Physicochemical properties of peels of plum and nectarine 'Nacional' and grape 'Rubi'

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Abstract

This work aimed at evaluating the physicochemical and nutritional properties of peels of plum 'Nacional', nectarine 'Nacional' and grape 'Rubi', in order to disclose the importance of consuming fruits without removing their peels. Therefore, the evaluated fruits were acquired in local commerce in Maringá. Once taken to the laboratory, the fruits were washed, peeled and their fresh peel wasanalyzed as for moisture, ashes, total titratable acidity, proteins, vitamin C, phenolic compounds, carotenoids, anthocyanins and color characterization. It has been observed that all studied peels had relevant physicochemical composition; however, the quantity of analyzed compounds was different in each case. Given the obtained characterization, the fresh fruit peels analyzed in this work can be considered as good sources of compounds that are indispensable to healthy feeding habits, thus, their consumption should be stimulated.

Keywords: fruit peel, vitamin C, phenolic compounds, anthocyanins

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1. Introduction

Nowadays there is a growing tendency to healthy feeding habits, aiming at better quality of life. Fruits are among this set of healthy foods, because they are provided with several substances that perform benefic functions in our body.

Fruit trees from temperate climate are distributed in 11 out of the 26 Brazilian states, being that the biggest producers are Rio Grande do Sul (49.3%), Santa Catarina (23.2%), São Paulo (10.3%), Paraná (6.2%), Pernambuco (5.3%), Bahia (3.0%) and Minas Gerais (1.8%) (IBGE, 2009; FACHINELLO et al., 2011). Among these fruits, we can find grape, nectarine and plum, the three of them having their peel colored from rosaceous to purple. The consumption of red and purple fruits is important because they are sources of phenolic compounds, which perform antioxidant activities. Fruits like grape, plum and nectarine are cultivated in the south of Brazil, because they adapt well to the climatic conditions (BARBOSA et al., 2003; ALASALVAR et al., 2005).

The nutritional value is one of the main factors that lead to the increase in fruit consumption (JESUS et al., 2004). The lack of knowledge on nutritive principles of foods leads to their bad use, which causes the waste of tons of food resources (GONDIM et al., 2005). An alternative that has been used in market from the beginning of the decade of 1970 consists of the use of residues, especially fruit peels which can be included in human feeding (OLIVEIRA et al., 2002). However, these residues are often discarded, generating waste accumulation and causing environmental problems (MACHADO et al., 2008).

The physicochemical composition of fruits comprises analyzes of determination of nutrients, such as carbohydrates, fiber, minerals, proteins, vitamins, coloration, texture, among other physicochemical components, and determination of secondary components, known as phenolic compounds (HARBORNE and WILLIAMS, 2000). Ascorbic acid (vitamin C) is one of the most important vitamins for the performance of vital functions in the human body (MAIA et al., 2007). It is a vitamin that cannot be synthetized by the human organism, thus being necessary its ingestion through diets, and fruits, especially fresh fruits, which are the main sources of this vitamin (CHITARRA and CHITARRA, 2005).

Phenolic compounds are substances that are widely distributed in the Plant Kingdom, particularly in fruits (SOARES et al., 2008). These compounds act as antioxidant, not only due to their ability to give hydrogen or electrons, but also because of their stable intermediate radicals, which prevent the oxidation of several food ingredients, mainly fatty acids (SOARES et al., 2008). Rockenbach et al., (2011), in one of their works, describe that there is great potential in the study of determination of the content of phenolic compounds and their antioxidant activity in grape peels and husks.

Anthocyanins are non-toxic phenolic compounds that are not limited to be applied in foods and their use is linked to manufacture practices. Anthocyanins are an option for the replacement of artificial red colorants, because they are provided with attractive colors, in addition to many recognized functional properties (HAGIWARA et al., 2001; RIBEIRO et al., 2005). They are not very used in foods and beverages, since they have low stability to processing and storage conditions, when compared with artificial colorants (VANINI et al., 2009). In red fruits, anthocyanins are in the peel, except for some species, whose pulp is also pigmented (FERNÁNDEZ-LÓPEZ et al., 1998).

This work aimed at evaluating the physicochemical properties of plums 'Nacional', nectarine 'Nacional' and grape 'Rubi', in order to disclose the importance of fruit consumption without removing their peel.

2. Material and Methods

The fruits we used in this work (plum 'Nacional', nectarine 'Nacional' and grape 'Rubi') were purchased in local commerce in Maringá, Paraná. The fruits were manually washed and peeled and their fresh peel was evaluated in accordance with the following methodology.

2.1.Physicochemical evaluations

Color characterization was carried out using a reflectance colorimeter Konica Minolta, previously calibrated. We obtained parameters for luminosity (L), ranging from 0% (white) to 100% (black) and tendencies to green (a-), red (a+), blue (b-) and yellow (b+).

Moisture content was obtained by drying the peels in hothouse at 60ºC until it reached constant weight and the ashes, by calcination of the samples in oven mufla at 550ºC (IAL, 2005).

The physicochemical evaluations were carried out in triplicates. The determination of total titratable acidity (TTA) was determined by titrating the sample with Sodium Hydroxide (NaOH) 100mM. The titration was carried out until the sample became rosaceous, and phenolphthalein was used as indicator of color transformation (ITAL, 1990).

Protein determination was carried out in accordance with IAL methodology (2005), by Micro-Kjeldahl method, which consists of three steps: digestion, distillation and titration. We used 0.2g of sample with 1.0g of catalytic mixture conditioned in digestion tubes. We added 5.0mL of concentrated sulfuric acid and inserted it in the digester. We heated it gradually until it reached 400ºC and the material remained in digestion for 30 minutes, after the clearance of samples. Afterwards, the materials were distilled in a Semi-Micro-Kjeldahl device with a solution of NaOH at 40%. Distilled ammonia was collected in an Erlenmeyer with solution of boric acid at 4% with the indicators methyl red 0.1% and bromocresol green 0.1%, both in alcoholic solution. The distilled volume was titrated with a solution of hydrochloric acid (HCl) at 100mM until color transformation. We noted the volume spent in the burette.

The content of vitamin C was evaluated in accordance with ITAL (1990). The method is based on the reduction of Sodium 2,6-dichlorophenolindophenol (DCFI) by ascorbic acid, by means of sample titration with DFCI, being that the final point is the change of color of the titrated sample from colorless to pink.

The determination of phenolic compounds was carried out by Follin-Ciocauteau method, in accordance with BUCIC-KOJIC et al., 2007. The determination of phenolic compounds was carried out using 2.50g of peel samples. We homogenized it with 50mL of ethanol at 50%, in a mixer, for 2 minutes. Afterwards, we centrifuged it for 5 minutes at 5000rpm. From this extract, we took 0.2mL in an essay tube, protected from light (covered in aluminum paper), adding 1.8mL of distilled water, 10mL of Follin-Ciocauteau solution at 10% and, between 30 seconds and 8 minutes, we added 8.0mL of solution of Sodium Carbonate (Na_2CO_3) at 7.5%. We agitated the tube and let it rest in the dark for two hours. The reading was made by spectrophotometer (UV/Vis) at 765nm, using as white, all the reagents without the aliquot of centrifuged sample and adding 2.0mL of distilled water in the sample volume. Gallic acid (GAE) was used as standard. The results were expressed as g GAE/100g.

The contents of carotenoids were quantified by determination of contents of chlorophyll and, later, with the same method, altering only the wave length of the spectrophotometer, we determined the content of carotenoids. The calculation was carried out in accordance with Lichtenthaler (1987) equations. The procedure was made by extraction with acetone 80%, filtration of mixture in room without light and further reading of the result in spectrophotometer at 663nm for chlorophyll a, 646nm for chlorophyll b and 470nm for the calculation of carotenoids.

The extraction of anthocyanins was carried out in accordance with Lee and Francis (1972) methodology (with alterations). We weighed 50g of sample. We homogenized it in a blender for two minutes, with 50mL of the solvent-solution (ethanol 70% acidified to pH 2.00 with HCl 0.10%). Afterwards, we completed the volume to 200mL in a beaker and covered it with parafilm. We stored it in a refrigerator at 4ºC during 12 hours in a dark room. The material was filtered in Büchner funnel, with the aid of a vacuum pump and the filtered solution was placed in a Kitassato flask. We took 125mL of the filtered sample and completed it with solvent to 250mL. We took 2.0mL from this solution and completed the volume to 100mL in a volumetric flask. Then, we let it rest in the dark for two hours. We carried out the reading in a spectrophotometer (UV/Vis) at 535nm, using the solvent as white.

2.2.Statistical analysis

The results obtained in the chemical evaluation of peels were statistically assessed by Analysis of Variance (ANOVA) and the means were assessed by Tukey Test ($p \leq 0.05$) (SAS, 2001).

3. Results and Discussion

The results obtained for the parameters of peel coloration can be seen in Table 1. As expected, all samples showed tendency to red and slightly dark yellow, due to the fact that color is an observation assessment.

Table 1. Parameters for color characterization of peels of plum, nectarine and grape

Parameters	Plum 'Nacional'	Nectarine 'Nacional'	Grape 'Rubi'
a	11.04	21.59	9.70
b	1.54	22.51	6.33
L	23.10	37.29	31.59

The color of the peel exercises great influence upon the appearance, at the moment of fruit consumption without removing their peel (MARÇO et al., 2008), being that in this work, it was influenced by the content of anthocyanins.

The results obtained for chemical characterization of fresh peel of plum 'Nacional', nectarine 'Nacional' and grape 'Rubi' are displayed on Table 2. According to Portela et al. (2012), the content of acidity is an important parameter to evaluate the quality of fruits as for their flavor. It can be observed in the results that there was a variation from 0.32 to 1.72g of acid.100g^{-1} of sample, being that the acid present in greater quantity in each of them differs. Citric acid represents the acidity in nectarine 'Nacional' and tartaric acid represents acidity in plum 'Nacional' and in grape 'Rubi'. Plum 'Nacional' was the fruit that presented higher levels of acidity, followed by grape 'Rubi' and nectarine 'Nacional', respectively.

Moisture is a parameter that involves succulence and conservation of fruits. When fruits present reduction in moisture content, it may be an indication of loss of succulence and reduction in time of conservation, because these fruits continue to develop physiologically after harvest (CHITARRA and CHITARRA, 2005). The peel samples presented high levels of moisture.

Ash content indicates the amount of minerals present in the fruit. Thus, the peels presented variation in values, being that grape 'Rubi' had the largest amount of minerals.

Vitamin C is the most important vitamin found in fruits and vegetables for human feeding. More than 90% of this vitamin in human diet comes from fruits and vegetables (MORAES, 2010). This information points out the importance of fruit consumption, especially without removing the peel, because, from the results obtained, it is possible to observe that the peel of plum 'Nacional' presents high levels of vitamin C, followed by peel of grape 'Rubi'. The peel of nectarine 'Nacional' also presented this vitamin in its composition. Based on this comparison, it is possible to cite the values found for this analysis in melon: 10 to 30mg.100g^{-1} (SOUZA, 2006); pineapple 'Pérola', 50.6mg.100g^{-1} (SANTANA and MEDINA, 2000); umbu, 12.9 to 18.35mg.100g^{-1} (LIMA et al., 2002) and jabuticaba, from 15.3 to 24.67mg.100g^{-1} (OLIVEIRA et al., 2003).

In this work, the values for phenolic compounds were higher in peels of plum 'Nacional' and lower in peels of grape 'Rubi', though no less important. Bernardes et al. (2011) found, while analyzing peels of plum (*Prunus* sp.), the concentration of 825.95 mg.100g^{-1} of total phenolic compounds, which differed from the numbers found in this paper. It can be justified by the fact that the fruits, main dietary sources polyphenols, as a function of intrinsic (cultivar, variety, ripening stage) and extrinsic (climatic conditions) factors, present, quantitatively and qualitatively, a varied composition of these compounds (MELO et al., 2008).

Table 2. Results obtained for the chemical characterization of peel of fruits from temperate climates

Determinations	Plum 'Nacional'	Nectarine 'Nacional'	Grape 'Rubi'
TTA[1]	1.72g a Tartatic acid.100g^{-1}	0.32g c Citric acid.100g^{-1}	0.69g b Tartatic acid.100g^{-1}
Moisture (%)	80.54 a*	77.49 a	84.50 a
Ashes (%)	0.55 c	0.99 b	1.37 a
Protein (%)	1.75 b	1.86 b	4.33 a
Vitamin C (mg of ascorbic acid.100g^{-1})	105.00a	8.33 c	51.28 b
Phenolic Compounds (g GAE.100g^{-1})	1.31 a	-	0.81 b
Carotenoids (µg.g^{-1})	8.21 a	1.78 c	2.49 b
Anthocyanins (mg.100g^{-1})	9.65 a	1.85 b	1.45 c

*Values followed by the same lower case letter in the line do not differ statistically by Tukey Test ($p>0.05$).

[1]TTA - Total Titratable Acidity

(-) the content of phenolic compounds was not detected in the methodology.

The content of total carotenoids highlighted that the peels of the analyzed fruits showed different values, which can be justified by the fact that carotenoids are natural pigments responsible for yellow, orange or red, which are present in a unique way in each fruit. Ambrósio, Campos and Faro (2006) reported that, due to the presence of unsaturation, carotenoids are sensitive to light, temperature, acidity and to oxidation, which may have influenced the results we obtained.

Among the fruits studied, we highlight the value found for the amount of anthocyanins in the fresh peel of plum 'Nacional', which was much superior to the other fruits. According to Soares et al. (2008), the peel of grape 'Niágara' presented an amount of 7.02mg.100g^{-1} of total anthocyanins, which was inferior to the values found for plum peel in this study and superior to the numbers found for nectarine and grape peels.

The grape peels evaluated presented high values of protein, when compared with peels of nectarine and plum 'Nacional', being that, the values found for the latters were similar to each other. Gondim et al. (2005), while studying fresh peels of passion fruit and pineapple found:

4.33% and 3.89% of protein, respectively, which are close to the values found for peel of grape 'Rubi'. Therefore, we can consider peel of grape 'Rubi' as a good source of proteins.

Phytochemicals (total phenols, anthocyanins, ascorbic acid) are compounds that derive from the secondary metabolism of plans and have been widely studied in fruits, due to their functional properties that are benefic to health (antioxidant activity) and, in some cases (Anthocyanins), its relation with color of fruits (MARÇO et al., 2008; PORTELA et al., 2012). According to Sato et al. (2012), the degradation of phenolic compounds can be directly influenced by climatic conditions. In their studies, the cited authors obtained contents that varied from 44.80 to 55.40 mg.100g^{-1}, for cultivars Syrah and Alicante.

4. Conclusion

Fresh peels of plum 'Nacional', grape 'Rubi' and nectarine 'Nacional, analyzed in this work, can be considered as goof sources of compounds indispensable for a healthy feeding. Therefore, its consumption should be stimulated, in order to enrich one's diet. From this study, it is possible to develop new products, implementing fruit peels and offering innovative options for market.

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