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Vitamin C, total phenolics, and antioxidant capacity of fruits cultivated in Brazil

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ABSTRACT

This study aimed to determined vitamin C content by capillary electrophoresis, total phenolic content (TPC), and 2,2-diphenyl-1-picrylhydrazyl radical-scavenging capacity in fruits of blackberry (*Rubus ulmifolius*), plum (*Prunus domestica*), carambola (*Averrhoa carambola*), cape gooseberry (*Physalis peruviana*), red and yellow guava (*Psidium cattleianum*), acerola (*Malpighia emarginata*), and jabuticaba (*Myrciaria cauliflora*). Among the studied fruits, acerola showed the highest vitamin C concentration (1266.5 ± 13.1 mg 100 g^{-1} fresh weight (FW)), TPC (666.4 ± 52.6 mg gallic acid equivalent 100 g^{-1} FW), and antioxidant capacity (1279.0 ± 25.9 mg ascorbic acid equivalent 100 g^{-1} FW), reinforcing that this fruit is an important natural source of bioactive compounds. The fruits jabuticaba, followed by red and yellow guava, showed intermediated values of TPC (285.4 ± 15.2 to 199.5 ± 10.6 mg gallic acid equivalent 100 g^{-1} FW) and antioxidant capacity (734.5 ± 5.8 to 362.0 ± 0.3 mg ascorbic acid equivalent 100 g^{-1} FW), while the fruits carambola and cape gooseberry showed the lowest values of both. Therefore, specially acerola, jabuticaba, red guava, and yellow guava can be considered a supply of bioactive compounds to the diet.

KEYWORDS: Ascorbic acid; DPPH; polyphenolic compounds; Folin-Ciocalteu; capillary electrophoresis.

INTRODUCTION

Free radicals are molecular species that contain an unpaired electron in its atomic orbital. It makes these radicals highly reactive, presenting oxidation-reduction proprieties. Due to its high reactivity, these compounds interact mainly with lipids, nucleic acids, and proteins, leading to cell damage. When free radical production is higher than the antioxidant defenses, an imbalance is created and results in the oxidative stress, which is associated with the occurrence of damage to a wide range of compounds (AHMAD, 2018; LOBO *et al.*, 2010).

The regular consumption of fruits has been associated with beneficial effects in human health due to its nutritional and bioactive constituents. The presence of phytochemical compounds with antioxidant properties in fruits has been studied and related to the potential prevention of various diseases and disorders (ACOSTA-ESTRADA; GUTIÉRREZ-URIBE; SERNA-SALDÍVAR, 2014; AHMAD *et al.*, 2016).

Phenolic compounds are important contributors and strongly correlated with the antioxidant proprieties of fruits. Phenolic acids, anthocyanins, carotenoids, and non-anthocyanins compounds are some of the classes of phenolic compounds present in fruits (HAMINIUK *et al.*, 2012). Vitamin C (L-ascorbic acid) is another important compound that deserves attention. It is considered the most abundant hydrosoluble antioxidant found in plants, contributing in the antioxidant proprieties of fruits (ACOSTA-ESTRADA; GUTIÉRREZ-URIBE; SERNA-SALDÍVAR, 2014; AHMAD *et al.*, 2016; RUFINO *et al.*, 2010).

Vitamin C determination in fruits and juices can be performed by titration and spectrophotometric methods, which are considered simple and low-cost methods. However, the difficult of detection of the endpoint in the titration, the presence of suspended matter in the sample during the spectrophotometric measurement, and the possibility of overestimating the results due to the presence of oxidizable species are some of the difficult that can be found by the using of these methodologies (ESSAYS, 2018; SPÍNOLA; LLORENT-MARTÍNEZ; CASTILHO, 2014).

In this sense, accurate analytical techniques, such as liquid chromatography and capillary electrophoresis, are commonly employed in the investigation of vitamin C in foods. Both techniques are considerate sensitive, reproducible, and specific. But the short-analysis time, low solvent consumption, and the absence or simple extraction procedures are some of the advantages of the use of capillary electrophoresis in comparison with liquid chromatography for determination of vitamin C especially in fruits and beverages, but also in determining a wide range of compounds (minerals, organic acids, sugars, phenolic compounds, amino acids, among others) in the most diverse types of food (cereals, dairy products, meat products, fruit and vegetable products, among others) (ESSAYS, 2018; IBÁÑEZ *et al.*, 2016; RAMOS-PAYÁN *et al.*, 2018; SPÍNOLA; LLORENT-MARTÍNEZ; CASTILHO, 2014; VOETEN *et al.*, 2018).

In Brazil, there is a large number of fruit species, many of them still underexploited especially for commercial purposes (SOUZA *et al.*, 2012; RUFINO *et al.*, 2010). These fruits representing a potential source to the agroindustry and of income for the local population (BORGES; CONCEIÇÃO; SILVEIRA, 2014; RUFINO *et al.*, 2010), but normally remain commercialized on a small scale (DONADO-PESTANA *et al.*, 2015; GURAK *et al.*, 2014). This reality is mainly due to the lack of

knowledge of their sensorial characteristics and nutritional value (GURAK *et al.*, 2014).

In this sense, the aim of this study was the determination of vitamin C by capillary electrophoresis, total phenolic content, and antioxidant capacity in fruits of blackberry (*Rubus ulmifolius*), plum (*Prunus domestica*), carambola (*Averrhoa carambola*), cape gooseberry (*Physalis peruviana*), red guava (*Psidium cattleianum*), yellow guava (*Psidium cattleianum*), acerola (*Malpighia emarginata*), and jabuticaba (*Myrciaria cauliflora*).

MATERIALS AND METHODS

REAGENTS AND SOLUTIONS

Analytical grade reagents (all with purity ≥ 95%) and ultra-pure water (Milli-Q, Millipore, Bedford, MA, USA) were used to prepare all solutions.

The reagents 2,2-diphenyl-1-picrylhydrazyl radical (DPPH), Folin-Ciocalteu reagent, sorbic acid, tris(hydroxymethyl)aminomethane (Tris), 2-morpholinoethanesulfonic acid (MES), gallic acid, and L-ascorbic acid (vitamin C) were obtained from Sigma-Aldrich (St. Louis, MO, USA). Methanol, sodium carbonate, and sodium hydroxide (NaOH) were obtained from Vetec (Duque de Caxias, Rio de Janeiro, Brazil). All solutions were prepared daily.

SAMPLES

Mature fruits of blackberry (*Rubus ulmifolius*), plum (*Prunus domestica*), carambola (*Averrhoa carambola*), cape gooseberry (*Physalis peruviana*), red guava (*Psidium cattleianum*), yellow guava (*Psidium cattleianum*), acerola (*Malpighia emarginata*), and jabuticaba (*Myrciaria cauliflora*) were harvested in Pinhalzinho (latitude 26º85'02''S, longitude 52º98'17''W, altitude 515 m), Santa Catarina State, Brazil, in January 2018.

The fruits were hand-picked from three plants randomly selected in a single collection and only fruits with no damage were harvested (about 200 g of each fruit). The fruit samples were maintained under refrigeration (5 ± 2 ^{o}C) until analysis (within 24 h). Immediately before analysis, the pulp and peel were manually separated from the seeds (the seeds were discarded) and triturated using a domestic food processor (Britânia, Curitiba, PR, Brazil).

VITAMIN C

The determination of vitamin C was performed according to the method proposed by Spudeit *et al.* (2016), with some modifications.

For vitamin C extraction, 2.5 ± 0.1 g of each fruit was weighed in a volumetric flask (5 mL) and the volume was adjusted with water. The resultant solution was transferred to a polypropylene tube and vortexed for 2 min, followed by centrifugation for 10 min at 1338 × *g* (Fanem, model 280R, São Paulo, SP, Brazil). The supernatant was diluted at proportion 9:1 (v/v) with sorbic acid (internal standard, 200 mg L^{-1}) and injected into the CE equipment. Subsequent dilutions were performed when necessary.

The measurements of vitamin C were carried out on capillary electrophoresis equipped with a diode array detector (CE-DAD) system (Agilent Technologies, model 7100, Palo Alto, CA, USA) at 25 °C, equipped with a diode array detector set at 266 nm. Background electrolyte (BGE) was composed of 40 mmol L^{-1} Tris and 20 mmol L^{-1} MES, at pH 8.1. Uncoated fused-silica capillary (Polymicro Technologies, Phoenix, AZ, USA) of 32 cm (8.5 cm effective length × 75 µm i.d.) was used. The capillary was rinsed for 1 min with BGE between runs. The samples and standards were injected hydrodynamically (at 50 mbar for 4 s) with negative pressure by the shorter extremity of the capillary (outlet). A separation voltage of 20 kV with positive polarity in the outlet was applied. HP ChemStation software (Palo Alto, CA, USA) was used for data acquisition and processing.

The concentration of vitamin C was calculated using an ascorbic acid calibration curve (1–50 mg L^{-1}) and was expressed in mg 100 g^{-1} of fresh weight (FW).

TOTAL PHENOLIC CONTENT AND *IN VITRO* ANTIOXIDANT CAPACITY

For the determination of total phenolic content and antioxidant capacity, the samples were extracted according to adaptations of the method proposed by Silva *et al.* (2014).

In a volumetric flask (10 mL), 2.0 ± 0.1 g of each fruit was weighed, and the volume was adjusted with a solution of methanol (80 %, v/v). The extraction was performed in an ultrasonic bath (Unique, model USC-1400, Sao Paulo, SP, Brazil) for 1 h in the dark at room temperature (25 ± 2 °C), followed by centrifugation for 10 min at 1338 × *g*. The supernatant was used for the determination of total phenolic content and antioxidant capacity.

The determination of total phenolic content (TPC) was performed by Folin-Ciocalteu method (SINGLETON; ROSSI, 1965).

In a volumetric flask (10 mL), 100 µL of the diluted extract and 2.0 mL of water were mixed with 0.5 mL Folin-Ciocalteu reagent. After 2 min, 1.5 mL of sodium carbonate solution (20 %, m/v) was added to the system and the volume was adjusted with water. This system was left to stand for 2 h in the dark at 25 ± 2 °C and the absorbance of the mixture was measured at 765 nm in a UV-Vis spectrophotometer (Spectro Vision SB 1810-60 S, Beijing, China).

The results were calculated using a gallic acid calibration curve (20–300 mg L^{-1}) and were expressed as mg of gallic acid equivalents (GAE) 100 g^{-1} of FW.

The antioxidant effect of the fruit extracts on the DPPH radical was determined according to the method of Brand-Williams, Cuvelier, and Berset (1995) with some modifications (KIM *et al.*, 2002).

Briefly, 100 µL of the diluted extract was mixed with 2.9 mL aliquot of DPPH radical solution (0.1 mmol L^{-1} in methanol 80 %, v/v), and left to stand for 30 min in the dark at 25 ± 2 °C. The absorbance of the DPPH solution was measured at 515 nm in a UV-Vis spectrophotometer before and after the addition of the extract.

The antioxidant capacity of the fruit extracts was calculated as inhibition percentage and expressed as mg ascorbic acid equivalent (AAE) 100 g^{-1} of FW through a standard ascorbic acid curve (20–120 mg L^{-1}).

STATISTICAL ANALYSIS

Data were reported as mean ± standard deviation of three independent assays (n=3) and subjected to analysis of variance (ANOVA) and Tukey test (Statistica 13.0, Statsoft Inc., Tulsa, OK, USA) to identify significant ($p < 0.05$) differences between the means values.

The Pearson correlation analysis was performed to evaluate associations between vitamin C, total phenolic content, and antioxidant capacity.

RESULTS AND DISCUSSION

In Table 1, the content of vitamin C and total phenolics, as well as the antioxidant capacity of eight fruits cultivated in Brazil are shown.

Table 1. Vitamin C, total phenolic content, and DPPH radical-scavenging capacity of different fruits cultivated in Brazil.

Fruit	Vitamin C (mg 100 g^{-1} FW)	Total phenolic content (mg GAE 100 g^{-1} FW)	DPPH assay (mg AAE 100 g^{-1} FW)
Blackberry	0.6 ± 0.0^{b}	117.8 ± 5.9^{d}	196.6 ± 10.7^{e}
Plum	nd	116.1 ± 5.9^{d}	140.2 ± 5.1^{f}
Carambola	6.9 ± 0.2^{b}	47.9 ± 3.0^{e}	63.2 ± 1.9^{g}
Cape gooseberry	3.7 ± 0.1^{b}	37.1 ± 1.5^{e}	34.2 ± 0.7^{g}
Red guava	0.5 ± 0.01^{b}	243.9 ± 12.0^{bc}	527.8 ± 32.5^{c}
Yellow guava	1.4 ± 0.1^{b}	199.5 ± 10.6^{c}	362.0 ± 0.3^{d}
Acerola	1266.5 ± 13.1^{a}	666.4 ± 52.6^{a}	1279.0 ± 25.9^{a}
Jabuticaba	0.5 ± 0.0^{b}	285.4 ± 15.2^{b}	734.5 ± 5.8^{b}

NOTE: Results expressed as mean ± standard deviation. $^{a-g}$ Mean values in the same column followed by different letters indicate significant differences ($p < 0.05$) using Tukey test. DPPH – 2,2-diphenyl-1-picrylhydrazyl. GAE – gallic acid equivalent. AAE – ascorbic acid equivalent. FW – fresh weight. nd – not detected.

Ascorbic acid is the biologically active form of vitamin C and commonly found in products of plant origin, especially in leafy vegetables and citrus fruits (DENARDIN *et al.*, 2015). This vitamin is considered the most abundant hydrosoluble antioxidant found in plants (RUFINO *et al.*, 2010) and its content is dependent on the species, maturity stage, environment conditions, as well as the postharvest, storage and processing handling, since this vitamin is highly unstable (DENARDIN *et al.*, 2015; PEREIRA *et al.*, 2012).

According to Table 1, the highest concentration ($p < 0.05$) of vitamin C was found for acerola. For the other investigated fruits, the vitamin C content did not differ ($p > 0.05$) between them.

The content of vitamin C found for acerola was about 180 times higher than the amount found in carambola, the second investigates fruit with the highest vitamin C concentration. The high content of this antioxidant compound in acerola is well known in the literature. Similar values to those found in the present study were reported for acerola cultivated in Brazil by Rufino *et al.* (2010) (1357 mg 100 g^{-1} FW) and Marques, Ferreira, and Freire (2007) (1341.1 mg 100 g^{-1} FW), reinforcing that this fruit is an important source of this vitamin.

Among the accepted routes, the Smirnoff-Wheeler pathway is considered the predominant pathway involved in the biosynthesis of vitamin C in plants. But depending on some conditions, such as fruit ripening, alternative pathways might become relevant, such as the D-galacturonate pathway, L-galactose pathway, and L-gulose pathway. However, it is still unknown how fruits extremely rich in vitamin C, such as acerola and camu-camu, can accumulate such quantity of this antioxidant while other fruits do not. Since the regulation of ascorbate biosynthesis in fruits remains unclear, the identification of regulators that determine high-ascorbate accumulation in the ascorbate-rich fruits becomes extremely important to clarify this characteristic (FENECH *et al.*, 2019; LI *et al.*, 2011).

Although the content of vitamin C in the other investigated fruits was much lower when compared to the concentration present in acerola, it is important to highlight especially carambola and cape gooseberry as the other investigated fruits that can also contribute to the daily intake of vitamin C.

The content of vitamin C found for these other seven fruits, were higher than those reported for blackberry and yellow guava (0.004 to 0.13 mg 100 g^{-1} FW) investigated by Denardin *et al.* (2015) and red (0.12 to 0.45 mg 100 g^{-1} FW) and yellow guava (0.10 to 7.20 mg 100 g^{-1} FW) evaluated by Medina *et al.* (2011). But were lower than those reported by Luximon-Ramma, Bahorun, and Crozier (2003) for carambola (14.4 to 19.0 mg 100 g^{-1} FW) and red and yellow guava (20.0 to 24.2 mg 100 g^{-1} FW) and by Olivares-Tenorio *et al.* (2017) for cape gooseberry (33.4 to 39.4 mg 100 g^{-1} FW)

It is known that in fruits from different species and even within the same species, large differences in the content of vitamin C can be observed. The amount of vitamin C in the plant cells is balanced by its synthesis and oxidation and influenced by internal and external factors, such as development processes, lighting and other environmental conditions, and oxidative stress. All these factors, besides the intrinsic genetic characteristics, influence in the regulatory mechanisms of biosynthesis of vitamin C in the fruits (FENECH *et al.*, 2019; LI *et al.*, 2011).

Therefore, considering the results found in this study and those found in the literature, it is clear the influence of several factors in the content of vitamin C in fruits, resulting in a wide range of vitamin C concentrations for the same species, for example.

Phenolic compounds, commonly grouped as water-soluble (such as phenolic acids and flavonoids) and water-insoluble compounds (such as condensed tannins and lignins), are another important group of compounds with bioactive potential found in fruits (HAMINIUK *et al.*, 2012). These compounds are secondary products of plants synthesized under stress conditions such as UV radiation, infections, water stress, besides contributing to plant pigmentation, and antioxidant activity (DENARDIN *et al.*, 2015; NACZK; SHAHIDI, 2006).

As shown in Table 1, acerola also showed the highest concentration ($p < 0.05$) of TPC compared to the other studied fruits, followed for jabuticaba, red guava, and yellow guava. For the other fruits, cape gooseberry and carambola showed the lowest concentrations ($p < 0.05$).

High TPC in acerola fruit was also found by Anantachoke *et al.* (2016) (723.8 mg GAE 100 g^{-1} FW) and Rufino *et al.* (2010) (1063 mg GAE 100 g^{-1} FW). The high TPC values found for acerola may be linked to the presence in a higher concentration of certain phenolic compounds in this fruit, such as isoquercitrin, quercetin, ferulic acid, *p*-coumaric acid, and kaempferol (BATAGLION *et al.*, 2015; BETTA *et al.*, 2018). But the contribution of other reducing compounds in the TPC of this fruit, such as vitamin C, cannot be omitted (EVERETTE *et al.*, 2010; HAMINIUK *et al.*, 2012).

For the other investigated fruits, the TPC values were similar to those reported for jabuticaba (222.90 mg GAE 100 g^{-1} FW) investigated by Seraglio *et al.* (2018) and for cape gooseberry (45.53 mg GAE 100 g^{-1} FW) evaluated by Vega-Gálvez *et al.* (2014). But were lower than those reported for red (501.3 mg GAE 100 g^{-1} FW) and yellow guava (292.0 mg GAE 100 g^{-1} FW) by Biegelmeyer *et al.* (2011), for jaboticaba (440 mg GAE 100 g^{-1} FW) by Rufino *et al.* (2010), for plum (227 to 495 mg GAE 100 g^{-1} FW) by Rop *et al.* (2009), and for carambola (142.9 to 209.9 mg GAE 100 g^{-1} FW) by Luximon-Ramma, Bahorun, and Crozier (2003).

The contribution of anthocyanins, besides the other classes of phenolic compounds, in the TPC of red and purple fruits, such as jabuticaba, red guava, and blackberry, can be cited. This fact is commonly associated with TPC values higher in dark fruits than those found for many other fruits (BETTA *et al.*, 2018; HAMINIUK *et al.*, 2012; SCHULZ *et al.*, 2019; SERAGLIO *et al.*, 2018).

Phenolic compounds are substances synthesized during the development of the plant and fruit, in which the genus, cultivar, species, ripening stage, and soil composition are factors that influence its profile and amount; as well as in response to different situations, such as UV radiation and stress (BIEGELMEYER *et al.*, 2011; DENARDIN *et al.*, 2015; HAMINIUK *et al.*, 2012; LEE; DOSSETT; FINN, 2012). In this sense, a large variation in the profile and amount of phenolic compounds in different fruits species and within the same species occurs, as observed when the results found in this study are compared with the results reported in the literature. Also, the complexity of reactions and the intrinsic and extrinsic factors involved makes it difficult to suggest precisely which are the main factors responsible for the content of phenolic compounds in each species of fruit.

Antioxidants are important compounds that contribute to the protection of the human body against damage caused by free radicals. These compounds can act in many ways, such as scavenging initial radicals, decreasing the O_2 concentration, breaking chain reactions, bonding metal ions, decomposing primary oxidation products, and intercepting singlet oxygen (SHAHIDI; ZHONG, 2015).

The *in vitro* scavenging of free radicals is one of the main antioxidant mechanisms evaluated in fruits and the DPPH assay is one of the most common methods used for this proposal. In DPPH assay, antioxidant compounds, which include phenolic compounds and vitamins, can reduce DPPH free radicals to yellow hydrazine (N_2H_4), involving an electron donation reaction (MAGALHÃES *et al.*, 2008; SHAHIDI; ZHONG, 2015).

Considering the presence of important bioactive compounds with radical scavenging potential in all investigated fruits, the antioxidant capacity of them was investigated in this study by DPPH assay.

Following the same tendency observed for TPC and vitamin C, the highest antioxidant capacity was observed for acerola ($p < 0.05$) (Table 1). Jabuticaba showed the second highest antioxidant capacity value, followed by red guava, yellow guava, blackberry, and plum ($p < 0.05$). The lowest antioxidant capacity values were found for cape gooseberry and carambola ($p < 0.05$).

The different units that can be used to express the results obtained through the DPPH assay, make it difficult to compare studies. However, a similar result to that found in the present study for jabuticaba was also reported in another study (SERAGLIO *et al.*, 2018).

The antioxidant capacity found for the investigated fruits represents an important indicator of the potential of these fruits as sources of natural bioactive constituents. Also, considering the results found for TPC and antioxidant capacity, it is possible to suggest that the phenolic compounds present in these fruits seem to be closely related to their scavenging capacity.

In agreement with this study, Rufino *et al.* (2010) observed that fruits with higher TPC values also showed higher DPPH antioxidant capacity, such as acerola, camu-camu, and puçá-preto, suggesting that phenolic compounds, such as flavonoids, anthocyanins, phenolic acids, are powerful antioxidant compounds and capable of scavenging free radicals (DENARDIN *et al.*, 2015).

The ability of antioxidant compounds to scavenge radicals is dependent on the type of antioxidant, in which small molecules can access radicals more easily than very large molecules, for example (MAGALHÃES *et al.*, 2008). In this sense, fruits can contain many different components with antioxidant proprieties (DENARDIN *et al.*, 2015).

For example, vitamin C can be highlighted as one of the main compounds with radical scavenging potential present in acerola, which can be considered one of the main responsible for the highest antioxidant capacity found in this fruit (RUFINO *et al.*, 2010). Also, anthocyanins are important compounds responsible for the color of red and purple fruits and highly correlated with their antioxidant capacity (DALLA NORA *et al.*, 2014; SHAHIDI; AMBIGAIPALAN, 2015). In this sense, this class of compounds can be suggested as important contributors of TPC and antioxidant capacity of jabuticaba, red guava, and blackberry. Additionally, the synergism among the antioxidant compounds is another important fact that can occur, directly affecting the antioxidant behavior of each fruit (SHAHIDI; AMBIGAIPALAN, 2015).

Considering the interdependence of the characteristic and compounds evaluated in this study, the correlation between vitamin C, total phenolic content, and antioxidant capacity of the studied fruits was investigated and are shown in Table 2.

Table 2. Coefficient values of correlation between vitamin C, total phenolic content, and antioxidant capacity.

Parameters	Vitamin C	Total phenolic content	Antioxidant capacity
Vitamin C	1	0.865*	0.818*
Total phenolic content	0.865*	1	0.979*
Antioxidant capacity	0.818*	0.979*	1

NOTE: * $p < 0.01$

As shown in Table 2, a positive and significant correlation was found between TPC and antioxidant capacity. The investigated fruits seem to present in their composition different classes of phenolic compounds that directly affect the antioxidant capacity of each fruit. In this sense, the correlation observed demonstrates the strong dependency existent between these two variables in the investigated fruits.

A strong dependency can also be proposed between vitamin C and antioxidant capacity (Table 2). It is known that vitamin C is an important antioxidant compound present in fruits. Therefore, its contribution to the antioxidant capacity of fruits is expected.

Also, a positive and significant correlation was found between TPC and vitamin C (Table 2). Folin-Ciocalteu method determines not only phenolic compounds, but also other compounds, including vitamin C, amino acids, metals, proteins (EVERETTE *et al.*, 2010; LUXIMON-RAMMA; BAHORUN; CROZIER, 2003). In this sense, vitamin C seems to have contributed to the TPC of the investigated fruits, which resulted in a significant correlation between these two variables.

These findings agree with the reports from other studies conducted with fruits, in which significant correlations were also found between TPC and vitamin C, as well as TPC and DPPH assay. Therefore, the results found in this study suggest especially that phenolic compounds and vitamin C are important contributors to the antioxidant capacity of the investigated fruits.

CONCLUSIONS

In this study, the potential of acerola as a natural source of vitamin C and TPC, and their influence in the high antioxidant capacity of this fruit, were reinforced. Also, jabuticaba, red guava, and yellow guava can be highlighted by their high TPC values, which seem to be linked to the high antioxidant capacity of these fruits.

Therefore, specially acerola, jabuticaba, red guava, and yellow guava can be highlighted as promising sources of natural bioactive compounds for direct consumption and use in the food industry, stimulating the economic exploration of these fruits. Also, the findings reported in this study contribute with scientific data still little reported in the literature related to fruits cultivated in Brazil.

Vitamina C, fenólicos totais e capacidade antioxidante de frutas cultivadas no Brasil

RESUMO

Este estudo teve como objetivo determinar o conteúdo de vitamina C por eletroforese capilar, o conteúdo de fenólicos totais (CFT) e a capacidade de desativação do radical 2,2-difenil-1-picrilhidrazil em frutos de amora (*Rubus ulmifolius*), ameixa (*Prunus domestica*), carambola (*Averrhoa carambola*), physalis (*Physalis peruviana*), araçá vermelho e amarelo (*Psidium cattleianum*), acerola (*Malpighia emarginata*) e jabuticaba (*Myrciaria cauliflora*). Dentre as frutas estudadas, a acerola apresentou a maior concentração de vitamina C (1266,5 ± 13,1 mg 100 g^{-1} em matéria fresca (MF)), CFT (666,4 ± 52,6 mg equivalente a ácido gálico 100 g^{-1} MF) e capacidade antioxidante (1279,0 ± 25,9 mg equivalente a ácido ascórbico 100 g^{-1} MF), fatos que reforçam este fruto como uma importante fonte natural de compostos bioativos. Os frutos de jabuticaba, seguido do araçá vermelho e amarelo, mostraram valores intermediários de CFT (285,4 ± 15,2 a 199,5 ± 10,6 mg equivalente a ácido gálico 100 g^{-1} MF) e capacidade antioxidante (734,5 ± 5,8 a 362,0 ± 0,3 mg equivalente a ácido ascórbico 100 g^{-1} MF), enquanto que os frutos de carambola e physalis apresentaram os menores valores para ambas as análises. Portanto, especialmente a acerola, jabuticaba, araçá vermelho e araçá amarelo podem ser considerados suprimentos de compostos bioativos na dieta.

PALAVRAS-CHAVE: Ácido ascórbico; DPPH; compostos polifenólicos; Folin-Ciocalteu; eletroforese capilar.

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