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CHEMICAL CHARACTERISTICS OF TWO STRAWBERRY CULTIVARS AND SENSORY ANALYSIS OF FRUITS

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ABSTRACT - Strawberry cultivation is of great economic importance to family farming. For this reason, studies and experiments have been carried out to improve management and increase the productivity of this fruit. The aim of this study was to evaluate the characteristics of the fruit's chemical qualities and sensory analysis between two strawberry cultivars, Pircinque and VR10. The strawberries used in the research were grown on a property in Serranópolis do Iguaçu, PR, in a protected environment. The plants were planted on top of white mulch using the traditional planting method. Chemical properties such as soluble solids(ºBrix), pH, AT (% citric acid), RATIO (soluble solids/titratable acidity) were evaluated. In addition, a sensory analysis was carried out, inviting 20 untrained tasters of both sexes and different ages from the Uniguaçu educational institution. The design used was completely randomized (DIC), with two strawberry cultivars Pircinque and VR10. Based on the chemical and sensory analyses carried out, the Pircinque strawberry cultivar stood out when compared to the VR10 cultivar, within the parameters and criteria evaluated. Standing out in all the parameters analyzed, the Pircinque cultivar is the best option when compared to the VR10 variety in terms of taste and quality.
Keywords: Strawberry fruit; tasting; strawberry chemical properties.

CARACTERÍSTICAS QUÍMICAS DE DUAS CULTIVARES DE MORANGO E ANÁLISE SENSORIAL DOS FRUTOS

RESUMO - O cultivo de morango possui grande importância econômica no ramo da agricultura familiar. Por este motivo, estudos e experimentos vem sendo realizados para o aprimoramento do manejo e aumento da produtividade desta fruta. Este trabalho teve como objetivo avaliar as características das qualidades químicas do fruto e análise sensorial entre duas cultivares de morango, Pircinque e VR10. Os morangos utilizados na pesquisa foram produzidos em uma propriedade situada em Serranópolis do Iguaçu- PR, em ambiente protegido. As plantas foram plantadas em cima de mulching branco, pelo método de plantio tradicional. Foram avaliadas propriedades químicas como sólidos solúveis (ºBrix), pH, AT (% ácido cítrico), RATIO (sólidos solúveis/acidez titulável). Além disso foi realizado análise sensorial, sendo convidados 20 degustadores não treinados, de ambos os sexos e de idades distintas frequentadores da Instituição de Ensino Uniguaçu. O delineamento experimental utilizado foi inteiramente ao acaso, com duas cultivares de morango (Pircinque e VR10), com 10 repetições e 5 frutas por repetição, para cada cultivar, resultando em um total de 100 frutas amostradas. A partir das análises químicas e sensoriais realizadas, a cultivar de morango Pircinque se destacou quando comparado a cultivar VR10, dentro dos parâmetros e critérios avaliados. Destacando-se em todos os parâmetros analisados, a cultivar Pircinque quando comparada a cultivar VR10 é a melhor opção entre critérios de sabor e qualidade.
Palavras-chave: Fruta de Morango; degustação; propriedades químicas do morango.

INTRODUCTION

The strawberry belongs to the genus *Fragaria* spp. and the family Rosaceae, originating in Europe. It is a ground-hugging plant, featuring stolons and asexual propagation through specialized structures. Interestingly, the strawberry is not classified as a fruit since it does not originate from the ovary but rather from the floral receptacle, thus being classified as a vegetable (LABADIE et al., 2023).

The cultivation of strawberries has significant economic importance for family farming in Brazil, with a production of 197,000 tons over a total area of 5,084 hectares. Among the Brazilian states, Rio Grande do Sul, São Paulo, and Minas Gerais stand out, accounting for about 90% of the entire production. Other regions with different edaphoclimatic conditions, such as Goiás, Santa Catarina, Espírito Santo, and the Federal District, also contribute to strawberry cultivation (ANTUNES et al., 2023). Although Brazil has favorable conditions for strawberry production, it does not rank among the world's top producers. It holds the 14th position in the global ranking of strawberry-producing countries, facing challenges such as the difficulty of freezing large volumes of fruit. This factor hinders the expansion of production

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and the maximization of strawberry commercialization (FRANQUETO; MATTOS, 2023).

Field cultural practices, such as pest and disease monitoring, enable the sustainability and continuity of the production system over the years, elevating the quality standards and competitiveness of the products to a level of excellence (DALASTRA et al., 2018).

Sensory analysis and tasting of the fruits reveal various organoleptic characteristics, which involve evaluating the sensory attributes of the fruit, such as flavor, aroma, texture, and color of the strawberry, through human perception. This process allows for determining the strawberry's acceptability by consumers and identifying possible quality variations. Meanwhile, the physicochemical characteristics include measuring parameters such as sugar content, acidity, pH, moisture content, and soluble solids content, among others. These data are crucial for determining the strawberry's ripeness, freshness, and nutritional value (ANDERSEN et al., 2023).

Due to edaphoclimatic conditions and crop management, the productivity and physicochemical, sensory, and nutraceutical characteristics of the fruits can vary significantly. These characteristics play a crucial role in evaluating the production and quality of the fruits, directly impacting the producer's income. Therefore, understanding and monitoring these aspects is essential to ensure high-quality fruits and maximize financial returns for producers (NUNES; NOVELLO, 2021).

Within crop management, an important factor to study is the cultivar chosen for field cultivation, as different cultivars have unique characteristics that impact productivity, disease resistance, climatic adaptation, and fruit quality. By selecting the most suitable cultivar, producers can optimize production, reduce risks, and ensure desired fruits that meet market and consumer demands. Therefore, careful selection of the cultivar is essential for successful cultivation and obtaining high-quality fruits (SILVA; SIMONETTI,).

The Pircinque strawberry cultivar is known for its distinct physicochemical and sensory characteristics. Physicochemically, the Pircinque strawberry tends to exhibit a notable balance between sugar content and acidity, resulting in a sweet and slightly acidic flavor. Additionally, it typically has good firmness, an intense red color, and a high soluble solids content, contributing to its sensory quality. Sensory-wise, the Pircinque strawberry is recognized for its strong and pleasant aroma, as well as a juicy texture and characteristic flavor, making it highly appreciated by consumers (FAGHERAZZI et al., 2021).

Several physicochemical quality characteristics of fruits are employed in the analysis of their composition, which involves evaluating and measuring the chemical and physical components present in the fruits, such as acidity, pH, moisture content, soluble solids content, vitamins, minerals, and other compounds. This analysis is essential for understanding the nutritional composition of the fruits, determining their ripeness, freshness, and quality, and meeting regulatory and labeling requirements (DALASTRA et al., 2018; COUTINHO et al., 2020). Given the above, the present study aimed to evaluate the physicochemical quality characteristics of the fruit and conduct a sensory analysis of strawberry cultivars.

METERIAL AND METHODS

The experiment related to the chemical and sensory analysis, and tasting of the fruits was conducted in the laboratory space of the Engineering Center at Uniguaçu College, in São Miguel do Iguaçu-PR. The fruits used in the experiment came from vernalized seedlings produced at Dmary Morangos farm, located in Linha Bellon, in the municipality of Serranópolis do Iguaçu/PR. The experimental design used was completely randomized, with two strawberry cultivars (Pircinque and VR10), with 10 repetitions and 5 fruits per repetition for each cultivar, resulting in 100 sampled fruits.

The strawberries were grown and managed in a a protected greenhouse-type environment from August 2022. The greenhouse had open sides, a wooden structure, and a translucent polyethylene plastic cover of 150 microns (Figure 1), located at the geographic coordinates of latitude 25° 33' 28" S, longitude 54° 26' 15" W, and an altitude of 420 meters. The seedlings were approximately 2 years old, cultivated on white mulch, in the soil, using the traditional planting method with spacing of 30-40 cm between plants and 1-1.2 meters between rows. Near the greenhouse, there were two water tanks, one of which was used for fertigation.

FIGURE 1 - Partial view of the strawberry cultivation area, showing the growing environment and the two water tanks, one of which is used for fertigation.

The strawberries were manually harvested, prioritizing ripe fruits of regular sizes, in the morning on August 20, 2022. Within 24 h after harvesting, the strawberries were sent to the Uniguaçu College Laboratory for subsequent analysis. The fruits were selected based on the red coloration of their surface, with those having 70-80% red coloration being chosen. Next, the strawberries were crushed using a blender and a fine mesh stainless steel sieve with a mesh size of about ⅙ to ⅛ inches, separating the pulp from the juice for future analyses (Figure 2).

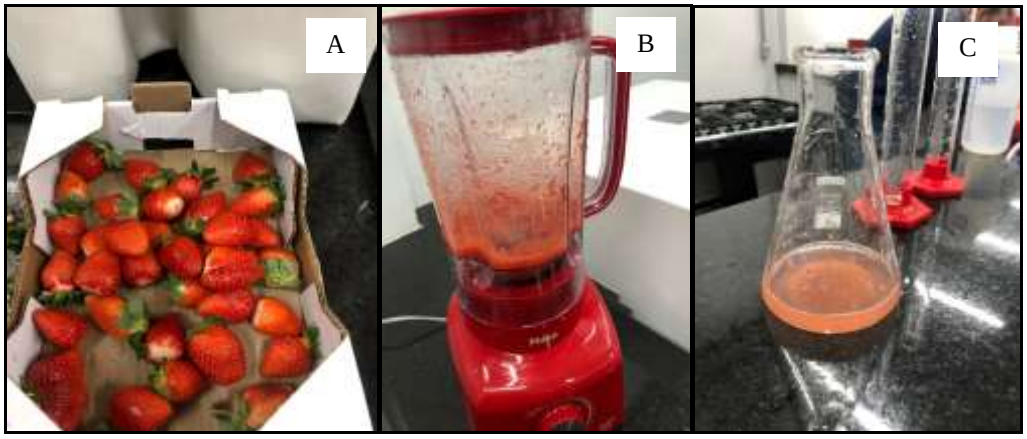

FIGURE 2 - Collection (A), fruit crushing (B), and separation of the liquid part (C) for determining the chemical analyses.

After crushing the fruits, analyses of soluble solids (SS), titratable acidity (TA), and pH were conducted using a refractometer to measure the concentration of sugars and other dissolved solids in the sample. An acid-base titration was then performed to specify the amount of acid present in the solution, and a portable digital pH meter was used to measure the pH values. The SS/TA ratio was calculated to obtain the ratio (GOMES et al., 2023). The SS were expressed in °Brix.

Next, a sensory analysis was conducted with 20 invited, untrained tasters of both genders and without a minimum age requirement, consisting of students and staff from the institution. After tasting, the participants assigned scores to attributes such as color, flavor, and texture of the strawberries (Table 1), using a questionnaire-based hedonic scale ranging from 1 to 10.

The collected data were tabulated in an Excel spreadsheet and subjected to normality tests ($p \leq 0.05$). Subsequently, they were analyzed using variance analysis with the F test at a 5% probability of error, using the statistical software SISVAR (FERREIRA, 2019).

TABELA 1 - Attributes, definitions, and characteristics of the strawberries used in the sensory analysis.

Attribute	Definitions	Characteristics
	Coloration	
Coloration	Red color on the external surface of the fruit	Light red or dark red
Uniformity of Color	Absence of spots	Uniform: without spots; Non-uniform: spotted
Shine	Shiny appearance on the external surface of the fruit	Absent: wilted; Present: freshly harvested
Defects	Presence of deformities in the fruit	Light: deformities and scars; Severe: bruises, rot, squashed
	Flavor	
Sweet taste	Sensation associated with the presence of sucrose	Absent: water; Present: sucrose solution
Acid taste	Sensation associated with the presence of acids	Absent: water; Present: citric acid
	Texture	
Softness	Force needed to crush samples between molars	Absent: candy Present: Gift: preserved pitted olives
Juiciness	Amount of liquid released by the sample when chewed	Absent: banana; Present: orange

Source: Adapted from Carpenedo et al. (2016).

RESULTS AND DISCUSSION

For the chemical characteristics of the two strawberry cultivars, it was observed that SS, pH, and the ratio showed significant differences at a 5% probability level, with Pircinque being superior (Table 2). Titratable acidity did not show significant differences, meaning both cultivars responded similarly to this variable.

Cecatto and Lenz (2022), in their analysis of strawberry fruit coating, obtained divergent results, stating that fruits coated with cassava starch had a higher sugar content by the end of the experiment. According to Farnezi et al. (2020), strawberry cultivars often show significant differences in SS content, which represents the concentration of soluble sugars in the fruits. This variation can be influenced by various factors, such as climate, soil type, cultivation practices, and even plant genetics.

TABLE 2 - Soluble Solids (SS), pH, Titratable Acidity (TA) and Ratio of two strawberry cultivars.

Strawberry Cultivars	SS (ºBrix)	pH	TA (% Citric Acid)	Ratio
Pircinque	6.00 a*	3.58 a	0.69 a	8.97 a
VR10	3.50 b	3.40 b	0.72 a	4.89 b
CV(%)	0.01	0.50	14.15	22.38

*Means in the column followed by the same letter do not differ from each other by the F test at a 5% probability level.

In the determination of pH, the Pircinque cultivar exhibited higher acidity compared to VR10. Fruits with more acidic pH (<3.5) are intended for processing (FARNEZI et al., 2020), confirming that those from the VR10 cultivar may be suitable for this purpose. Regarding the Ratio, it can be stated that the Pircinque cultivar demonstrated better performance, almost twice as high as that of VR10. According to Pacheco et al. (2014), the Ratio is an important characteristic for citrus varieties as it helps determine the fruit's maturity stage.

Cultivating in a protected environment allows for optimized management of the crop, potentially altering its source/sink relationship. The improved distribution of sunlight in the crop canopy ensures a proper balance between the vegetative and reproductive parts of the plant, reducing the impact of climatic variations on the growing space. This can influence both the productivity and quality of the fruits (ECHER et al., 2020). However, both cultivars were grown and managed under the same conditions, where the management and cultivation conditions did not alter the fruit acidity, indicating that the observed results stem from the plants' genetics.

After the fruit harvest, in addition to the chemical analysis of the strawberry cultivars, a sensory evaluation was conducted with 20 untrained judges of both genders. They rated attributes such as appearance (color, uniformity, shine, and defects), flavor (sweet and acidic taste), and texture (softness and juiciness).

Figure 3A shows similar results for the two cultivars regarding the color attribute, with ratings ranging from 0 to 10 (where 0 represents light red and 10 represents dark red), based on the external coloration of the strawberries. This similarity occurred because the fruits from both cultivars were harvested when they exhibited 80% red coloration on their surface.

The coloration of the fruit is crucial for harvesting and consumption, as consumers are attracted to products with excellent characteristics, with visual appeal being the most important, followed by attractive attributes such as color and flavor (PRATES; ASCHERI, 2011; COUTINHO et al., 2020). The Pircinque cultivar was preferred by 80% of the tasters, with ratings between 5 and 10 on the scale, while 75% of the tasters preferred VR10, with a rating of 10, indicating that the fruits of the latter had more appealing characteristics (Figure 3A). For assessing fruit uniformity, the judges were required to consider the presence or absence of spots.

According to Figure 3B, it is evident that judges should undergo training before sensory analysis, as stated by Oliveira et al. (2022). The VR10 cultivar exhibited 60% presence of spots, while the Pircinque cultivar, despite appearing in perfect condition, showed 75% deformities. Fruit uniformity is essential to reduce the number of losses in a given batch, as the presence of spots or any other deformities can indicate the entry of pathogens that might affect the post-harvest shelf life of the fruit (DALASTRA et al., 2018; COUTINHO et al., 2020). For uniformity, it can be concluded that the VR10 cultivar exhibited 60% of the fruits with spots.

Although the Pircinque cultivar also showed defects with 75% of deformities, the judges did not recognize these issues, indicating that they should undergo prior training. According to Lara et al. (2021), training individuals for sensory analysis plays a crucial role in various industries, such as food, beverages, cosmetics, and pharmaceuticals. This practice is vital as it allows for the objective assessment of the organoleptic characteristics of products, such as flavor, aroma, texture, and appearance.

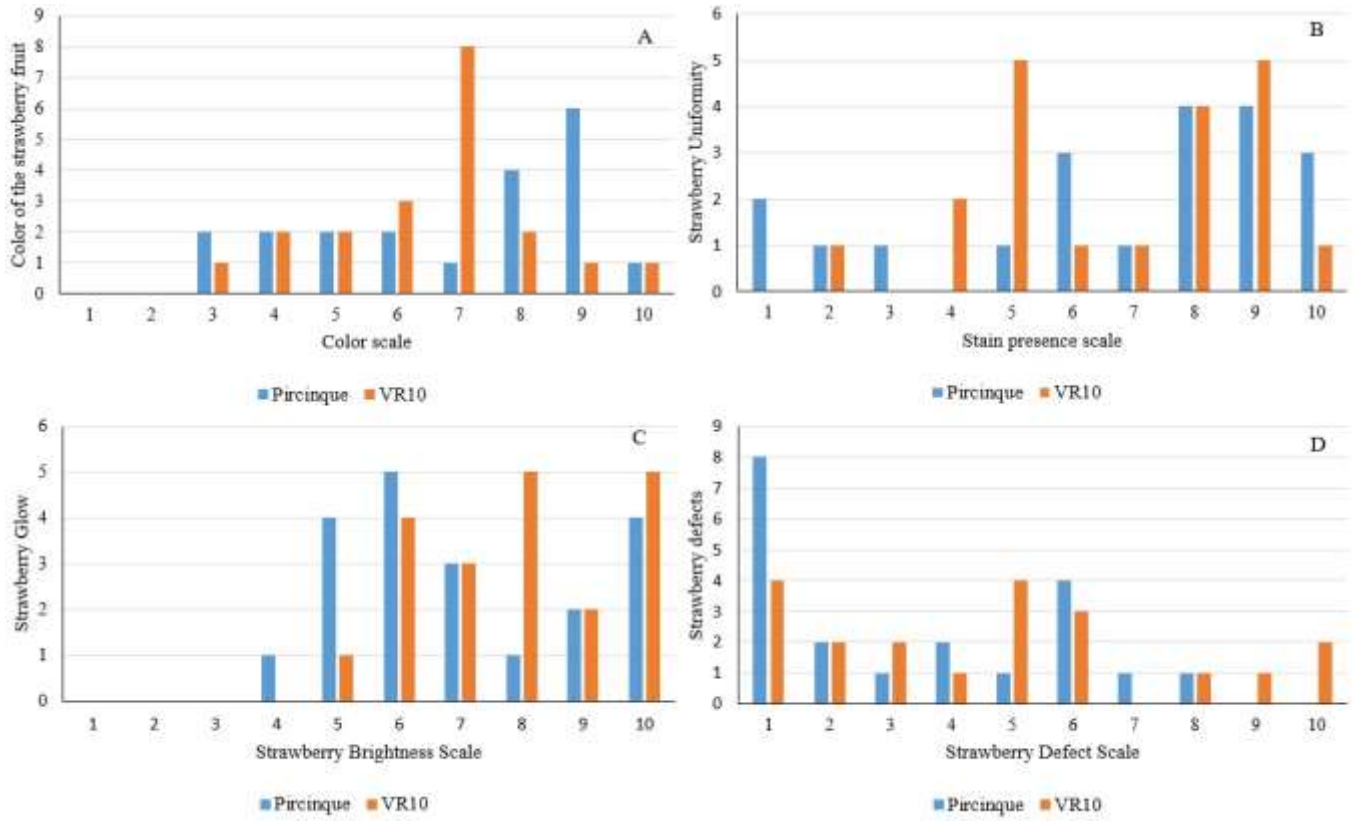

FIGURE 3 - Attributes assessed in strawberry cultivars (Pircinque and VR10) by 20 judges, based on sensory analysis: color (A), uniformity (B), shine (C), and defects (D) in the fruits.

Regarding the shine of the fruits, some judges did not notice the presence of shine in either cultivar, as shown in Figure 3C. However, analyzing the responses of the others, it can be affirmed that Pircinque presented shinier fruits. Shine is related to the structural integrity of the fruit, which can be enhanced by edible coatings, making products more attractive to consumers (KOGUTA et al., 2024). Although there was minimal difference between the two cultivars, this indicates that both were harvested at the right time, maintaining their integrity over time, as both chemical and sensory analyses were conducted on the same day.

Regarding defects in the fruits, the judges considered the presence of scars, rot, bruised, and damaged fruits, where the highest scores were related to the number of defects found in each cultivar. Analyzing Figure 3D, it is evident that the cultivar with the highest number of defects was Pircinque, aligning with results obtained by Santos et al. (2021). Their study aimed to evaluate the productive and qualitative performance of 12 strawberry genotypes, including different cultivars and selections. The Pircinque cultivar stood out for its high sugar content, showing a value 24% higher than the overall average of other cultivars, though it was lacking in physical parameters. Additionally, the Jonica and FRF 85,04 cultivars achieved better qualitative results in physical parameters, aligning with commercial standards.

When evaluating the flavor (sweetness) of the fruits, the judges assessed the presence of sugar or water in the strawberries. Figure 4A shows that the cultivar with the highest sugar content, according to the judges, was Pircinque. According to Pereira et al. (2021), the attribute of flavor (sweetness) is one of the characteristics for which the cultivar is well known.

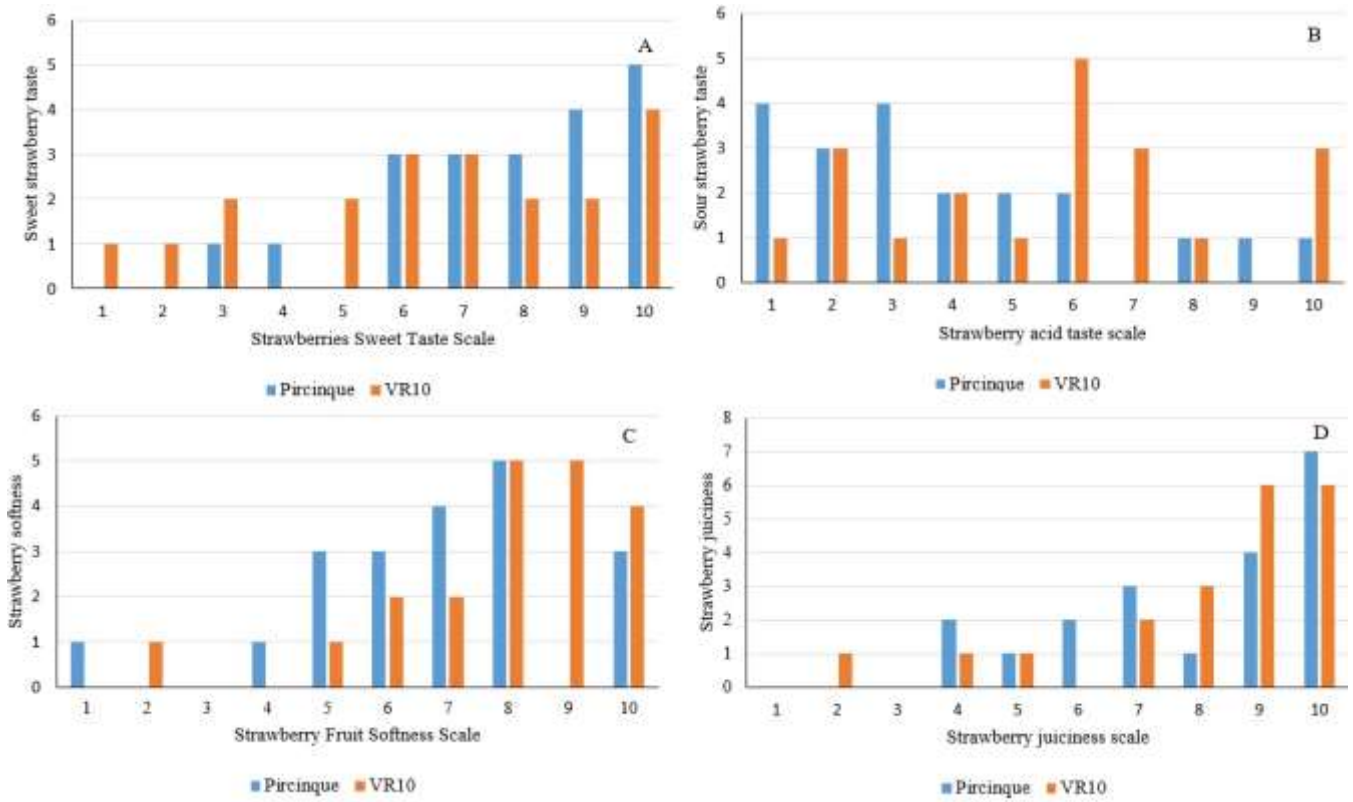

FIGURE 4 - attributes evaluated in strawberry cultivars (Pircinque and VR10) by 20 judges based on sensory analysis: sweetness (A), acidic taste (B), softness (C), and juiciness (D).

The sensory analysis revealed that the VR10 cultivar exhibited a distinct acidic taste (Figure 4B). Organic acids present in strawberries, in balance with sugar levels, are an important quality attribute. According to Nassur et al. (2016), acids are volatile and contribute to the perception of aroma, which is a key fruit quality characteristic. Acidity directly influences the flavor of fresh fruits and derived products, with cultivars suitable for each eating habit in society, being more or less sweet or acidic depending on the cultivation region (SILVA et al., 2020).

For evaluating fruit softness, the judges considered the amount of force applied during the chewing of the strawberries. According to Figure 4C, the VR10 cultivar was preferred by 95% of the respondents, who described it as very soft. According to Capellesso et al. (2022), working with planting density and chilling hours, it was stated that the VR10 cultivar presents, in addition to high productivity, resilience to fruit rot, a significant feature for this fruit. This highlights its important role in the agro-industry, especially for pulp production.

According to Figure 4D, although the VR10 cultivar demonstrated greater softness, followed by Pircinque (with 90% of the judges' preference), it is also the cultivar that exhibits more juiciness. Juiciness is considered a physical attribute of fresh fruits and is inversely proportional to texture, that is, the firmer the fruit, the less juicy it will be, resulting in a longer post-harvest shelf life (COUTINHO et al., 2020).

This study highlights the need for further research across different seasons, cultivars, and cultivation practices, as strawberry cultivation represents a significant investment for establishment and management, which can influence fruit quality.

CONCLUSIONS

Based on the chemical and sensory analyses carried out, the Pircinque strawberry cultivar stood out when compared to the VR10 cultivar, within the parameters and criteria evaluated.

Standing out in all the parameters analyzed, the Pircinque cultivar is the best option when compared to the VR10 variety in terms of taste and quality.

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