Journal of Drug Metabolism and Toxicology

Jerônimo et al., J Drug Metab Toxicol 2015, 6:4
DOI: 10.4172/2157-7609.1000188

Research Open Access

Chemical and Physical-Chemical Properties, Antioxidant Activity and Fatty Acids Profile of Red Pitaya [*Hylocereus Undatus* (Haw.) Britton & Rose] Grown In Brazil

Michelle Cristina Jerônimo[1*], **Joice Vinhal Costa Orsine**[2], **Karine Kristie Borges**[2] **and Maria Rita Carvalho Garbi Novaes**[3]

[1]*Federal Institute Goiás – Urutaí Campus, Avenue Valeriano de Castro, Brazil*

[2]*Federal Institute Goiás - Urutaí Campus, Brazil*

[3]*School of Health Sciences - ESCS / FEPECS, University of Brasilia, Brazil*

***Corresponding author:** Michelle Cristina Jerônimo, Food Technologist, Federal Institute Goiás – Urutaí Campus, Avenue Valeriano de Castro, 719, Apartment 301, Formosa, Goiás, Brazil, Tel: +556481440174; E-mail: michelle.cristina.jeronimo@gmail.com

Received date: June 24, 2015; **Accepted date:** August 5, 2015; **Published date:** August 11, 2015

Abstract

Pitaya is a cactaceae originally from Tropical and Subtropical America which belongs to the exotic fruit group, little explored to date by the food and pharmaceutical industries. The objective of the present study was to evaluate the chemical and physical-chemical properties, antioxidant activity and the fatty acid profile of the red pitaya fruit (pulp and peel) [*Hylocereus undatus* (Haw.) Britton & Rose], grown in Brazil. These analyses have shown that pitaya pulp has high moisture content (86.03%) and low lipid (0.16%) and protein (2.27%) content, which ensures a low fruit calorie value (53.68%). Among the highlighted minerals are potassium (3.090 mg / 100 g), manganese (2.230 mg / 100 g), chromium (1.250 mg / 100 g), sodium (0.140 mg / 100 g), calcium (0.040 mg / 100 g) and, at lower concentrations, phosphorus (0.003 mg / 100 g). On the other hand, the antioxidant activity of pitaya pulp (1266.3 μg mL^{-1}) was lower than in the pitaya peel (445.2 μg mL^{-1}). In the fatty portion of the fruit, we verified that the predominant fatty acid is linoleic acid (50.869% of total fatty acids in the fruit), followed by oleic acid (21.551%) and palmitic acid (12.632%). The antioxidant potential and the chemical properties of pitaya fruit can contribute to maintaining a healthy diet.

Keywords: Pitaya/dragon fruit; Red pitaya; Antioxidant potential; Chemical analysis

Introduction

The fruit called pitaya/dragon fruit is a cactaceae originally from Tropical and Subtropical America which belongs to a group of fruits considered promising for cultivation in Brazil. Until recently, this fruit was unknown and has come to represent a growing niche in the exotic fruit market due to appreciation of the organoleptic characteristics when eaten raw or inserted in gastronomy [1]. The red pitaya can be grouped into four botanical genera: Stonecereus Briton & Rose, Cereus MiLL., Selenicereus (A. Beger) Riccob and Hylocereus Briton & Rose [2]. The variability of the species is mainly related to size and color and production time [3]. The most common and commercialized species are: *Selenicereus megalanthus*, red yellow pitaya with white flesh known as "Colombian red pitaya"; *Hylocereus polyrhzius*, red pitaya with red peel and pulp; *Hylocereus undatus,* red pitaya with white pulp [4]. The *Selenicereus setaceus* species, also known as the red pitaya of the cerrado is commonly found in Brazil and presents small thorny fruit [5].

With many dark edible seeds, approximately 3 mm in diameter, the apparently juicy red pitaya pulp presents a sweet tasting, gelatinous consistency when ripe, which is usually consumed fresh or processed in the form of ice cream, juice, jelly, wine and salad [6]. In some regions of South America, the pulp is used in beverages, as successfully occurs in Brazilian restaurants where it is served in chunks, together with champagne [7]. The red pitaya shell has great potential to be used as natural pigment due to the presence of betacyanin [8], and presents possible antioxidant activity [9]. In Brazil, there are a few farming areas dedicated to the pitaya cultivation, in the state of São Paulo, mainly in Catanduva County where production occurs from December to May, with an average annual yield of 14 tons of fruit per hectare [1]. The high cost charged for the kilo of the fruit, which can range from ten to sixty reais (R$) in Brazil, depending on the season and demand, makes planting this fruit very attractive [10]. Therefore, this study aims to characterize the chemical-physicochemical properties and the antioxidant activity and to profile the fatty acids in the pulp and peel of red pitaya [*Hylocereus undatus* (Haw.) Britton & Rose] grown in Brazil.

Materials and Methods

Obtaining raw material

A selection of healthy-looking red pitaya fruit, free of bruises, rotting and odors was obtained from a producer in Brasília - Federal District, between January and February 2013.

Physical-chemical analysis of red pitaya

The duplicate physical-chemical analyses of the red pitaya pulp were carried out at the Laboratory of Physicochemical and Food Analysis - School of Pharmacy, Federal University, Goiás. The results were expressed by calculating the mean values obtained in each analysis. Moisture, ash, protein, lipids, crude fiber and carbohydrates were analyzed in the pulp and peel of the fruit, following the methodology proposed by the AOAC [11]. To calculate the total calories (Kcal), the following factors were used: four for protein and carbohydrates and nine for lipids, according to the methodology described by Ferreira and Graça [12]. The hydrogenionic potential (pH) was performed according to the methodology No. 017/IV of the Adolfo Lutz Institute [13], in which an electrometric method in water was used. The reducing (glucose) sugars and non-reducing (sucrose) sugars were quantified based on the Somogyi and Nelson method [14] adapted by Pereira and Campos [15]. Readings were taken using a spectrophotometer UV-VIS (510 nm wavelength). The analysis of the titratable acidity, soluble solids and ascorbic acid (vitamin C) were also carried out with methodology based on redox reaction [16].

Determination of Mineral

To determine mineral levels, the atomic absorption spectrophotometry technique (GBC Brand Spectrophotometer, Model 932AA) was used, in duplicate, at the physical-chemical analysis laboratory of the Food Research Center, School of Veterinary Medicine, Federal University of Goiás. Research on aluminium, arsenic, lead, cobalt, copper, chromium, cadmium, calcium, iron, phosphorus, magnesium, manganese, mercury, nickel, potassium, selenium, sodium, and zinc was conducted, in accordance with the presence of specific cathode lamps for each mineral. To determine sodium and potassium levels, flame photometry was used in a photometer (Model DM-6, Digimed brand). The results were expressed by calculating the mean values obtained for each analysis.

Determination of simple profile and fatty acid complex

The complete profile of fatty acids was performed at the Food Research and Analysis Food, School of Veterinary Medicine, Federal University of Goiás (CPA - EV - UFG). All analyses were performed in duplicate and the results were expressed by mean results. Oil was extracted from red pitaya pulp to perform fatty acid analysis following methodology proposed by Bligh and Dyer [17] and qualitative and quantitative identification followed the Visentainer and Franco [18] protocol. The ethereal extract of pulp underwent the methylation of fatty acids technique, according to the methodology described by Antoniosi Filho (1995), and transesterification followed the Maya technique [19]. In order to quantify and determine fatty acid, we used Focus Gas Chromatograph (Focus Model GC Finningan) equipped with a flame ionization detector (FID) and fused silica capillary columns Restek 2560 RT of 100 m long × 0.25 mm of internal diameter containing 0.2 µm. As carrier gas, hydrogen was used at a flow rate of 2.0 mL per minute, and the makeup gases used to maintain the flame detector were synthetic air, hydrogen and nitrogen at rates of 300, 30 to 28 mL per minute, respectively. The injection volume was 1 µL and the split ratio was 2/98. The retention time and peak area, as well as area rate values (normalization method), were obtained using the Chrom Quest 4.1 Software. The identification and quantification of fatty acids (%) were measured by using a calibration curve made with the assistance Fatty Acid Methyl esters standards (Sigma - FAME Mix C4-C24).

Determination of antioxidant potential

The analyses of red pitaya pulp and shell antioxidant activity were performed in triplicate, at the physical-chemical analysis lab at the Goiania Federal Institute - Urutaí Campus. The antioxidant activity was determined according to the methodology proposed by Borguini [20], upon evaluating the non-fractionated watery extract of the sample using the DPPH method (2,2-diphenyl picrylhydrazyl) following the technique described by Brand-Williams et al. (1995). A spectrophotometer UV-VIS (Spectrum brand, model SP 2000 UV wavelength of 517 nm) was used for the readings. To evaluate antioxidant activity, the values observed in the spectrophotometer were inserted in the formula:

% discoloration = {1- [Abs sample + Abs blank) / control × 100}

The antioxidant activity of the samples was evaluated at 0, 1, 2, 3, 4, 5, 10, 15 and 20 minutes after initiating the reaction with DPPH.

Results and Discussion

Physical-chemical analysis of red pitaya (*Hylocereus undatus* Haw)

The results of physical-chemical analyses of red pitaya pulp are expressed in Table 1. The red pitaya sample from Brasília - DF, Brazil, had high moisture content (86.03%), Table 1. Results reported by Le Bellec [21] corroborate the results of this study, since, according to the authors, this level ranges between 82 and 88%. Le Bellec [21] found lower protein values (between 0.3 and 1.5%) in red pitaya than the values found in this study (2.27%).

Physical-chemical analysis	Red pitaya pulp in natura
Moisture % m/m	86.03
Mineral Fixed residue % m/m	0.75
Lipids % m/m	0.16
Proteins % m/m	2.27
Total Carbohydrates %	10.79
Total caloric value Kcal 100/g	53.68
pH Determination Crude fibers % m/m	5.05 1.15
Total acidity mL sun M % m/v	1.82
Total sugars % m/m	5.92
Non-reducing sugars in sucrose % m/m C Vitamin (iodide method) mg/100g	3.66 0.84
Total Solids % m/m	13.97
Soluble solids in °Brix at 20°C	11.40
Insoluble solids in water % m/m	4.03

* A physical-chemical analysis was performed in duplicate and expressed as mean results

Table 1: Physical-chemical analysis of red pitaya pulp (*Hylocereus undatus Haw*).

In a study by Barbosa [22], the authors found 5.47% and 4.81% protein values, respectively, in xique-xique (*Cereus gounellei*) and mandacaru fruits (*Cereus jamacaru*), also belonging to the Cactaceae family, which are superior to the values found in the present study. In accordance with Rufino [23], the pH values of red pitaya pulp range from 4.3 to 4.7, which are lower than the pH (5.05) found in this study.

According to Baruffaldi and Oliveira [24] and Silva and Alves [25], pH values significantly affect the growth of microorganisms, since low-acid foods, with pH above 4.0, are susceptible to growth of *Clostridium botulinum* strains, toxin producers. According to Sim [26], *Salmonella* spp. may grow on freshly harvested red pitaya under inadequate storage conditions at room temperature. Considering that the optimum pH for the growth of Salmonella is between 6.5 and 7.5 [27], the use of low temperatures during storage of red pitaya would extend shelf life and contribute to consumption safety. Brunini and Cardoso [28] studied red dragon fruit storage at 13°C for 25 days and observed an increase in pH value from 4.60 to 5.8, consistent with results presented in this study. Studies on dragon fruit storage conditions show that an 8°C storage temperature is best to keep the same quality attributes [29]. The acid values found in the red pitaya was (1.82%), superior to those obtained by Oliveira [30] with 0.21% acidity values in the fruit of the mandacaru cactaceous (*Cereus jamacaru*). In research conducted by Nerd et al. [31], the authors found that the titratable acidity below 1% explains the pleasant flavor and sweetness red pitaya fruit. Total soluble solids are used as the maturity index for some fruit and indicate the amount of substances that are dissolved in the juice, constituted mostly by sugars [32]. The amount of soluble solids found in samples of red pitaya (11.40 °Brix) corroborate the results reported by Wu [33] in red pitaya pulp (11.1 °Brix). For Wanitchang [34], fruits with °Brix reading higher than 12% and 13% have better acceptance for consumption. The crude fiber found in red pitaya was 1.15%, a result similar to that found in the pulps of xique-xique cacti (*Cereus gounellei*) and mandacaru (*Cereus jamacaru*) 1.13% and 1.45%, respectively [22]. With the results obtained in this study, it holds true that red pitaya is a food with low energy value and a good source of crude fiber, thus contributing to a healthy diet. Additionally, it displays low lipid content (0.16%). The caloric value (53.68 Kcal 100/g) found in the pulp was higher than the caloric values quoted by Le Bellec [35], for the *Hylocereus undatus* and *Hylocereus costaricensis* species, corresponding to 37.9 kcal and 41.7 kcal respectively. The ash content which corresponds to the inorganic or mineral fraction of foods was 0.75%. According to Gondim [35], fruits are considered the main sources of minerals in human diet, found in higher levels in the fruit bark than in the edible parts. In a study conducted by Silva [36], the authors found 0.72% mineral values in "coroa-de-frade" fruit (*Melocactus zehntneri*), which was close to the value found in the present study for red pitaya. Morton [37], working with "ora-pro-nobis" cactaceous, found an ash content of 0.6%, which was lower than the red pitaya fruit content found in the present investigation. The red pitaya pulp showed higher total solids (13.97%) than the 11.82% value found by Queiroz [38] for the fig-of-India pulp, which is also a cactaceous.

On observing the amount of vitamin C in red pitaya (0.84 mg.100 g^{-1}), we found out that is was lower than the amounts found by Beltrán-Orozco [39], which were a mean 13 mg. 100 g^{-1} in red pitaya of the gender Stenocereus. On the other hand, Choo and Yong [40] found a mean concentration of vitamin C equal to 32.65 and 31.05 mg. 100 g^{-1} in red pitaya *Hylocereus polyrhizus* and *Hylocereus undatus*, respectively. In research conducted by Mahattanatawee [41], the authors found values of vitamin C equal to 55.8 and 13 mg.100 g^{-1} in red pitaya *Hylocereus sp.*, cv. Red Jaina (red pitaya with red pulp) and *Hylocereus sp.*, cv. David Bowie (red pitaya with white pulp), respectively. It can be seen that vitamin C levels may vary according to species, cultivar and origin.

Determination of Mineral

Determination of minerals present in red pitaya pulp is expressed in Table 2. The elements found in red pitaya pulp have great importance for human consumption. The body requires more than 100 mg/day of calcium and magnesium macronutrients, while it requires less than 100 mg/day of manganese, copper, zinc and iron.

Minerals	**Red Pitaya (*Hylocereus undatus*)**	**Quantity**	
		DDR	VMR or VMA
Aluminum (Al)	0.000 mg/100 g		1 mg/kg corporal/ week (VMA)
Arsenic	0.000 mg/100 g	-	-
Cadmium	0.000 mg/100 g		0.050 mg/kg weight when fresh (VMA)
Calcium	0.040 mg/100 g	800 mg/day	
Lead	0.000 mg/100 g		0.10 mg/kg weight when fresh (VMA)
Cobalt	0.000 mg/100 g	There is not, but for Vitamin B12 DDR 2.5 μ/day	
Copper	0.000 mg/100 g	1 mg/day	
Chrome	1.250 mg/100 g	40 μ/day	
Iron	0.000 mg/100 g	14 mg/day	
Phosphorus	0.003 mg/100 g	700 mg/day	
Magnesium	0.000 mg/100 g	375 mg/day	
Manganese	2.230 mg/100 g	3 mg/day	
Mercury	0.000 mg/100 g	-	-
Nickel	0.004 mg/100 g	50 mg/day	
Potassium	3.090 mg/100 g	2000 mg/day	
Sodium	0.140 mg/100 g		2.4 g of sodium/day – 6 g salt/day (VMR)
Selenium	0.000 mg/100 g	34 mcg	
Zinc (Zn)	0.000 mg/100 g	10 mg/day	

* Recommended daily dose (RDD), maximum recommended daily dose (MRDD) or maximum permissible values (MPV).

Table 2: Minerals found in red pitaya (*Hylocereus undatus*) cultivated in Brazil.

The mineral contents found in 100 g of red pitaya pulp with the exception of manganese, do not meet the recommended daily allowances for adults, which according to the World Health Organization are 1200 mg of calcium, 230-420 mg of magnesium, 1.8 to 2.3 mg of manganese, 11 mg of zinc for men and 8 mg for women [42]. Among the mineral elements analysed, potassium showed higher concentration, followed by manganese, chromium, sodium, calcium, and at a lower concentration, phosphorous. When Stinzing [43], characterized red pitaya pulp (*Hylocereus undatus*) chemically, the following concentrations were verified: calcium (23 mg. 100 g^{-1}), potassium (320 mg. 100 g^{-1}), magnesium (265 mg. 100 g^{-1}) sodium (33 mg. 100 g^{-1}). Moreover, in a study by Rodrigues [44], red pitaya from the cerrado showed levels of copper (1.1 mg. 100 g^{-1}), zinc (0.3 mg. 100 g^{-1}), and iron (2.9 mg. 100 g^{-1}), which were all higher than those found in the present study.

Determination of Fatty acids

The determination of fatty acids present in red pitaya pulp is displayed in Table 3.

Fatty Acids	Red pitaya pulp (*Hylocereus undatus*)	% Fatty acids
Palmitic acid C16:0	62.740 mg / 100 mL	12.632
Palmitoleic acid C16:1 ω 7	1.765 mg / 100 g	0.355
Heptadecanoic acid C17:0	0.373 mg / 100 g	0.075
Heptadecanoic acid C17:1 ω 7	0.580 mg / 100 g	0.116
Oleic acid C18:1 C ω 9	22.066 mg / 100 g	4.442
Oleic acid C18:1 T ω 9	107.040 mg / 100 g	21.551
Linoleic acid C18:2 C ω 6	252.650 mg / 100 g	50.869
Linoleic acid C18:2 T ω 6	0.690 mg / 100 g	0.138
Alpha Linolenic acid C18:3 ω 3	4.569 mg / 100 g	0.919
α-linolenic acid C18:3 ω 6	0.762 mg / 100 g	0.153
Arachidic acid C20:0	4.587 mg / 100 g	0.923
Eicosatrienoic acid C20:3 ω 6	0.615 mg / 100 g	0.123
Arachidonic acid C20:4 ω 6	1.384 mg / 100 g	0.278
Eicosapentaenoic acid C20:5 ω 3	0.304 mg / 100 g	0.061
Heneicosanoic acid C21:0	0.610 mg / 100 g	0.122
Behenic acid C22:0	3.713 mg / 100 g	0.747
Docosahexaenoic acid C22:6 ω 3	0.608 mg / 100 g	0.122
Tricosanoic acid C23:0	0.351 mg / 100 g	0.070
Lignoceric acid C24:0	2.527 mg / 100 g	0.508
Tetracosenoic acid C24:1 ω 9	0.309 mg / 100 g	0.062
Stearic acid C18:0	27.333 mg / 100 g	5.503
Eicosamonoeinoic C20:1 ω 9	1.091 mg / 100 g	0.219
Total saturated fatty acids (%)		20.580
Total unsaturated fatty acids (%)		79.408
* All analyses were performed in duplicate and results represent the mean of duplicates		

Table 3: Fatty acids present in red pitaya pulp (*Hylocereus undatus*) cultivated in Brazil.

On Table 3, observation showed that the predominant fatty acid in red pitaya pulp *Hylocereus undatus* is linoleic acid, which represents 50.869% of the total fatty acids in the fruit, followed by oleic acid with 21.551% and palmitic acid with 12.632 % of the total fatty acids. This mono and polyunsaturated composition of fatty acids is paramount to health, forasmuch as these acids contribute to reducing low-density lipoprotein fractions and very low density, both responsible for increased serum cholesterol [45]. Lipid components, especially fatty acids, play important roles in the structure of cell membranes and in metabolic processes. In humans, linoleic and alpha-linolenic acids are necessary to maintain cell membranes, brain function and the transmission of nerve impulses under normal conditions.

Also, these fatty acids play an active part in transferring atmospheric oxygen into blood plasma, in the synthesis of hemoglobin and cell division, and are called essential because they are not synthesized by the human body [46]. The MUFA/SFA and PUFA/SFA ratio (Table 4) in the red pitaya was 1.299 and 2.558, respectively, which represents an excellent result from a nutritional standpoint. We know that foods with values under 0.45 (MUFA/SFA and PUFA/SFA) are considered undesirable for humans, since it is correlated with the increase in blood cholesterol [47].

Rates	Red pitaya pulp
MUFA/SFA	1.299
PUFA/SFA	2.558
ω-6/ω-3	46.788
* SFA: Saturated fatty acids. MUFA: Monounsaturated fatty acids. PUFA: Polyunsaturated fatty acids. MUFA/SFA: ratio of monounsaturated fatty acids and saturated. PUFA/SFA: ratio of polyunsaturated fatty acids and saturated. ω-6/ω-3: ratio of fatty acid ω-6 and ω-3. Where ω: omega.	

Table 4: Ratio of ω-3 to ω-6 fatty acids present in red pitaya pulp obtained in Brasilia-FD.

Antioxidant activity of red pitaya pulp and peel

Figure 1 shows the antioxidant activity determined by the DPPH assay in red pitaya pulp and peel. The results are expressed as EC50 (μg mL^{-1}), which corresponds to the amount of extract required to reduce DPPH radical by 50%, therefore, the smaller the EC50, the better the antioxidant capacity of the extract. Some studies have shown that the dragon fruit has good antioxidant capacity in vitro. However, this antioxidant potential may vary among different species and different origins [41]. For red pitaya, the following absorbance values were obtained: Methanol (0.048 nm), Control: 750 μL + 1.5 mL DPPH (0.449 nm), White: 750 μL + 1.5 mL of methanol (0.043 nm). For standard BHT solutions, a powerful synthetic antioxidant, antioxidant activity was observed after a 20 minute reaction period with DPPH 90.20%.

Both pulp and peel extract displayed ability to sequester DPPH free radicals. The highest antioxidant activity was found in the peel (445.2 μg mL^{-1}), compared to the lowest value exhibited by the pulp (1,266.3 μg mL^{-1}).

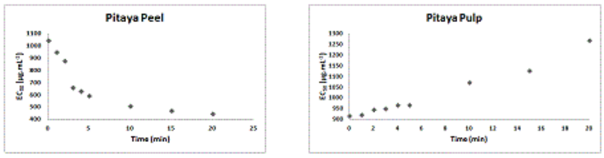

Figure 1: EC50 values (μg mL^{-1}) of aqueous extracts from red pitaya pulp and peel (*Hylocereus undatus*).

Vizzotto [48] evaluated the antioxidant potential of the pulp and peel of pitaya fruit by means of extraction in methanol and obtained EC50 values of 209.66 and 1,363.2 μg mL^{-1} for pulp and peel respectively, which were different from the values found in this work. Nevertheless, the authors also observed higher antioxidant activity in the pitaya peel in methanol extract than in the pulp.

According to Wu [33], the total phenolic contents of pitaya pulp and peel are similar, as well as the flavonoid content, which suggests that pulp and peel are rich in polyphenols and good sources of antioxidants. Even though polyphenols, flavonoids and phenolic contents were not evaluated in this study, observation shows that the red pitaya peel harvested in Brasilia has higher antioxidant activity than the pulp, in other words, both are nutritionally interesting for human consumption. However, it is essential to investigate the possible presence of anti-nutritional substances in the peel before recommending its use to the population. In a study by Kim [49], the authors also noticed that polyphenols and flavonoid contents in the methanol extract of red pitaya peel and white pitaya peel were approximately three to five times higher than the content of these same antioxidants in the red and white pitaya pulp, respectively. In research conducted by Orazco [50-55], the authors observed antioxidant activity in red pitaya, white pitaya and yellow pitaya belonging to the *Stenocereus stellatus* gender and showed some variation in the antioxidant capacity of this fruit, in accordance with its species.[Table 5]

Types	TEAC (mg. g^{-1}) T	TEAC (mmol g^{-1})T
Red	2763.2 ± 50.7	11.0 ± 0.20
Cherry	3047.1 ± 38.2	12.2 ± 0.15
Yellow	4202.1 ± 52.1	16.8 ± 0.21
White	4336.8 ± 36.3	17.3 ± 0.14
T Concetration based upon Trolox as standard (mean ± SD; n = 3)		

Table 5: Antioxidant capacity (TEAC) of different pitaya species obtained in research conducted by Orozco et al. (2009).

Conclusion

The pitaya pulp [*Hylocereus undatus* (Haw.) Britton & Rose] displayed high moisture content, which explains the low shelf life if stored at room temperature. The pulp showed reduced levels of lipids, proteins, vitamin C and sodium. Ordinarily, fruits have low levels of lipids and proteins. The concentration of ascorbic acid in fruit varies according to the type of cultivation, the stage of maturity and the conditions of cultivation, among others.

The low calorific value and the presence of micronutrients in fruit pulp is a great benefit for use in food, especially in low-calorie diets. The red pitaya grown in Brazil exhibits predominance of essential linoleic fatty acid (C18:2) followed by oleic acid (C18:1), important essential fatty acids with beneficial health effects.

Through the present study, weak antioxidant activity of red pitaya pulp was verified in comparison to the peel of the fruit, which suggests that the highest concentration of compounds with antioxidant activity is found in the peel. Therefore, we suggest that the fruit peels not be discarded in food preparation and emphasize that they be dried and valued as leftovers and fiber, rich in nutrients and bioactive compounds, import to the health of human beings.

References

1. Granulado Bioclástico, Rodrigo Amato Moreira, José Darlan Ramos, Neimar Arcanjo De Araújo,Virna Braga Marques (2012) Produção e qualidade de frutos de pitaia vermelha com adubação orgânica e granulado bioclástico. Revista Brasileira de Fruticultura, Jaboticabal E: 762-766.
2. Le Bellec F (2003) La pitaya (*Hylocereus sp.*) en culture de diversification à I'île de la Réunion. Paris: Institut National d'Horiculture 57: 219-230.
3. Marques VB (2010) Germinação, fenologia e estimativa do custo de produção da pitaia [*Hylocereus undatus (Haw.)* Briton & Rose].141 f. Tese (Doutorado em Fitotecnia) – Universidade Federal de Lavras, Lavras.
4. Donadio LC (2009) Pitaya. Revista Brasileira de Fruticultura, Jaboticabal 31: 637-929.
5. Junqueira KP, Junqueira NTV, Ramos JD, Pereira, AV (2002) Informações preliminares sobre uma espécie de Pitaya do Cerrado. Documentos 62: 9-18.
6. Nerd A, Mizrahi Y (1997) Reproductive biology of cactus fruit crops. Horticultural Reviews, New York, 18: 321-346.
7. Kling EO (2003) Fruto das flores: novas espécies tornam mais rentáveis os investimentos no campo. Revista Isto É, São Paulo 6: 21-23.
8. Harivaindaran KV, Rebecca OP, Chandran S (2008) Study of optimal temperature, pH and stability of dragon fruit (*Hylocereus polyrhizus*) peel for use as potential natural colorant. Pakistan Journal of Biological Sciences 11: 2259-2263.
9. Kim H, Choi HK, Moon JY, Kim YS, Mosaddik A, et al. (2011) Comparative antioxidant and antiproliferative activities of red and white pitayas and their correlation with flavonoid and polyphenol content. Journal of food science 76: 38-45.
10. Souza CE (2013) Economia e Negócios. Fruta exótica pouco cultivada na região faz sucesso. Disponível em.
11. (2012) AOAC (Association of Official Analytical Chemistry). Official methods of analysis. 19th ed. Gaithersburg.
12. Ferreira FAG, Graça MES (1983) Food Composition Database Activities Portugal. Lisboa: Instituto Superior de Higiene Dr. Ricardo Jorge.
13. Instituto Adolfo Lutz (2008) Métodos químicos e físicos para análises de alimentos. (1st edn.), São Paulo.
14. Nelson NA (1944) A photometric adaptation of Somogyi method for determination of glucose. Journal of Biological Chemistry 153: 375-380.
15. Pereira AS, Campos A (1999) Teor de açucares em genótipos de batata (*Solanum tuberosum L.*). Ciênc. Rural, Santa Maria 29: 13-16.
16. (1984) AOAC (Associaton of Official Analytical Chemistry). Official methods of analysis. 14. ed. Arlington.
17. Bligh EG, Dyer WJ (1959) A rapid method of total lipid extraction and purification. Can J Biochem Phys 37: 911-917.
18. Visentainer JV, Franco MRB (2006) Fatty acids in oils and fats : Identification and quantification , São Paulo: Varela 11-17.

19. Maia EL (1990) Optimization methodology for characterization of lipid constituents and determination of fatty acid composition and freshwater fish amino acids, Faculty of Food Engineering , State University of Campinas, Campinas.
20. Borguini RG (2006) Antioxidant potential and physical-chemical characteristics of organic tomato (Lycopersicon esculentum) in comparison with conventional tomato. 121f. Tese (Doutorado em Saúde Pública), Universidade de São Paulo, São Paulo.
21. Le Bellec F, Vaillant F, Imbert E (2006) Pitahaya (Hylocereus spp.): A new fruit crop, a market with a future. Welcome to Cambridge Journals Fruits, Paris 61: 237-250.
22. Barbosa AS, Araújo AP, Canuto TM, França VC, Barbosa AS (2006) Avaliação preliminar da composição fisico-quimica dos frutos do mandacaru (*Cereus jamacaru*) e xique-xique (*Cereus gounellei)*. Anais do Congresso Brasileiro de Química - Salvador – BA.
23. RufinO MSM, Alves RE, Brito ES, Morais SM, Sampaio CG, et al. (2007) Metodologia científica: determinação da atividade antioxidante total em frutas pela captura do radical livre DPPH. EMBRAPA Com Técn 127:1-4.
24. Baruffaldi R, Oliveira MN (1998) Factors that influence the stability of food. Food technology fundamentals. São Paulo : Atheneu 3: 13-25.
25. Silva LR, Alves RE (2009) Physico-chemical characterization of fruit mandacaru. Academic Journal of Agricultural and Environmental Sciences, Curitiba 7: 199-205.
26. Sim HL, Hong YK, Yoon WB, Yuk HG (2012) Behavior of *Salmonella* spp. and natural microbiota on fresh-cut dragon fruits at different storage temperatures. Journal of Food Micrbiology 160: 239-244
27. Costa FN (1996) Salmonella serotypes in chicken carcasses and cuts made in industry and commerce and behavior of strains isolated to the action of antibiotics. Faculty of Agricultural and Veterinary Sciences - Universidade Estadual Paulista (UNESP) , Jaboticabal , São Paulo.
28. Brunini MA, Cardoso SS (2011) Qualidade de pitayas de polpa branca armazenadas em diferentes temperaturas. Revista Caatinga, Mossoró, 24: 78-84.
29. Magaña BW (2006) Principales caracteristicas de calidad de las pitahayas (*Hylocereus undatus* haworth), frigoconservadas em atmosferas controladas. Revistas Ciencias Técnicas Agropecuarias, Habana 15: 52-56.
30. Oliveira FMN, Alexandre HV, Figueirêdo RMF, Queiroz AJM, Oliveira AR (2004) Características físico-químicas da polpa e casca do fruto do mandacaru. In: Congresso Brasileiro de Ciência e Tecnologia de Alimentos, Brazil.
31. Nerd A, Mizrahi Y (1999) Effect of ripening stage on fruit quality after storage of yellow pitaia. Postharvest Biology and Technology, Amsterdam 15: 99- 105.
32. Chaves MCV, Gouveia JPG, Almeida FAC, Leite JCA, Silva FLH (2004) Características físicoquímicas do suco de acerola. Revista de Biologia e Ciências da Terra 4.
33. Wu LC, Hsu HW, Chen YC, Chiu CC, Lin YI, et al. (2006) Antioxidant and antiproliferative activities of red pitaya. Food Chemistry 95: 319–327.
34. Wanitchanga J, Terdwongworaku A, Wanitchanga P, Noypitak S (2010) Maturity sorting index od dragon fruit: *Hylocereus polyerhizus*. Journal of Food Engineering 10: 409-416.
35. Gondim JAM, Moura MFV, Dantas AS, Medeiros RLS, Santos KM (2005) Composição centesimal e de minerais em cascas de frutas. Ciência e Tecnologia de Alimentos, Campinas 25: 825-827.
36. Silva ASA, Figueirêdo RMF, Queiroz AJM (2005) Lima, E. Avaliação da composição físico – química da coroa – de – frade. Revista de Biologia e Ciências da Terra.
37. Morton JF (2013) Barbados gooseberry. In: Fruits of warm climates. Creative Resource Systems, Inc, Miami, Florida.
38. Queiroz AJM, Figueirêdo RMF, Grandeiro AA (2004) Características físico-químicas de polpas de figo-da-índia concentradas. In: Congresso Brasileiro De Engenharia Agrícola, São Pedro.
39. Beltrán Orozco MC, Oliva Coba TG, Gallardo Velázquez T, Osorio Revilla G (2009) Ascorbic acid, phenolic content, and antioxidant capacity of red, cherry, yellow and white types of pitaya cactus fruit (Stenocereus stellatus Riccobono). Agrociencia 43: 153-162.
40. Choo WS, Yong WK (2011) Antioxidant properties of two species of Hylocereus fruits. Advances in Applied Science Research 2:418-425.
41. Mahattanatawee K, Manthey JA, Luzio G, Talcott ST, Goodner K, et al. (2006) Total antioxidant activity and fiber content of select Florida-grown tropical fruits. Journal of Agricultural and Food Chemistry 54: 7355-7363.
42. ANVISA (2005) Regulamento técnico sobre a ingestão diária recomendada (IDR) de proteína, vitaminas e minerais, Brazil.
43. Stintzing FC, Schieber A, Carle R (2003) Evaluation of colour properties and chemical quality parameters of cactus juices. European Food Research Technology, London 216: 303-311.
44. Rodrigues LJ (2010) Development and minimal processing of native dragon fruit (*Selenicereus setaceus* Rizz .) Of the Brazilian cerrado 164 p . Thesis (Doctorate in Science of Food) - Federal University of Lavras.
45. Jenkins DJ, Kendall CW, Marchie A, Parker T, Connelly PW, et. al (2002) Dose response of almonds on coronary heart disease risk factors: blood lipids, oxidized low density lipoproteins, lipoprotein(a), homocysteine, and pulmonary nitricoxide. A randomized, controlled, crossover trial. Circulation. 106: 1327- 1332.
46. Martin CA, De Almeida VV, Ruiz MR, Visentainer JEL, Matshushita M, et al. (2006) Polyunsaturated fatty acids omega- 3 and omega -6 : importance and occurrence in foods. Nutrition Magazine 19: 761-770.
47. Department of Health and Social Security (1984) Diet and Cardiovascular Disease. Report on Health and Social Subjects, London.
48. Vizzoto, M, Schiavon Mv, Munhoz Pc, Coelho Dds, Nachtigal Jc (2014) Determinação de compostos fenólicos, carotenóides e atividade antioxidante em genótipos de pitaia (espécies não determinadas). XXIII Congresso Brasileiro de Fruticultura. Cuiabá.
49. Kim H, Choi HK, Moon JY, Kim YS, Mosaddik A, et al. (2011) Comparative antioxidant and antiproliferative activities of red and white pitayas and their correlation with flavonoid and polyphenol content. Journal of Food Science 76: C38-45.
50. Orazco MCB, Coba TGO, Velázquez TG, Osorio Revilla G (2009) Ácido ascórbico, contenido fenólico, y capacidade antioxidante de las variedade roja, cereza, anarilla yblanca del fruto del cactos de la pitaya (Stenocereus stellatus Riccobono). Agrociência, Montevideo 43: 153-162.
51. Antoniosi Filho NR (1995) Análise de óleos e gorduras vegetais utilizando métodos cromatográficos de alta resolução e métodos computacionais. 1995. Tese (Doutorado) - Instituto de Química de São Carlos. Universidade de São Paulo, São Carlos.
52. Brand Williams W, Cuvelier ME, Berset C (1995) Use of a free radical method to evaluate antioxidant activity. Food Science and Technology 28: 25-30.
53. Brasil (2015) Ministry of Health. National Health Surveillance Agency. Technical regulation on the recommended daily intake (RDI) of protein , vitamins and minerals, Available at : Accessed on: 14.
54. Brunini MA, Cardoso SS (2011) Qualidade de pitayas de polpa branca armazenadas em diferentes temperaturas. Revista Caatinga, Mossoró 24: 78-84.
55. Chaves MCV, Gouveia JPG, Almeida FAC, Leite JCA, Silva FLH (2004) Caracterização físico-química do suco da acerola. Revista Biológica e Ciências da Terra 4: 1-10.