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Determination of some physicochemical characteristics, bioactive compounds and antioxidant activity of tropical fruits from Yucatan, Mexico

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ABSTRACT

The aim to the study was to determine the physicochemical composition, bioactive compounds and antioxidant activity of fruits from Yucatan, Mexico such as star apple, cashew, mombin, mamey sapote, white sapote, sugar apple, sapodilla, dragon fruit, nance, ilama, custard apple, mamoncillo and black sapote. The physicochemical characteristics were different between fruits and were good sources of bioactive compounds. The edible part with the highest values of antioxidant activity were mamoncillo, star apple, mombin, cashew, white sapote, ilama, custard apple, sugar apple, and nance. Total soluble phenols content showed a correlation with antioxidant activity by ABTS ($R = 0.52$, $P \leqslant 0.05$) and DPPH ($R = 0.43$, $P \leqslant 0.05$). A high correlation was obtained between the two assays (ABTS and DPPH) used to measure antioxidant activity in the tropical fruit species under study ($R = 0.82$, $P \leqslant 0.05$). The results show promising perspectives for the exploitation and use of tropical fruits studied with significant levels of nutrients and antioxidant activity.

1. Introduction

Nowadays, the consumption of tropical fruits is increasing in both domestic and international markets due to growing recognition of its nutritional and therapeutic value. Therefore, fruits play important roles both economically, through commercialization of their products and nutritionally, through their consumption (Cardoso, Martino, Moreita, Ribeiro, & Santana, 2011). In Yucatan, Mexico there are a large number of underexploited tropical fruits (star apple, cashew, mombin, mamey sapote, white sapote, sugar apple, sapodilla, dragon fruit, nance, ilama, custard apple, mamoncillo and black sapote), which is of potential interest to agroindustry and constitute a possible source of income for the local population in the near future. These fruits represent an opportunity for local growers to gain access to special markets where consumers appreciate the exotic character of such products and the presence of bioactive compounds capable of preventing some diseases (Alves, Brito, Rufino, & Sampaio, 2008).

The uncontrolled production of oxygen-derived from free radicals, is involved in the onset of many diseases such as cancer, rheumatoid arthritis, as well as in the degenerative process associated with aging, including Parkinson's and Alzheimer's diseases (Ali et al., 2008).

Recent epidemiological studies indicate that the frequent consumption of fruits is associated with a lower risk of chronic diseases (Yahia, 2010). The combination of vitamins, minerals, phenolic antioxidants and fiber seems to be responsible for these effects (Saura-Calixto & Goñi, 2006).

Fruits have been the subject to several studies conducted around the world, reporting in their nutritional values, data especially in relation to the evaluation of antioxidant activity (Almeida et al., 2011; Vasco, Ruales, & Kamal-Eldin, 2008; Contreras-Calderón, Calderón-Jaimes, Guerra-Hernández, & García-Villanova, 2011).

Several methods are used to measure the antioxidant activity of biological material. The most commonly used are those involving chromogen compounds of a radical nature which stimulates reductive oxygen species, because to their ease, speed and sensitivity, and the presence of antioxidants leads to the disappearance of the radical chromogens. The most widely used methods being the ABTS and DPPH (Ali et al., 2008; Almeida et al., 2011).

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In this study, it was determined the physicochemical composition, bioactive compounds content and activity antioxidant of tropical fruits from Yucatan, Mexico.

2. Materials and methods

2.1. Chemical reagents

Ascorbic acid, gallic acid, Folin–Ciocalteu reagent, quercetin, β-carotene, ABTS, DPPH and Trolox, were purchased from Sigma–Aldrich Chemical Company (St. Louis, MO). All the other chemicals used were in an analytical grade.

2.2. Samples

Nineteen fruits, which are commonly cultivated and consumed in Yucatan, Mexico, were chosen for this study (Table 1). About 5 kg of each species fruits (except sapodilla) were purchased at eating ripeness from the local markets in Yucatan, Mexico during 2012.

5 kg of sapodilla fruits were harvested from a single tree from an orchard located in the municipality of Cansahcab, in Yucatan, Mexico and were identified according to quality based on the stage of physiological maturity and determined by the absence of latex. The fruits were stored at 25 °C to reach an eating ripeness according to Moo-Huchin et al. (2013).

The fruits without blemishes or damage were selected and sent to the laboratory for edible parts extraction. After the fruits had been cleaned with tap water, edible part were extracted manually with a knife and then were then mixed in a blender, stored in sealed plastic bags at −20 °C until the time of analyses (vitamin C, total anthocyanin, total soluble phenols, total flavonoids, total carotenoids, total dietary fibre, soluble dietary fibre, insoluble dietary fibre and antioxidant activity). In addition, representative samples were physically and chemically characterised by measuring moisture (g/100 g), total soluble solids content (TSS, °Brix), lightness (L^*), hue angle (h), and titratable acidity (g of citric acid/100 g).

2.3. Analysis of bioactive compounds

2.3.1. Total soluble phenols (TSP) and total flavonoids determination

TSP and flavonoid compounds were extracted using 1 g of edible part of each fruit which was homogenized in 10 mL of 80% methanol. The homogenated was sonicated for 30 min at 40 °C and centrifuged in an eppendorf centrifuge, model 5702 R, at 1200g for 10 min at room temperature. The supernatant was collected, and the sediment was subjected to an additional extraction using the same procedure. Both supernatants were mixed and stored at −20 °C until analysis. Concentrations of total soluble phenols were measured by the methods described by Singleton and Rossi (1965) modified by González-Aguilar, Villegas-Ochoa, Martínez-Téllez, Gardea, and Ayala-Zavala (2007). 50 μL of each extract were mixed with 3 mL of H_2O, 250 μL of 1 N Folin–Ciocalteu reagent. After 8 min of equilibrium, 750 μL of 20% Na_2CO_3 and 950 μL of H_2O were added to the extracts; after incubation for 30 min at room temperature, the absorbance was read at 765 nm with an UV–Vis spectrophotometer PerkinElmer Lambda 11. Concentration of total soluble phenols compound was calculated using a standard curve of aqueous solutions of gallic acid (0–10 ppm) and expressed as mg gallic acid equivalents (GAE)/100 g fresh weight (FW).

Flavonoid content was determined based on the methods described by Zhishen, Mengcheng, and Jianming (1999) modified by González-Aguilar et al. (2007). 1 mL of flavonoids extracted of each sample was mixed and equilibrated with 4 mL of H_2O, 300 μL 5% $NaNO_2$ by 5 min. After equilibrium 300 μL of 10% $AlCl_3$ (methanolic solution) were added; the mixture were reposed by 1 min and then 2 mL of 1 M NaOH were added. The last volume was made up to 10 mL with H_2O, stirred, and lectures were taken. The mixture absorbance was determined at 415 nm, using a UV–Vis spectrophotometer PerkinElmer Lambda 11. Concentration of total flavonoids of fruits was calculated using a standard curve of quercetin (0–60 ppm) and expressed as mg quercetin equivalents (QE)/100 g of FW.

2.3.2. Vitamin C

For vitamin C determination the titrimetric method with 2,6-dichlorophenolindophenol reagent (AOAC Association of Official Analytical Chemists, 1995) with some modifications was applied. 5 g of homogenized edible part fruits was mixed with 100 mL of 4% oxalic acid solution. The mixture was homogenized and filtered. 5 mL of filtrated solution were diluted to 10 mL with 4% oxalic acid solution. This solution was titrated with 0.01% of 2,6-dichloro-phenol-indophenol solution. The final point was considered when the solution had a pink colour for 15 s. The calibration of 2,6-dichlorophenolindophenol solution was performed with 0.05% ascorbic acid solution. Results were expressed as mg of ascorbic acid equivalents per 100 g of FW.

Table 1
List of the species tropical fruits from Yucatan included in the study and parts analyzed.

English name	Common name	Scientific name	Used edible part
Green star apple	Caimito verde	*Chrysophyllum cainito* L.	Pulp
Purple star apple	Caimito morado		
Yellow cashew	Marañón amarillo	*Annacardium occidentale*	Pulp
Red cashew	Marañón rojo		
Green–yellow mombin	Ciruela verde-amarillo	*Spondias purpurea* L.	Pulp + peel
Red mombin	Ciruela roja		
Mamey sapote	Mamey	*Pouteria sapota* Jacq.	Pulp
White sapote	Zapote blanco	*Lucuma hypoglauca* Stanley	Pulp
Green sugar apple	Saramuyo verde	*Annona squamosa* L.	Pulp
Purple sugar apple	Saramuyo morado		
Sapodilla	Chicozapote	*Manilkara sapota* L.	Pulp
Dragon fruit	Pitahaya	*Hylocereus undatus* Haworth	Pulp + seed
Yellow nance	Nance amarillo	*Byrsonima crassifolia*	Pulp + peel
Green nance	Nance verde		
Red nance	Nance rojo		
Ilama	Anona	*Annona diversifolia*	Pulp
Custard apple	Anona roja	*Annona reticulata*	Pulp
Mamoncillo	Uaya	*Melicoccus bijugatus* (Jacq.)	Pulp
Black sapote	Zapote negro	*Diospyros digyna*	Pulp