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Proceeding Paper

Nutritional Contribution of an Undervalued Ancestral Cucurbita, Study of *Sicana* sp. Endocarp, Epicarp and Seeds Composition †

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Abstract: Native to South America, the *Sicana* sp. fruits, known in Paraguay as "kurugua", belongs to the Cucurbit family and is almost extinct in the region. The aim of this study was to determine the physicochemical characteristics, composition and antioxidant activity of "kurugua" with reddish peel color. The determinations were made by official and regional standardized methodologies on fresh weight (FW). The pulp has an alkaline pH (7.41 ± 0.11), and its main components are carbohydrates (9.44 ± 0.45 g·100 g^{-1}), followed by dietary fiber (1.74 ± 0, 04 g·100 g^{-1}), as minor proteins (0.53 ± 0.05 g·100 g^{-1}) and lipids (0.08 ± 0.01 g·100 g^{-1}). On the evaluated antioxidants compounds, they were higher in peel than in pulp as; total phenols (279.2 ± 12.1, 55.7 ± 10.3 mg of GAE·100 g^{-1}), Vitamin C (9.67 ± 0.09, 7.84 ± 1.71 mg·100 g^{-1}) and beta-carotene (0.37 ± 0.03, 0.19 ± 0.01 mg·100 g^{-1}), respectively. Fresh seeds have a high moisture content (38.8%), dietary fiber (40.2%) and lipids (11.74%), they mineral composition showed a high content of Mg and Ca and a high content of micronutrients such as Cu, Mn, Fe and Zn, which can represent a great contribution to the daily requirements of the diet. The red kurugua fruits are a natural source of nutritious and bioactive compounds beneficial to health, with multiple potential applications in foodstuff, which should be promoted in healthy dietary guidelines for the benefit of the populations.

Keywords: composition; carotenes; antioxidants; total phenol compounds; *Sicana* sp.

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1. Introduction

The kurugua fruit belongs to the genus *Sicana*, which in turn belongs to the curcubitaceae family. This oval-shaped fruit, which grows on the vine similar to grapes, is native to South America [1]. Its pulp or endocarp is widely used by the inhabitants for various culinary recipes, including sweet and salty foods [2]. Despite having a very pleasant aroma and a tasty pulp, this fruit is not currently widely consumed in the region, due to lack of knowledge of its uses. This is because new generations and the urban population no longer grow them domestically. Unlike the fruits of *Sicana* sp. with reddish skin, the black *Sicana odorifera* variety is currently better known and studied [1,3]. The objective of this work was therefore to determine the physicochemical characteristics, proximal composition and antioxidant activity of the endocarp, epicarp and seeds of "kurugua" fruits *Sicana* sp. growing in Paraguay.

2. Materials and Methods

2.1. Plant Material

The fruits of *Sicana* spp. were collected in January 2020, from the department of Cordillera of the city of Juan de Mena (24°57′35.8″ S, 56°44′20.0″ W) Paraguay. The "kurugua" with the reddish peel color by convenience sampling of the harvest of the year 2020 in a mature state. They did not show any visible signs of damage and were sent to the Department of Food Biochemistry of the Faculty of Chemical Sciences of the National University of Asunción (FCQ-UNA). The seeds and epicarp were manually separated from the endocarp and analysed immediately.

2.2. Physicochemical Characteristics

Morphological studies were carried out on whole fruits without previous treatment, as described by Coronel et al. [3]. The pH (method N° 920.152), tithable acidity (method N° 925.53) and soluble solids (method N° 932.14) were measured according to AOAC Methods [4]. A potentiometer (BOECO, MBT-700 model, Berlin, Germany) at 25 °C and an analytical balance (KERN ADB, Baligen, Germany) were used.

2.3. Proximal Composition

The proximal composition of the endocarp and seed of the analysed fruits was determined by official methodologies (AOAC) [4]: moisture (method No. 950.06), ash (method No. 923.03), dietary fiber (method No. 991.42), total lipids (method No. 970.51) and total nitrogen using the conversion factor 6.25 from nitrogen to proteins (method No. 920.152). The content of total carbohydrates and soluble sugars was determined using the Clegg anthrone method, with and without previous acid hydrolysis, respectively [5]. The results were expressed in g/100 g fresh sample.

2.4. Minerals Content

The minerals content of the endocarp and seed of the analyzed fruits was determined by the atomic absorption (AA 6300 Shimadzu, Kyoto, Japan) AOAC method 975.03 [4]. The minerals analyzed were Na, Ca, Mg, Fe, Cu, Zn and Mn. For each mineral, a calibration curve was made using standard solutions (MERCK, Darmstadt, Alemania). The results were expressed in mg/100 g fresh sample.

2.5. Total Phenol Content

The content of total phenols was determined in the endocarp and epicarp of the fruits. The extracts were made with methanol: water (80:20), as described by IICA (2018) [6]. Total phenols were measured spectrophotometrically using the Folin–Ciocalteu reagent by the method described by Singleton and Rossi, (1965) [7], where the blue colored complex was quantified at 765 nm (UV-1800, Shimadzu, Kyoto, Japan). A gallic acid calibration curve (10–160 µg/mL) was used. The results were expressed in mg of gallic acid equivalents (GAE) per 100 g of sample fresh (mg of GAE/100 g).

2.6. Vitamin C Content

The Vitamin C content was determined in the endocarp and epicarp of the fruits. The determination was made using the spectrofluorometric method 967.22 of AOAC [4]. The results were expressed in mg of Vitamin C per 100 g of pulp fresh weight.

2.7. Content of β-Carotene

For the extraction of total carotenoids, the method previously described by Procisur, IICA was used [6]. The content of β-carotene was determined by HPLC-PDA with some modifications [6]. First, the extraction with BHT (in acetone) was performed. The injections were made immediately after each extraction. The chromatographic system used was: C18 column (Phenomenex Inc., Torrance, CA, USA) 250 cm × 4.6 mm, 5 µm, 100 Å, kept at 30 °C, FM: methanol: acetonitrile: triethylamine (900:100:1) isocratic. Flow 1.5 mL/min,

injection volume 20 µL. Detector; PDA SPD-M20A (Shimadzu, Kyoto, Japan) at 450 nm. A calibration curve of β-carotene dissolved in HPLC grade acetone was used (0.3–3 µg/mL).

2.8. Statistical Analysis

The data were recorded in an Excel spreadsheet and analyzed in the statistical program Graphpad prism 5.0 (GraphPad Software Inc., San Diego, CA, USA). Student's t ($p \leq 0.05$) was used to determine the significant differences.

3. Results

3.1. Physicochemical Characteristics

The fruits of *Sicana* spp. analyzed has a reddish (Figure 1) peel that easily distinguishes it from the *Sicana odorífera* variety anthropurpurea, which has a black peel, as published in other works [1]. The morphological characteristics of the analyzed fruits are detailed in Table 1, where we can see that the weight of the fruits is quite similar to that reported in *S. odorífera* var. mature with black peel [1], as well as its transverse diameter; however, its longitudinal diameter turned out to be smaller. On the other hand, it was observed that the soluble solids and the pH of the endocarp of the kurugua with reddish skin analyzed are higher than the kurugua with black peel, however we found that the titratable acidity found in this work is lower than that reported by Coronel et al. [3].

A **B** **C**

Figure 1. Reddish *Sicana* spp. fruits. (**A**) Whole fruits. (**B**) Measurements made. (**C**) Cross section of the fruit showing pulp and seeds.

Table 1. Physicochemical characterization of *Sicana* spp. with reddish peel.

Parameter	Result
Weight (g)	1656 ± 11
Longitudinal diameter (cm)	23.13 ± 1.82
Transverse diameter (cm)	10.90 ± 0.23
Soluble solids (°Brix) *	11.86 ± 0.21
Titrable acidity (g of Ac. Citrus) *	0.06 ± 10.02
pH *	7.41 ± 0.11

The values express the average of three repetitions ± SD.* Determinations made in fresh fruit endocarp.

3.2. Proximal Composition and Minerals Content of the Endocarp and Sed

The proximal composition and the mineral content of the endocarp and the fruit seeds analyzed are presented in Table 2, where we can observe that there are significant differences in all the determinations made (student's t, $p \leq 0.5$). This is to be expected due to it being a fresh fruit, where endocarp is also known as fruit pulp and has water as the majority component (86.67%), as reported by other authors [1,8]. In the seeds, the high content of dietary fiber (40.19%), total proteins (18.58%) and lipids (11.74%) stand out. Although the moisture content of the analyzed seeds (35.29%) is similar to that reported for the *Curcubita maxima* (pumpkin) [9], it has a much lower dietary fiber content and the

total protein content is higher than that of this job. Of the minerals analyzed, Ca was the majority, both in the endocarp and in the analyzed seeds.

Table 2. Proximal and minerals content of endocarp and seed of *Sicana* spp. with reddish peel.

Parameter	Endocarp	Seed
Moisture (g/100 g)	86.67 ± 1.97 [a]	35.29 ± 0.04 [b]
Ash (g/100 g)	0.08 ± 0.01 [a]	2.64 ± 0.02 [b]
Total protein (g/100 g)	0.53 ± 0.05 [a]	18.58 ± 4.17 [b]
Total lipids	0.08 ± 0.01 [a]	9.16 ± 1.22 [b]
Total carbohydrate (g/100 g)	9.44 ± 0.45 [a]	3.35 ± 0.40 [b]
Dietary fiber (g/100 g)	1.74 ± 0.04 [a]	40.19 ± 0.00 [b]
Caloric Value (Kcal/100 g)	41	170
Na (mg/100 g)	3.46 ± 0.32 [a]	35.26 ± 0.02 [b]
Ca (mg/100 g)	21.21 ± 1.88 [a]	148.42 ± 3.74 [b]
Mg (mg/100 g)	1.58 ± 0.46 [a]	193.15 ± 4.84 [b]
Fe (mg/100 g)	0.25 ± 0.01 [a]	8.14 ± 0.63 [b]
Zn (mg/100 g)	0.42 ± 0.06 [a]	3.21 ± 0.01 [b]
Cu (mg/100 g)	0.19 ± 0.03 [a]	0.84 ± 0.05 [b]
Mn (mg/100 g)	0.42 ± 0.02 [a]	2.10 ± 0.05 [b]

The values express are means ± SD. Different letters indicate significant differences between means (*t* of Student $p \leq 0.05$).

3.3. Content of Total Phenols, Vitamin C and β-Carotene in the Endocarp and Epicarp

Content of total phenols, Vitamin C and β-carotene of the endocarp and epicarp of the fruits of *Sicana* spp. with reddish peel are shown in Figure 2. Significant differences (student's *t*, $p \leq 0.5$) are observed between the endocarp and epicarp in these three determinations, being the highest value for the epicarp in the case of phenol and β-carotene content and for the endocarp in the case of Vitamin C. The content of total phenols found in this work is higher than that reported in the pulp (endocarp) and peel (epicarp) of the kurugua with black peel [1], however, the Vitamin C content found in this work is less than the same [3]. The reddish color of the fruit's peel or the yellowish color could be due to a good content of β-carotene, although in this work it is shown that its content is low, so other substances that cause these colorations should be sought.

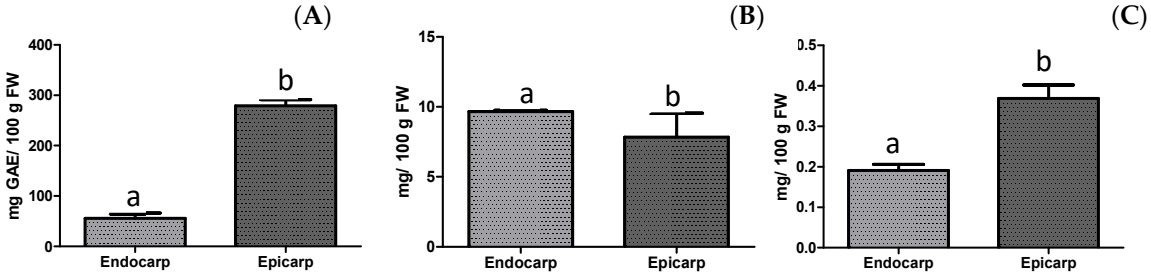

Figure 2. (**A**) Content of total phenols, (**B**) Vitamin C and (**C**) β-carotene of endocarp and epicarp of reddish *Sicana* spp. The values express are means ± SD. Different letters indicate significant differences between means (*t* of Student $p \leq 0.05$).

4. Conclusions

The morphological and physicochemical characteristics of the fruit of "kurugua" *Sicana* sp., and its proximal composition and minerals have been described, where the high content of dietary fiber, total proteins and lipids of the seeds, which are currently underused, stands out.

The presence of antioxidant compounds such as phenolic compounds and Vitamin C has been observed in the pulp and peel of the fruits. Significant amounts of carotenes have not been observed in the reddish rind or in the pulp of the fruit.

The fruits of *Sicana* sp. "kurugua" are a natural source of nutritional and bioactive compounds beneficial to health, with multiple potential applications in food, which should be promoted in healthy eating guidelines for the benefit of the population.

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