in relation to soluble solids during fruit ripening.

The SS to TA ratio (ratio) was significantly higher for genotypes FB 300, IAC 273, IAC 275, and IAC 277, with 4.57, 4.54, 4.57, and 4.68, respectively (**Table 2**).

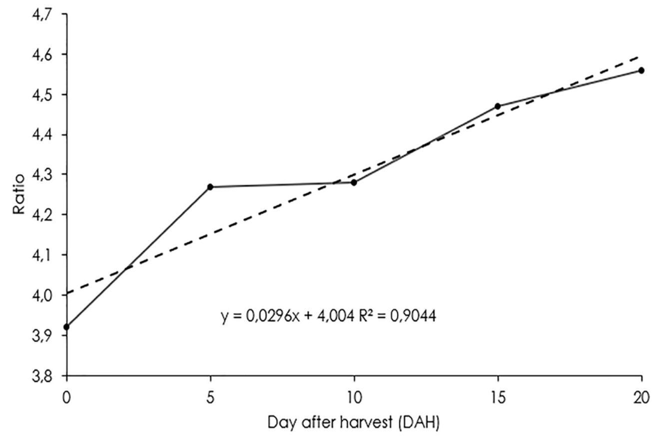

Figure 10 – Total soluble solid ratio and total titratable acidity of sour passion fruit as a function of the evaluation time after harvest (days).

The SS to TA ratio is one of the most important variables used to determine flavor (Aguiar et al., 2015) since the balance between the two components is efficient to quantify pulp quality and fruit sweetness. Therefore, the higher the value of this parameter, the greater is fruit sweetness (Chitarra & Chitarra, 2005). Moreover, the SS to TA ratio can fluctuate depending on the cultivar, climatic conditions, and maturation stage. However, it tends to increase with reductions in acidity (Moura et al., 2016).

Table 2 - Means of the ratio of soluble solids to titratable acidity (ratio) of sour passion fruit genotypes

Genotypes	Ratio (SS/AT)
Seleção Acre	4.26 b
BRS Gigante Amarelo	3.75 c
BRS Rubi do Cerrado	4.19 b
BRS Sol do Cerrado	4.05 b
FB 200 Yellow Master	4.00 b
FB 300 Araguari	4.57 a
CPAC 325 x VML	4.21 b
IAC 273	4.54 a
IAC 275	4.57 a
IAC 277	4.68 a

Means followed by the same letter do not differ according by the Scott Knott test at 5% significance.

Conclusions

The genotypes showed oscillations with regard to the physical and chemical characteristics of the fruits depending on the storage time.

All genotypes evaluated are recommended for cultivation. However, when harvested directly from the ground after detaching from the plant, fruits must be stored for up to 10 days at room temperature.

References

Aguiar, R.S., Zaccheo, P.V.C., Stenzel, N.M.C., Sera. T., Neves, C.S.V.J. 2015. Produção e qualidade de frutos híbridos de maracujazeiro amarelo no norte do Paraná. *Revista Brasileira de Fruticultura* 37: 130-137.

Andrade Neto, R.C., Negreiros, J.R.S., Faleiro, F.G., Junqueira, K.P., Nogueira, S.R., Santos, R.S., Almeida, U.O., Ribeiro, A.M.A.S. 2015. *Recomendações técnicas para o cultivo do maracujazeiro- amarelo cvs. Brs gigante amarelo e BRS Sol do Cerrado*. Embrapa, Rio Branco, Brasil. 187 p.

Arjona, H.E., Matta, F.B., Garner, J.O. 1992. Temperature and storage time affect quality of yellow passion fruit. *HortScience* 27: 809-810.

Arruda, M.C., Fischer, I.H., Jeronimo, E.M., Zanette, M.M., Silva, B.L. 2011. Efeito de produtos químicos e temperaturas de armazenamento na pós-colheita de maracujá-amarelo. *Ciências Agrárias* 32: 201-208.

Botelho, S.C., Hauth, M.R., Botelho, F.M., Roncatto, G., Wobeto, C., Oliveira, S.S. 2019. Qualidade pós-colheita de frutos de maracujazeiro-amarelo colhidos em diferentes estádios de maturação. *Revista Ciências Agrarias* 62: e2019.

Campos, A.J., Manoel, L., Damatto Júnior, E.R., Vieites, R.L., Leonel, S., Evangelista, R.M. 2005. Tratamento hidrotérmico na manutenção da qualidade pós-colheita de maracujá-amarelo. *Revista Brasileira de Fruticultura* 27: 383-385.

Cavichioli, J.C., Kasai, F.S., Nasser, M.D. 2014. Produtividade e características físicas de frutos de *Passiflora edulis* enxertado sobre *Passiflora gibertii* em diferentes espaçamentos de plantio. *Revista Brasileira de Fruticultura* 36: 243-247.

Cerqueira-Silva, C.B.M., Jesus, O.N., Santos, E.S.L., Corrêa, R.X., Souza, A.P. 2014. Genetic breeding and diversity of the genus passiflora: progress and perspectives in molecular and genetic studies. *International Journal of Molecular Sciences* 15: e14122-14152.

Chitarra, M.I.F., Chitarra, A.B. 2005. *Pós-colheita de frutas e hortaliças: fisiologia e manuseio*. UFLA, Lavras, Brasil. 785 p.

Costa, A.S., Ribeiro, L.R., Koblitz, M.G.B. 2011. Uso de atmosfera controlada e modificada em frutos climatéricos e não-climatéricos. *Sitientibus série Ciências Biológicas* 11: 1-7.

Durigan, J.F., Sigrist, J.M.M., Alves, R.E., Filgueiras, H.A.C., Vieira, G. 2004. Qualidade e tecnologia pós-colheita do maracujá. In: Lima, A.A., Cunha, M.A.P. *Maracujá: produção e qualidade na passicultura*. Embrapa Mandioca e Fruticultura, Cruz das Almas, Brasil. 303 p.

Favorito, P.A., Villa, F., Taffare, L.E., Rotili, M.C.C. 2017 Qualidade e conservação pós-colheita de frutos de maracujá-amarelo sob armazenamento. *Scientia Agraria Paranaensis* 16: 449-453.

FAEP. Federação da Agricultura do Estado do Paraná. 2015. Disponível em: http://.www.faep.com.br/comissoes/frutas/cartilhas/frutas/maracuja.htm <Acesso em: 25 ago. 2021>

Ferreira, D.F. 2019. SISVAR: A COMPUTER ANALYSIS SYSTEM TO FIXED EFFECTS SPLIT PLOT TYPE DESIGNS. *REVISTA BRASILEIRA DE BIOMETRIA* 37: 529-535.

Giovanaz, A., Fachinello, J.C., Goulart, C., Radünz, A.L., Amaral, P.A., Weber, D. 2014. Produção e qualidade de pêssegos, cv. Jubileu, com uso de fitorreguladores. *Revista Ceres* 61: 552-557.

IAL. 2008. *Métodos físico-químicos para análise de alimentos.* Instituto Adolfo Lutz, São Paulo, Brasil. 1020 p.

Moura, G.S., Schwan-Estrada, K.R.F., Clemente, E., Franzener, G. 2016. Conservação pós-colheita de frutos de maracujá-amarelo por derivados de capim-limão (*Cymbopogon citratus*). *Ambiência* 12: 667-682.

Pocasangre Enamorado, H.E., Finger, F.L., Barros, R.S., Puschmann, R. 1995. Development and ripening of yellow passion fruit. *Journal of Horticultural Science* 70: 573-576.

Rinaldi, M.M., Costa, A.M., Faleiro, F.G., Junqueira, N.T.V. 2017. Conservação pós-colheita de frutos de *Passiflora setacea* DC. submetidos a diferentes sanitizantes e temperaturas de armazenamento. *Brazilian of Journal of Food Technology* 20: e2016046.

Santos, A.C.G., Silva, N.S., Sousa, F.F. 2019. Pós-colheita do maracujá amarelo com revestimento a base de amido da entrecasca de mandioca. *Revista verde* 14: 238-245.

Silva, M.S., Ataíde, E.M., Santos, A.K.E., Souza, J.M.A. 2016. Qualidade de frutos de maracujazeiro amarelo produzidos na safra e entressafra no Vale do São Francisco. *Revista Iberoamericana de Tecnología Postcosecha* 17: 41-49.

Silva Filho, E.D., Figueirêdo, R.M.F., Queiroz, A.J.M., Brasileiro, J.L.O. 2015. Variáveis físicas, químicas e reológicas da polpa integral da manga cv. Haden. *Engenharia na Agricultura* 23: 397-405.

Silva, L.J.B., Souza, M.L., Araujo Neto, E., Morais, A.P. 2009. Revestimentos alternativos na conservação pós-colheita de maracujá-amarelo. *Revista Brasileira de Fruticultura* 3: 995-1003.

Venâncio, J.B., Silveira, M.V. Fehlauer, T.V., Pegorare, A.B., Rodrigues, E.T., Araújo, W.F. 2013. Tratamento hidrotérmico e cloreto de cálcio na pós-colheita de maracujá-amarelo. *Científica* 41: 122–129.

Vespucci, I.L., *Silva, D.D.A., Machado, V.S., Campos, A.J.* 2018. Conservação de maracujá silvestre sob atmosfera modificada passiva. *Revista Eletrônica de Educação da Faculdade Araguaia* 13: 32-43.

Vianna-Silva, T., Resende, E.D., Pereira, S.M.F., Viana, A.P., Rosa, R.C.C., Carlos, L.A., Vitorazi, L. 2008. Influência dos estádios de maturação sobre as características físicas dos frutos de maracujá-amarelo. *Bragantia* 67: 521-525.

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