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CULTIVARES DE PÊSSEGO DE CLIMA TEMPERADO – CAMPO DAS VERTENTES – MG[1]

Karoline Aparecida da Cruz Arruda
Gilson Gustavo Lucinda Machado[2]
Rejiane Avelar Bastos Silva
Gilma Auxiliadora Santos Gonçalves

RESUMO

O objetivo desta pesquisa foi avaliar seis cultivares de pessegueiro produzidas nos Campo das Vertentes, quanto aos compostos físicos, físico-químicos e bioativos. Foram avaliadas as cultivares Aurora, Top Bilt, Fascínio, "PS", Campari e Maciel. As análises realizadas foram: cor, pH, acidez titulável, sólidos solúveis (SS), firmeza, carotenoides, compostos fenólicos totais, antocianinas e vitamina C. Os resultados indicaram que houve diferença significativa entre todas as cultivares de pêssego em todos os parâmetros avaliados. Quanto à coloração, as cultivares mais claras foram Maciel e PS. Todas as amostras apresentaram valores de a* e b* indicando uma cor amarela avermelhada. O pH oscilou entre 3,68 e 4,72, enquanto a acidez titulável ficou entre 0,38% e 2,26%, sendo a cultivar Campari a mais ácida e Aurora a menos ácida. O SS das cultivares ficou entre 5,33% (PS) e 12,66% (Aurora). A cultivar mais firme foi a Top Bilt. O teor de Compostos Fenólicos não diferiu entre as cultivares, com média de 2,79 mg/100 g. Quanto às antocianinas, Aurora e Fascínio obtiveram os maiores teores (média de 12,82 mg/100 g). A cultivar Maciel apresentou o maior teor de vitamina C (29,35 mg/100 g). Concluiu-se que a cultivar Top Bilt apresentou coloração mais amarelada e firme, Fascínio obteve maior pH, Campari maior acidez, Aurora maior teor de SS. Quanto aos compostos bioativos, a cultivar Maciel se destaca por possuir maior teor de carotenoides e vitamina C.

Palavras-chave: *Prunus persica L. Batsh***,** Compostos bioativos, coloração, cultivares, análises físico-químicas.

TEMPERATE CLIMATE PEACH CULTIVARS - CAMPO OF VERTENTES – MG

ABSTRAC

The objective of this research was to evaluate six peach cultivars produced in Campo das Vertentes in terms of physical, physical-chemical and bioactive compounds. The cultivars

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[2] **Corresponding author**: Gilson Gustavo Machado, e-mail: gilsonguluma@gmail.com.

Aurora, Top Bilt, Fascínio, PS, Campari and Maciel were evaluated. The analyzes performed were color, pH, titratable acidity, soluble solids (SS), firmness, carotenoids, total phenolic compounds, anthocyanins and vitamin C. The results indicated that there was a significant difference among all peach cultivars in all evaluated parameters. Regarding the coloration, the lightest cultivars were Maciel and PS. All samples had a* and b* values indicating a reddish yellow color. The pH fluctuated between 3.68 and 4.72, whereas the titratable acidity was between 0.38% and 2.26%, with the Campari cultivar being the most acidic and Aurora the least acidic. The SS of the cultivars was between 5.33% (PS) and 12.66% (Aurora). The firmest cultivar was Top Bilt. The content of Phenolic Compounds did not differ among cultivars, with an average of 2.79 mg/100 g. As for anthocyanins, Aurora and Fascínio obtained highest levels (average of 12.82 mg/100 g). The Maciel cultivar had the highest vitamin C content (29.35 mg/100 g). It was concluded that the Top Bilt cultivar had a more yellowish and firmer color, Fascínio obtained a higher pH, Campari had higher acidity, Aurora had a higher SS content. As for bioactive compounds, the Maciel cultivar is stands out for having a higher content of carotenoids and vitamin C.

Keywords: *Prunus persica L. Batsh*, Bioactive compounds, coloration, cultivars, physicochemical analysis.

1 INTRODUCTION

The peach (*Prunus persica* L.) is highly appreciated worldwide due to its delicious flavor, juicy pulp, characteristic aroma and, attractive appearance, in addition to its high nutritional value thanks to its compounds such as pectin, phenolic compounds and vitamin C (ASSUMPÇÃO *et al*., 2015; WILLIAMSON *et al*., 2018). In general, fruits such as peaches have received greater attention due to greater awareness of health and the search for healthier lifestyles.

Fruits with high external quality, related to their shape, color and size, are usually preferred by consumers. The internal quality, such as texture, sugars, organic acids and content of nutritional compounds, is significantly correlated with the taste and aroma of fruits (ZEBALLOS *et al*., 2015).

These attributes have resulted in increased peach consumption both in fresh and processed form, consequently arousing growing interest in its commercial cultivation.

Brazilian peach production was 219.6 thousand tons in 2018, and Minas Gerais produced 7.8 thousand tons. The state of Minas Gerais occupied the fifth place among the main producing states, with a 3.6% share of the national volume and Barbacena, the largest producer in Minas Gerais. The area used for cultivation in the state is 585 hectares, the productivity of the peach planted in Minas is 13.410 kg/ha, which is 7.5% higher than the average Brazilian yield (Instituto Brasileiro de Geografia e Estatística (IBGE) (2018). Data indicate the high market potential for

peaches in Brazil, since according to Souza *et al*. (2013), domestic production is insufficient to meet this demand, justifying the search for increased production of peaches in subtropical and tropical regions, characteristic of the Campo das Vertentes in Minas Gerais.

Although the peach tree is a temperate climate crop, some cultivars have adapted well to the tropical climate, requiring less cold, allowing to offer high quality fresh fruits in periods of low production in the south of the country, allowing good marketing prices (SOUZA *et al*., 2013). Temperate climate fruit can be satisfactorily produced in the Southeast region of Brazil due to its high altitude (WAGNER JÚNIOR *et al*., 2011).

In this sense, several peach cultivars have been produced in the region of Campo das Vertentes/MG, however studies are lack regarding physical and physico-chemical characterization and bioactive compounds in order to identify those that best suit the consumer requirements for the fresh fruit. Although some studies have been dedicated to peach cultivars in tropical regions (MATIAS *et al*., 2014;CREMASCO *et al*., 2016; SILVA *et al*., 2016; CURI *et al*., 2017;), none have characterized fruits of the Barbacena region, in Campo das Vertentes or evaluated the phenolic and anthocyanin compounds of these fruits.

Considering the lack of studies and that the composition of the fruits can vary depending on factors such as the species, stage of ripeness, the place and conditions of cultivation and climate, the present study aimed to evaluate different peach cultivars produced in Campo das Vertentes/MG, regarding their physical, physical-chemical and bioactive compounds.

2 MATERIAL AND METHODS

The experiment was developed at the Federal Institute of Education, Science and Technology, Campus Barbacena/MG, in the food physical-chemical analysis laboratory.

Campari, Fascínio, Aurora, Maciel, 'PS' and Top Bilt peach cultivars produced and donated by the Mantiqueira Rural Community Association of Palmital de Barbacena were used. A region characterized by the tropical climate of the Cwb ocean type with cold winters and mild summers. The average annual temperature is 18 °C with an annual rainfall above 1400 mm concentrated in the spring and summer months. The approximate amount of sunshine is 1800 hours per year.

Fruits at a fresh commercialization standard, that is, those that are already ripe and slightly soft, were selected and cleaned for the following analyzes, in 3 repetitions:

2.1 ANALYZES

2.1.1 Coloration: the external coloration of the pseudofruits was determined using a konica Minolta CR400 colorimeter, using the previously calibrated L*, a* and b* color system (CIELAB).

2.1.2 Firmness: determined using a TA.XT texturometer (Stable Micro Systems). Test conditions: P/2 N aluminum cylindrical probe sensor test speed 5.0 mm/s, distance 20.0 mm and force 5.0 g (PONS; FISZMAN, 1996).

2.1.3 pH: a TEKNA T-1000 pH-meter was used according to the methodology proposed by Instituto Adolfo Lutz (IAL, 2008). The pH meter was previously calibrated using buffer solutions (pH 4.0 and 7.0).

2.1.4 Titratable acidity: determined by titration with standardized 0.1 N sodium hydroxide solution, using phenolphthalein as an indicator and according to the methodology proposed by the Analytical Standards of (IAL, 2008). Results were expressed in g of malic acid per 100 g of sample.

2.1.5 Soluble solids (SS g/100 g): determined by refractometry using an IONLAB bench top refractometer (Evem).

2.1.6 Total phenolic compounds: extracts were obtained as described by Brand-Williams, Cuvelier and Berset (1995) and adapted by Rufino *et al*. (2007). The determination was made as described by Waterhouse (2002). Gallic acid was used as the reference standard and the results were expressed in milligrams of gallic acid equivalents (mg GAE) per 100 g of fresh sample.

2.1.7 Anthocyanins: extracted with acidified methanol and quantified following the differential pH method, proposed by Giusti and Wrolstad (2001). The result was calculated using equation:

$$A = (A510\ nm - A700\ nm)\ pH = 1.0 - (A510\ nm - A700\ nm)\ pH = 4.5 \quad (1)$$

The content of monomeric anthocyanins (AM) was calculated as cyanidin-3-glycoside (PM = 449.2) using equation:

$$AM\ (mg/100\ mL) = A \times PM \times \text{fator de diluição} \times \varepsilon\ (22900) \times 1 \quad (2)$$

Where: A = Absorbance and ε = Molar Absorptivity

2.1.8 Total carotenoids: Carotenoid extraction and determination was performed as described by Rodriguez-Amaya (1999). Results were expressed in mg/100 g.

2.1.9 Vitamin C: determined by the Balentine method, which is based on the oxidation of ascorbic acid by potassium iodate (TAVARES *et al*., 1999). Results were expressed in mg/100 g.

The data obtained were subjected to analysis of variance (ANOVA) and the means compared by the Tukey test at 5% significance in the Sisvar 5.9 program (FERREIRA, 2019).

3 RESULTS AND DISCUSSION

The physical and physical-chemical characteristics and bioactive compounds of the evaluated peach cultivars are shown in Table 1.

Table 1 - Physical and physical-chemical characterization and bioactive compounds of the evaluated peach cultivars

	CULTIVARS					
ANALYSIS	Aurora	Campari	Fascínio	Maciel	'PS'	Top Bilt
Cor - L*	53.67^{b}	56.53^{ab}	57.04^{ab}	51.01^{b}	65.45^{a}	57.58^{ab}
a*	23.92^{a}	15.21^{a}	18.56^{a}	19.49^{a}	-1.57^{b}	16.67^{a}
b*	33.05^{a}	26.11^{abc}	25.31^{bc}	20.48^{c}	32.09^{ab}	33.34^{a}
Firmness (N)	6.00^{b}	6.77^{b}	9.67^{b}	6.07^{b}	12.46^{b}	28.43^{a}
pH	3.68^{b}	4.37^{a}	4.72^{a}	4.51^{a}	3.85^{b}	3.74^{b}
TA (g/100 g)	0.38^{e}	2.26^{a}	0.55^{dc}	0.68^{c}	0.85^{b}	0.51^{ed}
SS (g/100 g)	12.67^{a}	6.00^{b}	5.67^{c}	6.00^{b}	5.34^{c}	10.34^{a}
Total phenolics (mg GAE/100 g)			2.79**			
Anthocyanins (mg/100 g)	11.62^{a}	0.49^{b}	12.82^{a}	0.00^{b}	0.00^{b}	0.38^{b}
Carotenoids (mg/100 g)	0.03^{b}	0.01^{b}	0.00^{b}	0.54^{a}	0.02^{b}	0.12^{b}
Vitamin C (mg/100 g)	4.79^{c}	3.78^{dc}	4.83^{c}	29.35^{a}	1.60^{d}	9.26^{b}

* Means followed by different letters, on the line, are statistically different by the Tukey test ($p < 0.05$)**No significant ($p>0,05$)

Source: Authors (2022).

Color is one of the most important attributes of sensory quality of fresh fruits, and it can influence consumer choice and preferences, characterize maturity, as well as correlate with other quality attributes, such as sugar and acid content and flavor (PATHARE; OPARA; AL-SAID, 2013). In the evaluation of the color of the studied peaches, there was a significant difference among the samples regarding the color parameters L*, a* and b*. The L* values ranged from 51.01 to 65.54 and the cultivar 'PS' was considered lighter, while Maciel and Aurora were the darkest. These results are similar to those observed for different peach cultivars in the study by Curi *et al*. (2017), who found L* values between 56.58 and 67.40.

The values found for parameter b* were from 20.48 to 33.34. All cultivars analyzed showed color in the yellow region, however the cultivar Maciel showed a b* value significantly lower ($p > 0.05$) than the other cultivars analyzed.

As for the variable a*, the values found ranged from -1.57 to 23.92 and cultivar 'PS' showed color in the green region while the others showed color in the red region.

In relation to the coloration of the epidermis of the fruits evaluated in terms of parameters a* and b*, it can be inferred that the coloration of most fruits was classified as yellow/reddish, the preferred color for most consumers (70%) of peach, according to a study performed by Trevisan *et al.* (2010), when assessing the profile and preference of fresh peach consumers in three cities in Rio Grande do Sul-Brazil.

The cultivars analyzed showed firmness values between 6.0 and 28.43 N and the cultivar Top Bilt showed firmness statistically superior ($p > 0.05$) to the others. Higher firmness in the fruits is an important attribute in the post-harvest, as according to Wagner Júnior *et al.* (2011), it is related to higher resistance to transport and shelf life of fruits. In addition, firmness as a texture characteristic indicates the degree of resistance of plant tissues to compression; being considered as one of the main attributes of quality and in conjunction with other parameters is used to assess the useful life of vegetables (CHITARRA; CHITARRA, 2005). After harvesting, the calcium content linked to pectins plays an important role in maintaining the firmness of fruit pulp, such as that of peach, which decreases with advancing maturation (CREMASCO *et al*., 2016). Much firmer fruits were identified by Azevedo *et al*. (2016), Morais *et al.* (2017) and Silva *et al.* (2016), when evaluating physical and chemical characteristics of fruits of peach cultivars from the experimental orchard at Universidade Federal de Viçosa/MG, Brazil. However, consumers tend to prefer softer peaches as identified by Trevisan *et al.* (2010).

The pH is one of the intrinsic factors related to the development of microorganisms, enzymatic activity, taste and odor retention and the general conservation of the peach, regardless of the cultivar. The cultivars Campari, Fascínio and Maciel did not differ statistically from each other in relation to pH (average of 4.53), and showed to be statistically superior to the cultivars Aurora, 'PS' and Top Bilt, which had an average pH of 3.75. In general, the cultivars studied present low acid pH values. This characteristic is desirable, as the low pH would indicate that the fruit is not ripe enough, negatively influencing consumer acceptance. The results of this study are similar to those found by Curi *et al.* (2017), when evaluating peach cultivars from tropical regions.

As for the titratable acidity, the cultivar Aurora, presented lower acidity (0.38 g/100 g), differing statistically from the others. It is worth noting that less acidic fruit is interesting, as both the wholesale market and the final consumer tend to prefer this characteristic in fruits. Additionally, the lower acidity guides the harvest point and favors a more pleasant flavor. The study by Barreto *et al.* (2019), identified the titratable acidity of the BRS Kampai peach of 0.37 g/100 g after harvest, a value close to that of the Aurora cultivar, evaluated in this study. Generally higher acidity levels than those obtained in fruits from the region of Campo das Vertentes - MG were found in peaches from Viçosa - MG (MATIAS *et al.*, 2014; AZEVEDO *et al*., 2016; CURI *et al*., 2017).

Regarding soluble solids (Table 1), the Top Bilt and Aurora samples showed the highest values (average of 11.5%), consequently it can be inferred that they are the sweetest cultivars and would probably be more accepted, considering that studies indicate consumer preference. for sweeter fruits (KELLEY *et al*., 2015; OLMSTEAD; GILBERT; COLQUHOUN, 2015), requiring a sugar content above 10 °Brix as a minimum quality standard for ripe peaches (CRISOSTO; CRISOSTO, 2005), identified in these cultivars.

Similar soluble solids content was found by Barreto *et al*. (2019), for the cultivar BRS Kampai (average of 12.3 g/100 g). In studies by Curi *et al.* (2017), the value of 9.86 g/100 g for this parameter was found for the cultivar Top Bilt.

Phenolic compounds, chemical structures that express hydroxyls and aromatic rings, in simple or polymer forms, confer antioxidant power; they can be natural or synthetic (ANGELO; JORGE, 2007). The content of these compounds in the peach cultivars (Table 1) did not differ statistically, presenting an average of 2.79 mg GAE/100 g, lower than that found in the cultivar BRS Kampai (95.64 mg/100 g) and also those identified for the cultivars Santa Áurea (49.01 mg/ 100 g), Esmeralda (52.40 mg/100 g) and Maciel (64.25 mg/100 g) from the region of Pelotas/RS, Brazil (MACHADO; MACHADO; ZAMBIAZI, 2020). However, in this case, the result was expressed in mg of chlorogenic acid while the results of the present study are expressed in mg of gallic acid. As observed in this work, divergences in results in the total content of phenolic compounds are frequent among cultivars, different crops and different cultivation places.

Although there is no recommended content for the consumption of total phenolic compounds, foods that are rich in these compounds, such as vegetables and fruits as well as peach, have aroused progressive interest among the scientific community, consumers and health

professionals due to scientific evidence that these compounds are beneficial to health (SANTOS *et al*., 2017).

Anthocyanins as well as phenolic compounds are able to add value to the food quality of vegetables and processed foods, which can contain these pigments naturally or added in the form of natural dyes, as they have a high antioxidant capacity. Therefore, the need to evaluate new sources of anthocyanins, as well as techniques to quantify them in order to know their content and enable their use as a source of bioactive compounds, becomes evident (TEIXEIRA; STRINGHETA; OLIVEIRA, 2008).

In this study, the cultivars Aurora and Fascínio presented higher levels of anthocyanins (11.62 and 12.82 mg/100 g respectively) (Table 1), and these samples did not differ statistically. However, in studies carried out with other cultivars by Segantini *et al*. (2012), the values found were much lower for the cultivar Aurora (92.17 μg/100 g) and Chiripá (296.38 μg/100 g). The results for the cultivars Aurora and Fascínio produced in Campo das Vertentes - MG, were also superior to those found for Santa Áurea (4.19 mg/100 g), Esmeralda (6.75 mg/100 g) and Maciel (2.46 mg/100 g) from the region of Pelotas/RS, Brazil (MACHADO; MACHADO; ZAMBIAZI, 2020).

In addition to anthocyanins, another important bioactive compound to be studied are the carotenoids, which are groups of natural pigments that are present in fruits and vegetables and are responsible for the predominantly yellow and orange colors. The cultivar Maciel showed the highest carotenoids content (0.54 mg/100 g), whereas Segantini *et al.* (2012), found 0.0286 mg/100 g for the cultivar Aurora, a content similar to that found in this study for the same cultivar (0.03 mg/100 g). Studies with other peach cultivars from Minas Gerais found varying levels of total carotenoids such as those found by Matias *et al.* (2014) (0.33 to 1.40 mg/100 g); Morais *et al*. (2017) (0.13 to 0.89 mg/100 g), Silva *et al*. (2016) (0.06 to 0.46 mg/100 g) and by Azevedo *et al.* (2016) (0.68 to 1.4 mg/100 g).

According to Silva *et al.* (2014), carotenoid content of fruits and vegetables is influenced by several factors such as: the degree of ripeness, the type of soil and the cultivation conditions, the climatic conditions, the variety, the part of the plant consumed, the effect of pesticides, exposure to sunlight, processing conditions and storage.

Vitamin C (Table 1), by absorbing free radicals and inhibiting the chain of initiation or interrupting the chain of propagation of oxidative reactions promoted by radicals, acts as an important natural antioxidant (VIDAL; FREITAS, 2015). For vitamin C, the cultivars showed

quite varied levels, however the cultivar Maciel was that with the highest concentration (29.35 mg/100 g), much higher than that found by Cremasco *et al.* (2016) for the same cultivar produced in Viçosa, which was 14.1 mg/100 g. The other cultivars showed concentrations similar to those of other studies with different cultivars (MATIAS *et al*., 2014; AZEVEDO *et al*., 2016; SILVA *et al*., 2016 MORAIS *et al*., 2017).

These variations are due to several factors, such as the difference in cultivars; conditions of climate, soil, crop treatments and harvest time, among others. In addition, the methodology for carrying out the analyzes can also influence the results.

4 CONCLUSION

Although the fruits showed different characteristics according to each cultivar, the cultivar Top Bilt showed a more yellowish and firmer color, Fascínio has a higher pH, Campari has higher acidity, Aurora has a higher soluble solids content. As for the bioactive compounds, the cultivar Maciel is highlighted for having a higher content of carotenoids and vitamin C. These results can help the producer to select the cultivar that best meets their expectations or the target market, whether fresh consumption or processing.

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AUTHOR INFORMATION:

Nome: Karoline Aparecida da Cruz Arruda
E-mail: karolinearruda0028@gmail.com
Curriculum Lattes: http://lattes.cnpq.br/3750780063153651
Mestranda em Ciência e Tecnologia de Alimentos pela Universidade Federal de Viçosa, graduação em Tecnologia de Alimentos pelo Instituto Federal de Educação, Ciência e Tecnologia do Sudeste de Minas Gerais – Campus Barbacena.

Nome: Gilson Gustavo Lucinda Machado
E-mail: gilsonguluma@gmail.com
Curriculum Lattes: http://lattes.cnpq.br/9166646554125226
Doutorando e mestrado em Ciência dos Alimentos pela Universidade Federal de Lavras, especialização *lato sensu* em Biologia Molecular e Toxicologia Alimentar pela Faculdade Unyleya e, graduação em Tecnologia de Alimentos pelo Instituto Federal de Educação, Ciência e Tecnologia do Sudeste de Minas Gerais – Campus Barbacena.

Nome: Rejiane Avelar Bastos Silva
E-mail: rejiane.bastos@ifsudestemg.edu.br
Currículo Lattes: http://lattes.cnpq.br/9841870715433224
Doutorado e mestrado pela Universidade Federal de Lavras, graduação complementar em matemática, graduada e Tecnologia de Alimentos. Atualmente é docente no Instituto Federal de Educação, Ciência e Tecnologia do Sudeste de Minas Gerais - Campus Barbacena

Nome: Gilma Auxiliadora Santos Gonçalves
E-mail: gilma.goncalves@ifsudestemg.edu.br
Curriculum Lattes: http://lattes.cnpq.br/5452118132335809
Doutorado e mestrado em Ciência dos Alimentos pela Universidade Federal de Lavras e, graduação em Economia Doméstica pela Universidade Federal Rural do Rio de Janeiro. Atualmente é docente no Instituto Federal de Educação, Ciência e Tecnologia do Sudeste de Minas Gerais - Campus Barbacena. Tem experiência na área de Ciência e Tecnologia de Alimentos, com ênfase em Processamento de Frutas e Hortaliças.