

SELECTION OF PEACH GENOTYPES FOR BIOCHEMICAL FRUIT QUALITY CHARACTERIZATION¹

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ABSTRACT - Peach is much appreciated by consumers and its popularity is mainly related with organoleptic characteristics. However, with emergence of concepts of functional foods (health promoters), there is high interest to study and to quantify the biochemical components of fruits. The aim of this work was to perform the biochemical characterization of peach genotypes, evaluating the genetic diversity and selecting those with desirable biochemical qualities for use as parents in future breeding programs. The experiment was carried out at the Laboratory of Plant Physiology - UTFPR - *Campus* of Dois Vizinhos, PR (Brazil), with fruits from 26 and 29 peach genotypes (*Prunus persica*) in the 2009/2010 and 2010/2011 crop years, respectively. The experimental design was entirely randomized, considering each genotype as treatment, using four replicates and four fruits per plot. Total and reducing sugars, total proteins, amino acids, total phenols, anthocyanins, flavonoids and phenylalanine ammonia-lyase enzyme activity (PAL) in fruits were evaluated. According to the results of two crop years, 'Cascata 967', 'Conserva 985', 'Kampai', 'Tropic Snow' and 'Cascata 1055' were selected as those with the highest levels of these compounds.

Index terms: biochemical compounds, genetic divergence, *Prunus persica*.

SELEÇÃO DE GENÓTIPOS DE PESSEGUEIRO QUANTO À CARACTERIZAÇÃO BIOQUÍMICA

RESUMO- O pêssego é uma fruta muito apreciada, cuja popularidade é decorrente principalmente de seu sabor agradável. Entretanto, com o surgimento dos conceitos de alimentos funcionais (com propriedades promotoras de saúde), haverá interesse maior em estudar e quantificar os componentes bioquímicos das frutas. Os objetivos deste trabalho foram caracterizar bioquimicamente frutos de genótipos de pessegueiro e selecionar aqueles que apresentarem qualidades bioquímicas desejáveis para sua futura inserção como genitores em programas de melhoramento. O experimento foi conduzido no Laboratório de Fisiologia Vegetal da UTFPR - Câmpus Dois Vizinhos, PR (Brasil), com frutos de 26 e 29 genótipos de pessegueiro (*Prunus persica*), provenientes dos ciclos produtivos de 2009/2010 e 2010/2011, respectivamente. O delineamento experimental foi o inteiramente casualizado, considerando-se cada genótipo como tratamento, utilizando-se de quatro repetições, com quatro frutos cada. Foram analisados os açúcares totais e redutores, as proteínas totais, os aminoácidos, os fenóis totais, as antocianinas, os flavonoides e a atividade da enzima fenilalanina amônia-liase (FAL) dos frutos. Os pêssegos foram caracterizados bioquimicamente, selecionando-se como superiores, na média dos dois ciclos produtivos, os genótipos 'Cascata 967', 'Conserva 985', 'Kampai', 'Tropic Snow' e 'Cascata 1055'.

Termos para indexação: compostos fitoquímicos, divergência genética, *Prunus persica*.

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INTRODUCTION

Peach is much appreciated by consumers, and its popularity stems mainly from its pleasant taste, nutritional characteristics, appearance and practicality for fresh consumption (FISHER et al., 2016), being also widely used for canning, jellies and sweets.

In the last years, peach production has presented significant growth (TOMAZ et al., 2016). According to FAO (2008) data, Brazil is the 13th largest world's peach producer.

The southern region of Brazil is responsible for more than half of the country's peach production (IBRAF, 2007), with potential for expansion, as there is a growing market for its consumption, since the population has searched for foods that in addition to nourishing, can offer compounds that provide health benefits (SANTANIN and AMAYA, 2007).

Thus, in the last few years, there has been a greater interest in studying and quantifying phenolic metabolites present in fruits and vegetables due to their health-promoting properties (GIL et al., 2002). The beneficial effects observed by the consumption of phytochemical compounds include the protection of individuals against the risks of genetic and environmental harm (ANGELIS, 2001).

Phenolic metabolites, including flavonoids, are composed of flavones, flavonols, catechins and anthocyanins, acting against free radicals, allergies, inflammations, ulcers, viruses and hepatotoxic tumors. They also protect against the oxidation of LDL-cholesterol (GERMAN and DILLARD, 2000).

Functional phenolic compounds present in fruits provide visual quality to them, making them more attractive to consumers, since they act as pigments. Another important function of these phytochemical compounds is that they are generally used by the plant in defense against diseases and pests.

As the phytochemical composition of fruits varies greatly among genotypes and are important quality attributes, it should be considered in peach breeding programs, since fruits with low sensory quality may present some desirable biochemical characteristics.

Faced with this growing productive potential and the need for fruits with additional qualities, it is necessary to identify and select genotypes with better biochemical characteristics for use as parents within

breeding programs and / or as cultivars for use in commercial orchards.

For this, genetic divergence studies are important and necessary, which would provide parameters necessary for the identification of the most favorable parents to obtain segregating populations in hybridization programs, which allows the selection of superior genotypes and, consequently, genetically improved populations (COSTA et al., 2006).

The aim of this work was to perform the biochemical characterization of peach genotypes, evaluating the genetic diversity and selecting those with desirable biochemical qualities for use as parents in breeding programs.

MATERIAL AND METHODS

The experiment was conducted at the Laboratory of Plant Physiology of the Federal Technological University of Paraná (UTFPR) - Campus of Dois Vizinhos, PR, with fruits of 26 and 29 peach genotypes (*Prunus persica*) at crop years, respectively, 2009/2010 (Libra, Tropic Beauty, Bonão, Cascata 962, Conserva 1187, Kampai, Cascata 1063, Tropic Snow, Conserva 1396, Cascata 1303, Rubimel, Conserva 985, Conserva 1153, Cascata 967, Conserva 844, Conserva 1129, Cascata 1070, Cascata 1055, Atenas, Conserva 1434, Conserva 1186, Cascata 587, Conserva 681, Conserva 871, Âambar, Santa Áurea) and 2010/2011 (Libra, Tropic Beauty, Bonão, Cascata 962, Conserva 1187, Kampai, Cascata 1063, Tropic Snow, Conserva 1396, Cascata 1303, Rubimel, Conserva 985, Conserva 1153, Cascata 967, Conserva 844, Conserva 1129, Cascata 1070, Cascata 1055, Atenas, Conserva 1434, Conserva 1186, Cascata 587, Conserva 681, Conserva 871, Âambar, Conserva 1223, Conserva 1127, Conserva 1216, Cascata 1065).

The experimental design was completely randomized, considering each genotype as treatment and using four replicates of four fruits.

Fruits with maximum development and with background coloration of the epidermis, from green to yellowish-green or white-cream (CANTILLANO; SACHS, 1984) were collected from the peach collection implanted at the UTFPR experimental area, in the City of Pato Branco, PR (26°10'39" S and 56°41'21" W, and altitude of 750 m a.s.l.). Plants of each genotype were conducted in a pot system, spaced 5 x 4 m between plants and lines, respectively.

Management practices were performed according to general recommendations for the crop.

After harvested, fruits were transported to the laboratory for biochemical analyses [total and reducing sugars, total proteins, amino acids, total phenols, phenylalanine ammonia-lyase enzyme (PAL), anthocyanins and flavonoids]. Subsequently, samples were stored in freezer at -20°C until evaluations were performed. Biochemical analyses were performed with epidermis tissues and fruit pulp.

For the quantification of total sugars, reducing sugars and proteins, samples were prepared, which were composed of approximately 1 g of each fruit. These samples were macerated in mortar along with 10 mL of 0.2 M phosphate buffer (pH 7.5) and then placed in eppendorf tubes and taken to refrigerated centrifugation at 4°C for 10 minutes at 12,000 rpm (14,700 xg), thus obtaining the extract supernatant.

The concentration of total sugars of peach tissues was determined by the phenol-sulfuric method described by Dubois et al. (1956). Samples were read at 490 nm in spectrophotometer (UV-SP2000-Spectrum). The concentration of total sugars was obtained by standard glucose curve ($100\ \mu\text{g L}^{-1}$).

For the quantification of reducing sugars of fruits, the dinitrosalicylate (DNS) method was used (MILLER, 1959). Samples were read at 540 nm in spectrophotometer model UV-SP2000-Spectrum. The concentration of reducing sugars of samples from each genotype was calculated as a function of a standard glucose curve.

For the determination of total proteins, the Bradford test (1976) was used. Reading was performed in spectrophotometer model UV-SP2000-Spectrum at 630 nm, with bovine serum albumin as standard.

The determination of total amino acids of peach genotypes was obtained by macerating samples with masses between 0.3 and 0.5 g in mortar with 5 mL of sulfosalicylic acid. Centrifugation was performed for 15 minutes at 6,000 rpm (7,350 xg) at 5°C in spectrophotometer (UV-SP2000-Spectrum). About 2 mL of supernatant extract were collected, adding 2 mL of acetic acid and 2 mL of acetic ninhydrin, leaving in a water bath for one hour at 100°C . Samples were then cooled on ice. Samples were read in spectrophotometer at 520 nm. The concentration of amino acids was estimated by a standard proline curve.

The quantification of total phenolic

compounds of fruits was carried out in two stages, according to method adapted from Bieleski and Turner (1966). The first stage was composed of the extraction of total phenols from the pulp and epidermis of fruits through the maceration of approximately 1 g of fruit in a mortar, adding 4 mL of methanol, chloroform and water solution (MCA) at the ratio of 6:2.5: 1.5 (v / v), followed by centrifugation at 6.000 rpm (7,350 xg) for 20 min, and all supernatant was collected.

Subsequently, a further extraction of the remaining residue was performed, adding 4 mL of MCA, centrifuging again at 6.000 rpm (7.350 xg) for 20 min and mixing the supernatant extract to the former, thereby obtaining the MCA extract. This extract was added of 1 mL of chloroform and 1.5 mL of distilled water, centrifuging at 6.000 rpm (7.350 xg) for 15 min to separate the phases. The second stage comprised the determination of total phenols performed by the adapted method of Jennings (1991). Quantification of phenols was performed through a standard curve using tyrosine and the result was expressed as mg total phenols.g⁻¹ of fresh tissue.

For the quantification of the phenylalanine ammonia-lyase enzyme (PAL), the methodology adapted from Rodrigues et al. (2006) was used. The PAL activity was evaluated based on the difference in absorbance resulting from the conversion of phenylalanine into trans-cinnamic acid (HYODO et al., 1978).

For the determination of the anthocyanin and flavonoid content of fruits, the methodology described by Lees and Francis (1972) was used.

Biochemical data were submitted to analysis of variance and the means were compared by the Scott & Knott test ($\alpha = 0.05$).

As a selection criterion, the selection of 20% of the evaluated genotypes was adopted, which presented the highest frequency of superiority in the evaluated characteristics in both crop years (PATERNIAN; MIRANDA FILHO, 1987). In order to calculate the frequency, genotypes were ranked in each of the 8 variables analyzed, from the 1st to the 26th or 29th (2009/2010 crop year or 2010/2011 crop year, respectively), classified by means of the variables in descending order. The ranking position of each genotype in each of the variables was summed up. With the result, genotypes were classified in ascending order. For each evaluation cycle, genotypes ranked among the top 20% were

selected.

RESULTS AND DISCUSSION

The results of analyses performed for PAL enzyme in the 2009/2010 crop year were not significant among genotypes analyzed. However, all other biochemical variables (total and reducing sugars, total proteins, amino acids, total phenols, anthocyanins and flavonoids) analyzed in this crop year were significant (Table 1). On the other hand, in the second crop year (2010/2011), all variables evaluated were significant, demonstrating, that genotypes differed in biochemical characteristics (Table 2).

The concentration of flavonoids and reducing sugars (2009/2010 crop year) and PAL enzyme activity (2010/2011 crop year) present in fruits, although being significant through the F test, indicated grouping of genotypes into a single group by the Scott & Knott test.

The contents of total sugars of fruits grouped genotypes in two groups in both crop years (Tables 1 and 2). In the 2009/2010 crop year, 12 genotypes with total sugar contents between 332.2 and 441.67 mg.g⁻¹ of tissue were grouped, namely: 'Tropic Beauty', 'Cascata 962', 'Kampai', 'Rubimel', 'Conserva 985', 'Cascata 967', 'Cascata 1055', 'Conserva 1434', 'Conserva 681', 'Conserva 871', 'Ambar' and 'Santa Áurea'. The other 14 evaluated genotypes formed the second group with contents between 208.0 and 310.2 mg.g⁻¹ of tissue, composed of the following genotypes: 'Libra', 'Bonão', 'Conserva 1187', 'Cascata 1063', 'Tropic Snow', 'Conserva 1396', 'Cascata 1303', 'Conserva 1153', 'Conserva 844', 'Conserva 1129', 'Cascata 1070', 'Atenas', 'Conserva 1186' and 'Cascata 587' (Table 1).

In the second crop year, 13 genotypes were grouped according to their higher content of total sugars (209.62 to 301.44 mg.g⁻¹), being formed by genotypes: 'Cascata 962', 'Conserva 1187', 'Conserva 1396', 'Conserva 985', 'Cascata 967', 'Conserva 844', 'Conserva 1129', 'Cascata 1070', 'Atenas', 'Conserva 1434', 'Conserva 1223', 'Conserva 1216' and 'Cascata 1065'. The other genotypes evaluated in this crop year formed the second group with their contents of total sugars ranging from 88.39 to 195.09 mg.g⁻¹, being composed of the following genotypes: 'Libra', 'Tropic Beauty', 'Bonão', 'Kampai', 'Cascata 1063', 'Tropic Snow', 'Cascata 1303', 'Rubimel', 'Conserva 1153', 'Cascata 1055', 'Conserva 1186', 'Cascata 587', 'Conserva 681', 'Conserva 871', 'Ambar', 'Conserva 1127' (Table 2).

Of the genotypes evaluated in both crop years (Tables 1 and 2), only four were grouped as those with the highest content of total sugars, namely 'Cascata 962', 'Conserva 985', 'Cascata 967', 'Conserva 1434'.

Regarding reducing sugars, three groups were formed in the first crop year (2009/2010), one of them with levels ranging from 24.43 to 33.94 mg.g⁻¹, with eight genotypes ('Kampai', 'Tropic Snow', 'Rubimel', 'Conserva 1153', 'Cascata 967', 'Conserva 681', 'Conserva 871' and 'Ambar'), another grouped with those between 15.78 and 21.14 mg.g⁻¹, consisting of the following genotypes: 'Tropic Beauty', 'Bonão', 'Cascata 962', 'Conserva 1187', 'Cascata 1063', 'Cascata 1303', 'Conserva 985', 'Conserva 844', 'Conserva 1129', 'Cascata 1055', 'Atenas', 'Conserva 1186', 'Cascata 587' and 'Santa Áurea'. The last group, with the lowest sugar content of this crop year (9.8 to 12.76 mg.g⁻¹), consisted of four genotypes ('Libra', 'Conserva 1396', 'Cascata 1070' and 'Conserva 1434') (Table 1).

In the second crop year (2010/2011), all genotypes were grouped into a single group for reducing sugars (Table 2).

When comparing the results of both crop years for the content of total and reducing sugars, it was observed that there was a decrease in the concentrations of the second crop year in relation to the first one (Tables 2 and 1, respectively), which may possibly be related to the higher yield of the 2010/2011 crop year, since, with greater number of fruits, the number of drains per source increases. In addition, there was an increase in precipitation at harvest time in the second crop year (351.3 mm) in relation to the first one (190.6 mm), which may also be related to the decrease in sugar concentrations.

The sugar content of fruits is important because it is indicative of quality, and sweeter fruits are more accepted by consumers, especially for fresh consumption, emphasizing that peach breeding programs have emphasized the importance of flavor in the selection of new cultivars (CRISOSTO, CRISOSTO, 2005).

Analyzing the content of amino acids of fruits, two groups were formed in each crop year analyzed (2009/2010 and 2010/2011) (Tables 1 and 2, respectively).

Genotypes 'Libra', 'Cascata 962', 'Conserva 1187', 'Cascata 1063', 'Conserva 1396', 'Cascata 1303', 'Conserva 1129', 'Cascata 1070', 'Conserva 1434', 'Conserva 681', 'Ambar' and 'Santa Áurea' formed the group with the highest concentrations of amino acids (0.0294 to 0.0555 mg.g⁻¹) in the first crop year (2009/2010), and the other genotypes ('Tropic

Beauty', 'Bonão', 'Kampai', 'Tropic Snow', 'Rubimel', 'Conserva 985', 'Conserva 1153', 'Cascata 967', 'Conserva 844', 'Cascata 1055', 'Atenas', 'Conserva 1186', 'Cascata 587' and 'Conserva 871') composed the second group of this crop year, with lower content of amino acids in fruits (0.0080 to 0.0270 mg.g⁻¹) (Table 1).

In the 2010/2011 crop year, the group with the highest content of amino acids was composed of genotypes 'Conserva 1129', 'Conserva 1223', 'Conserva 1127' and 'Conserva 1216', and the last three were analyzed only in this crop year. The other genotypes evaluated in this crop year ('Libra', 'Tropic Beauty', 'Bonão', 'Cascata 962', 'Conserva 1187', 'Kampai', 'Cascata 1063', 'Tropic Snow', 'Conserva 1396', 'Cascata 1303', 'Rubimel', 'Conserva 985', 'Conserva 1153', 'Cascata 967', 'Conserva 844', 'Cascata 1070', 'Cascata 1055', 'Atenas', 'Conserva 1434', 'Conserva 1186', 'Cascata 587', 'Conserva 681', 'Conserva 871', 'Âambar' and 'Cascata 1065') (Table 2) composed the second group, with fruits with lower content of amino acids (Table 2).

In both crop years, genotype 'Conserva 1129' presented high levels of amino acids. However, genotype 'Libra', even though not remaining in the group with the highest content by the Scott & Knott test in the 2010/2011 crop year, it showed a very similar average in both crop years.

It was verified that fruits of the 2009/2010 crop year presented higher protein concentrations than those obtained in the 2010/2011 crop year. When analyzing peach genotypes for the protein content, the formation of two groups was observed in both crop years analyzed (Table 1 and 2).

Both groups of the first crop year (2009/2010) were composed of 17 and nine genotypes, thus constituted by presenting higher and lower concentrations of total protein, respectively. The grouping with genotypes with the highest total protein concentration ('Libra', 'Cascata 962', 'Conserva 1187', 'Tropic Snow', 'Conserva 1396', 'Cascata 1303', 'Conserva 985', 'Cascata 967', 'Conserva 1129', 'Cascata 1070', 'Cascata 1055', 'Atenas', 'Conserva 1434', 'Conserva 681', 'Conserva 871', 'Âambar' and 'Santa Áurea'), presented variation from 6.37 to 12.05 mg.g⁻¹, while those with the lowest total protein concentration ('Tropic Beauty', 'Bonão', 'Kampai', 'Cascata 1063', 'Rubimel', 'Conserva 1153', 'Conserva 844', 'Conserva 1186', 'Cascata 587') ranged from 1.55 to 4.61 mg.g⁻¹ tissue (Table 1).

However, in the 2010/2011 crop year, groups were formed with six and 23 genotypes, and those with the highest total protein concentrations

composed the group with the lowest number of genotypes ('Conserva 985', 'Cascata 587', 'Conserva 681', 'Conserva 871', 'Âambar' and 'Cascata 1065'), with contents ranging from 2,999 to 4,436 mg.g⁻¹. The other genotypes evaluated ('Libra', 'Tropic Beauty', 'Bonão', 'Cascata 962', 'Conserva 1187', 'Kampai', 'Cascata 1063', 'Tropic Snow', 'Conserva 1396', 'Cascata 1303', 'Rubimel', 'Conserva 1153', 'Cascata 967', 'Conserva 844', 'Conserva 1129', 'Cascata 1070', 'Cascata 1055', 'Atenas', 'Conserva 1434', 'Conserva 1186', 'Conserva 1223', 'Conserva 1127' and 'Conserva 1216') composed the group whose total protein concentrations ranged from 0.36 to 2.00 mg.g⁻¹ (Table 2).

Thus, genotypes 'Conserva 985', 'Conserva 681', 'Conserva 871' and 'Âambar' remained in both crop years grouped among the genotypes with the highest protein content, showing regularity in the production of this fruit component in subsequent crop years, conferring greater reliability for their selection considering this variable.

In the 2009/2010 crop year, the PAL activity did not present significant differences among genotypes. It may have occurred due to the higher protein content found in this crop year, when compared to the contents evaluated in the next one, since for the determination of the activity of this enzyme, the protein content is used.

However, in the second crop year analyzed, the F test detected significant differences among genotypes, but the Scott & Knott test grouped them into a single group, as previously mentioned.

Plants have structural and biochemical apparatus that compose their mechanism of defense against the action of biotic, abiotic and physical agents (AGRIOS, 1998). One of the key enzymes in the defense of plants is PAL, and when they are being attacked by some aggressor (pests or diseases) that trigger the defense process, this enzyme can be quantified in greater activity.

The PAL enzyme acts on the removal of the ammonia group from the aromatic amino acid phenylalanine, transforming it into trans-cinnamic acid, which is precursor of phenolic compounds. Thus, it is important to estimate the activity of this enzyme for the selection of genotypes to be used in breeding programs, since when it is found in greater activity, fruits with greater possibility of defenses against pathogens will be produced, being determinant in the resistance of plants to diseases.

The selection of genotypes with higher contents of phenolic compounds is important because these compounds present functional characteristics (ANJO, 2004), and, thus, meet the emerging trend

of the market, which seeks foods that can act in the prevention and cure of diseases (SENTANIN and AMAYA, 2007).

It is also possible that these compounds act by increasing the levels of resistance of fruits to brown rot, since these appear to be related to the higher accumulations of phenolic compounds in pulp and epidermis (BYRDE and WILLETS, 1977; GRADZIEL et al., 1998).

For the concentration of total phenols, genotypes were grouped into three distinct groups in both crop years (2009/2010 and 2010/2011) (Tables 1 and 2).

In the first crop year, five genotypes ('Cascata 962', 'Cascata 1070', 'Conserva 681', 'Conserva 871' and 'Âmbar') were grouped as those with higher contents of total phenols, presenting levels from 0.66 to 0.86 mg.g⁻¹. The second group consisted of genotypes ('Conserva 1187', 'Kampai', 'Cascata 1055', 'Atenas' and 'Santa Áurea'), which presented intermediate levels, ranging from 0.47 to 0.60 mg.g⁻¹. The other genotypes evaluated in this crop year ('Libra', 'Tropic Beauty', 'Bonão', 'Cascata 1063', 'Tropic Snow', 'Conserva 1396', 'Cascata 1303', 'Rubimel', 'Conserva 985', 'Conserva 1153', 'Cascata 967', 'Conserva 844', 'Conserva 1129', 'Conserva 1434', 'Conserva 1186', 'Cascata 587') had the lowest concentrations of total phenols (0.11 to 0.42 mg.g⁻¹) (Table 1).

The second crop year (2010/2011) also presented five genotypes individualized due to their higher contents of total phenols, but only genotypes 'Cascata 1070' and 'Conserva 681' were repeated, the other three genotypes grouped by the highest contents of total phenols in this crop year were 'Conserva 985', 'Cascata 587' and 'Conserva 1223', the latter being evaluated only in this second crop year. This group had contents of total phenols ranging from 0.57 to 0.88 mg.g⁻¹.

The second group formed in the 2010/2011 crop year includes 14 genotypes ('Bonão', 'Cascata 962', 'Conserva 1187', 'Kampai', 'Conserva 1396', 'Conserva 844', 'Cascata 1055', 'Atenas', 'Conserva 1434', 'Conserva 871', 'Âmbar', 'Conserva 1127', 'Conserva 1216' and 'Cascata 1065'), with contents of total phenols ranging from 0.29 to 0.42 mg.g⁻¹. The last group has levels ranging from 0.05 to 0.24 mg.g⁻¹ and is formed by genotypes 'Libra', 'Tropic Beauty', 'Cascata 1063', 'Tropic Snow', 'Cascata 1303', 'Rubimel', 'Conserva 1153', 'Cascata 967',

'Conserva 1129' and 'Conserva 1186'.

Polyphenols present in fruits include a wide variety of compounds with redundant antioxidant activity (GIL et al., 2002). Thus, the knowledge of the levels of flavonoids in genotypes, and therefore those with the highest yields of this class of phenolic compounds, is important mainly due to the modern society's appeal for functional foods, as previously mentioned. Flavonoids have, within their class of compounds, molecules with importance in the prevention of diseases.

Peach and nectarine shells contain higher amounts of phenolic compounds, anthocyanins and flavonoids than pulp tissues; however, no significant differences were found between genotypes of white and yellow pulp (GIL et al., 2002), which allows a single selection criterion for both.

As for the content of flavonoids present in fruits of genotypes analyzed in the 2009/2010 crop year, there was no separation of genotypes in different groups (Table 1). However, in the 2010/2011 crop year, two groups were formed, one being composed of genotypes 'Libra', 'Bonão', 'Conserva 1187', 'Rubimel', 'Conserva 985', 'Cascata 967', 'Atenas', 'Cascata 587', 'Conserva 681', 'Conserva 1123', 'Conserva 1127', 'Conserva 1216' and 'Cascata 1065', which presented mean contents ranging from 2.45 to 3.68 mg.g⁻¹, and the other composed of genotypes 'Tropic Beauty', 'Cascata 962', 'Kampai', 'Cascata 1063', 'Tropic Snow', 'Conserva 1396', 'Cascata 1303', 'Conserva 1153', 'Conserva 844', 'Conserva 1129', 'Cascata 1070', 'Cascata 1055', 'Conserva 1434', 'Conserva 1186', 'Conserva 871' and 'Âmbar', with contents of flavonoids in fruits ranging from 1.34 to 2.32 mg.g⁻¹ (Table 2).

Anthocyanins are a group of phenolic compounds belonging to the class of flavonoids. This pigment, which reflects the red light, in addition to providing functional qualities to fruits due to its antioxidant potential, adds desirable characteristics, since fruits with high levels of anthocyanins present a very attractive visual aspect.

Concerning the content of anthocyanins, genotypes in both crop years were grouped into two groups (Tables 1 and 2).

In the 2009/2010 crop year, six genotypes were grouped by the highest content of anthocyanins in fruits, with levels ranging from 1.35 to 1.81 mg.g⁻¹ ('Cascata 962', 'Tropic Snow', 'Cascata 1303', 'Cascata 1070', 'Cascata 1055' and 'Cascata 587'). In the second

group, concentration of anthocyanins in fruits ranged from 0.11 to 0.78, mg.g⁻¹, including the other genotypes evaluated in this crop year ('Libra', 'Tropic Beauty', 'Bonão', 'Conserva 1187', 'Kampai', 'Cascata 1063', 'Conserva 1396', 'Rubimel', 'Conserva 985', 'Conserva 1153', 'Cascata 967', 'Conserva 844', 'Conserva 1129', 'Atenas', 'Conserva 1434', 'Conserva 1186', 'Conserva 681', 'Conserva 871', 'Âmbar' and 'Santa Áurea') (Table 1).

In the 2010/2011 crop year, only two genotypes ('Cascata 967' and 'Cascata 1065') were grouped by the highest concentration of anthocyanins, presenting 2.66 and 2.04 mg.g⁻¹, respectively. The other genotypes evaluated in this crop year ('Libra', 'Tropic Beauty', 'Bonão', 'Cascata 962', 'Conserva 1187', 'Kampai', 'Cascata 1063', 'Tropic Snow', 'Conserva 1396', 'Cascata 1303', 'Rubimel', 'Conserva 985', 'Conserva 1153', 'Conserva 844', 'Conserva 1129', 'Cascata 1070', 'Cascata 1055', 'Atenas', 'Conserva 1434', 'Conserva 1186', 'Cascata 587', 'Conserva 681', 'Conserva 871', 'Âmbar', 'Conserva 1223', 'Conserva 1127' and 'Conserva 1216') constituted the other group with contents of anthocyanins ranging from 0.13 to 0.93 mg.g⁻¹ (Table 2).

Considering that the process of genotype selection in the breeding program considers the preferences of the consumer market, the characteristic of fruit coloring becomes of paramount importance.

In the past, peach fruits were accepted by the consumer market for their visual and sensory characteristics, and today there is a tendency for the functional characteristics they present, which makes the evaluation of the biochemical characteristics important for breeding programs.

Based on the criteria adopted, five genotypes were selected in the 2009/2010 crop year because they presented the best biochemical characteristics, namely 'Kampai', 'Cascata 1055', 'Conserva 871', 'Rubimel' and 'Âmbar'. In the second crop year (2010/2011), six genotypes were selected based on their desired biochemical characteristics: 'Conserva 985', 'Cascata 967', 'Cascata 1065', 'Conserva 1216', 'Conserva 1223' and 'Conserva 844'.

However, as there was no convergence in the selection of genotypes in both crop years, the average of crop years was adopted as the selection method with the aim of selecting genotypes with lower oscillation for biochemical characteristics. Thus, the five best genotypes for the biochemical

characteristics, based on the evaluations made during the two crop years, were 'Cascata 967', 'Conserva 985', 'Kampai', 'Tropic Snow' and 'Cascata 1055'.

However, genotypes 'Cascata 1065', 'Conserva 1216' and 'Conserva 1223' should be evaluated in subsequent crop years in order to verify if the superior biochemical characteristics presented in a single crop year are maintained during the next ones or if they were conditioned by the environment in the crop year analyzed.

TABLE 1 - Contents of total and reducing sugars, amino acids, proteins, phenylalanine ammonia-lyase enzyme (PAL), phenols, anthocyanins and flavonoids of 26 genotypes in the 2009/2010 crop year. UTFPR, Campus of Pato Branco, PR, 2011.

Genotypes	Biochemical Analyses 2009/2010							
	Total sugars mg . g ⁻¹	Reducing sugars mg . g ⁻¹	Amino acids mg . g ⁻¹	Protein mg . g ⁻¹	PAL Uabs min mg ⁻¹ (ptma.)	Phenols mg . g ⁻¹	Anthocyanins mg . 100g ⁻¹	Flavonoids mg . 100g ⁻¹
Libra	285.97 b	12.76 c	0.0299 a	10.96 a	0.0005 a	0.228 c	0.268 b	10.14 a
Tropic Beauty	341.11 a	18.00 b	0.0224 b	3.23 b	0.0028 a	0.135 c	0.169 b	3.07 a
Bonão	232.23 b	19.53 b	0.0265 b	3.49 b	0.0067 a	0.337 c	0.106 b	20.64 a
Cascata 962	367.27 a	16.01 b	0.0427 a	6.41 a	0.0043 a	0.858 a	1.448 a	11.24 a
Conserva 1187	261.72 b	15.78 b	0.0390 a	10.02 a	0.0013 a	0.503 b	0.323 b	10.22 a
Kampai	361.84 a	33.94 a	0.0127 b	4.39 b	0.0067 a	0.557 b	0.504 b	14.35 a
Cascata 1063	270.69 b	20.84 b	0.0312 a	3.46 b	0.0094 a	0.135 c	0.230 b	6.16 a
Tropic Snow	310.75 b	29.72 a	0.0251 b	9.51 a	0.0007 a	0.231 c	1.487 a	10.18 a
Conserva 1396	307.55 b	11.32 c	0.0294 a	7.78 a	0.0006 a	0.415 c	0.152 b	8.25 a
Cascata 1303	308.73 b	17.79 b	0.0555 a	6.37 a	0.0011 a	0.279 c	1.573 a	12.19 a
Rubimel	337.34 a	27.18 a	0.0080 b	3.07 b	0.0191 a	0.287 c	0.782 b	9.57 a
Conserva 985	332.20 a	16.83 b	0.0130 b	7.05 a	0.0242 a	0.288 c	0.487 b	6.92 a
Conserva 1153	208.35 b	24.43 a	0.0188 b	1.55 b	0.0080 a	0.105 c	0.201 b	4.11 a
Cascata 967	357.98 a	27.60 a	0.0102 b	7.77 a	0.0016 a	0.157 c	0.420 b	8.56 a
Conserva 844	252.56 b	18.65 b	0.0219 b	3.22 b	0.0034 a	0.400 c	0.175 b	6.43 a
Conserva 1129	261.61 b	17.63 b	0.0462 a	9.68 a	0.0005 a	0.321 c	0.195 b	11.08 a
Cascata 1070	237.94 b	10.49 c	0.0408 a	7.11 a	0.0027 a	0.663 a	1.723 a	11.30 a
Cascata 1055	370.36 a	21.14 b	0.0270 b	10.87 a	0.0019 a	0.468 b	1.807 a	12.47 a
Atenas	287.81 b	18.90 b	0.0266 b	9.02 a	0.0008 a	0.498 b	0.295 b	12.47 a
Conserva 1434	339.48 a	9.80 c	0.0350 a	6.62 a	0.0040 a	0.284 c	0.216 b	7.53 a
Conserva 1186	289.28 b	18.76 b	0.0122 b	1.81 b	0.0073 a	0.181 c	0.276 b	7.37 a
Cascata 587	285.49 b	19.00 b	0.0171 b	4.61 b	0.0026 a	0.366 c	1.349 a	11.79 a
Conserva 681	372.71 a	27.25 a	0.0380 a	10.83 a	0.0008 a	0.699 a	0.197 b	8.56 a
Conserva 871	366.98 a	28.15 a	0.0195 b	12.05 a	0.0008 a	0.769 a	0.176 b	7.62 a
Âmbar	441.66 a	25.37 a	0.0391 a	8.92 a	0.0009 a	0.698 a	0.276 b	11.13 a
Santa Áurea	336.99 a	19.90 b	0.0296 a	8.64 a-	0.0010 a	0.598 b	0.265 b	7.62 a-
VC (%)**	22.61	23.75	58.07	45.83	241.82	42.38	105.89	51.14

* Means followed by the same letter in the column do not differ from each other by the Scott and Knott test ($p \leq 0.05$). ** VC (variation coefficient).

TABLE 2 - Contents of total and reducing sugars, amino acids, proteins, phenylalanine ammonia-lyase enzyme (PAL), phenols, anthocyanins and flavonoids of 29 genotypes in the 2010/2011 crop year. UTFPR, Campus of Pato Branco, PR, 2011.

Genotypes	Biochemical Analyses 2010/2011							
	Total sugars mg · g ⁻¹	Reducing sugars mg · g ⁻¹	Amino acids mg · g ⁻¹	Protein mg · g ⁻¹	PAL Uabs min mg ⁻¹ (ptna.)	Phenols mg · g ⁻¹	Anthocyanins mg · 100g ⁻¹	Flavonoids mg · 100g ⁻¹
Libra	170.77 b	6.74 a	0.0296 b	0.706 b	0.0163 a	0.158 c	0.272 b	2.46 a
Tropic Beauty	150.55 b	7.70 a	0.0156 b	1.307 b	0.0066 a	0.107 c	0.276 b	1.59 b
Bonão	143.36 b	10.51 a	0.0299 b	1.005 b	0.0076 a	0.424 b	0.145 b	2.68 a
Cascata 962	222.92 a	8.31 a	0.0101 b	1.064 b	0.0068 a	0.344 b	0.131 b	2.25 b
Conserva 1187	241.40 a	6.51 a	0.0148 b	0.364 b	0.0177 a	0.323 b	0.162 b	2.45 a
Kampai	118.55 b	9.83 a	0.0117 b	0.432 b	0.0180 a	0.350 b	0.356 b	1.92 b
Cascata 1063	163.45 b	7.45 a	0.0116 b	0.687 b	0.0086 a	0.050 c	0.190 b	1.34 b
Tropic Snow	169.59 b	13.49 a	0.0120 b	0.937 b	0.0120 a	0.223 c	0.367 b	2.21 b
Conserva 1396	264.94 a	5.36 a	0.0138 b	0.655 b	0.0118 a	0.354 b	0.791 b	1.94 b
Cascata 1303	172.31 b	5.90 a	0.0132 b	0.703 b	0.0167 a	0.130 c	0.235 b	2.32 b
Rubimel	162.02 b	9.41 a	0.0162 b	0.507 b	0.0396 a	0.156 c	0.259 b	2.45 a
Conserva 985	293.73 a	19.18 a	0.0241 b	4.051 a	0.0025 a	0.878 a	0.339 b	3.08 a
Conserva 1153	184.13 b	28.50 a	0.0155 b	0.689 b	0.0147 a	0.242 c	0.424 b	2.12 b
Cascata 967	301.44 a	15.35 a	0.0143 b	1.882 b	0.0024 a	0.163 c	2.660 a	2.71 a
Conserva 844	211.37 a	12.21 a	0.0208 b	1.436 b	0.0211 a	0.402 b	0.379 b	1.56 b
Conserva 1129	217.61 a	9.16 a	0.0441 a	1.999 b	0.0011 a	0.123 c	0.296 b	1.41 b
Cascata 1070	210.56 a	13.37 a	0.0204 b	0.635 b	0.0087 a	0.643 a	0.648 b	2.03 b
Cascata 1055	180.09 b	7.31 a	0.0160 b	1.450 b	0.0008 a	0.290 b	0.337 b	2.30 b
Atenas	260.06 a	14.77 a	0.0174 b	0.471 b	0.0108 a	0.359 b	0.244 b	2.45 a
Conserva 1434	241.61 a	8.74 a	0.0278 b	0.383 b	0.0125 a	0.326 b	0.349 b	1.83 b
Conserva 1186	195.09 b	12.35 a	0.0149 b	0.727 b	0.0025 a	0.174 c	0.408 b	2.09 b
Cascata 587	141.87 b	4.76 a	0.0204 b	3.129 a	0.0027 a	0.571 a	0.931 b	2.73 a
Conserva 681	141.24 b	9.66 a	0.0211 b	3.871 a	0.0019 a	0.739 a	0.297 b	2.82 a
Conserva 871	141.71 b	12.88 a	0.0250 b	3.662 a	0.0021 a	0.355 b	0.290 b	2.31 b
Âmbar	88.39 b	7.53 a	0.0130 b	2.999 a	0.0013 a	0.394 b	0.240 b	1.88 b
Conserva 1223	251.95 a	15.25 a	0.0555 a	0.887 b	0.0031 a	0.780 a	0.351 b	2.94 a
Conserva 1127	151.61 b	6.79 a	0.0559 a	0.797 b	0.0019 a	0.296 b	0.406 b	2.63 a
Conserva 1216	281.79 a	22.08 a	0.0400 a	0.593 b	0.0061 a	0.420 b	0.667 b	3.68 a
Cascata 1065	209.62 a	11.80 a	0.0148 b	4.436 a	0.0016 a	0.335 b	2.039 a	2.98 a
VC (%)**	32.47	74.44	89.98	53.32	142.72	49.50	133.76	30.00

* Means followed by the same letter in the column do not differ from each other by the Scott and Knott test (p≤0.05). ** VC (variation coefficient)

CONCLUSION

Regarding the biochemical characteristics in both crop years (2009/2010 and 2010/2011), genotypes 'Cascata 967', 'Conserva 985', 'Kampai', 'Tropic Snow', and 'Cascata 1055' were selected as superior genotypes.

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