Oil Characterization and Seeds Composition of *Sicana odorifera*, an Ancestral Cucurbita from Paraguay [†]

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Abstract: *Sicana odorifera* seeds, from an ancestral *Cucurbita* growing in Paraguay, possess important biowaste after fruit pulp use. However, there are reports that its infusions can reduce and cure the symptoms of viral diseases such as hepatitis, denoting its medicinal properties. The recovery of nutrients and bioactive molecules from its bio-residues has potential uses in the industrial sector with high added value as functional food ingredients. In *S. odorifera* species, although it is not a fruit for mass consumption, it is precisely the lack of a market for its biowaste that has limited its integral use. Based on this, the centesimal composition, oil characterization, and fatty acids profile of the kurugua seeds from two accessions (atropurpurea (black) and reddish) were studied. Kurugua seeds have been subjected to a cold extraction with a hydraulic press from dried whole seeds, and ISO and AOCS standard methods were used for analytical determinations. The major components in the centesimal composition of kurugua seeds were lipids, dietary fiber, and proteins. The oils presented iodine, saponification, and refractive indices characteristic of preferentially polyunsaturated oils. The major component in the fatty acid profile was linolenic acid, an important essential fatty acid in the diet. Although the characteristics of kurugua oil, demonstrate its potential application in the food industry as a polyunsaturated oil, source of essential fatty acids, future studies on stability and sensory analysis for food applications are suggested, with great possibilities for the food safety framework.

Keywords: biowaste; composition; Cucurbita; fatty acids; oil; *Sicana odorifera*

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1. Introduction

The ancestral species of the Cucurbitaceae family are part of the cultural and food heritage of several nations. However, some members of this family, such as *S. odorifera*, have been losing prominence to the point of being undervalued at the regional level, despite their delicate and delicious aroma and flavor and the multiple potential applications of its pulp [1].

The seeds of these fruits are important bio-residues. There are reports that its infusions can reduce and cure the symptoms of viral diseases such as hepatitis, denoting its medicinal properties. In *S. odorifera* species, although it is not a fruit for mass consumption, it is precisely the lack of a market for its biowaste that has limited its integral use. The recovery of nutrients and bioactive molecules from the bio-residues has potential uses in the industrial sector with high added value as functional food ingredients, which can be used by the health food industry [2].

The aim of this work was to characterize the composition of the seeds of *S. odorifera* in its two varieties (with fruits with black skin and reddish skin), which presents an opportunity to explore the use of biowaste from their pulp.

2. Materials and Methods

2.1. Plant Material

The fruits of *Sicana odorifera* collected in January 2020, from the Cordillera Department, Juan de Mena city (24°57'35.8" S, 56°44'20.0" W) Paraguay, are of two varieties; anthropurea (black) and reddish, harvested in 2020 in a mature state they did not show visible damage, and were sent to the laboratory for further analysis. The seeds were manually separated from the pulp and immediately analyzed to determine their physicochemical characteristics. For the centesimal composition, they were dried in a vacuum oven for 24 h at 60 °C.

2.2. Obtaining the Oil

The sample was weighed into a 250 mL Erlenmeyer flask and hexane was added maintaining the ratio 1:5 (*p/v*), this was stirred for approximately 3 h. Then, it was filtered under vacuum and subsequently the solvent was evaporated in a rotary evaporator (60 °C).

2.3. Analysis

The proximal composition analysis was determined by official methodologies [3] moisture (method No. 934.06), ash (method No. 968.08), dietary fiber (method No. 985.29), total lipids (method No. 948.22), and total nitrogen using the conversion factor 6.25 from nitrogen to proteins (method No. 970.39). The content of total carbohydrates and soluble sugars was determined by the Clegg anthrone method. The results were expressed in g/100 g on dry samples. The oil characterization parameters were measured by official AOCS methodologies (2009) [4], where the iodine index was performed by the Cd 1-25 method, the saponification index by the Cd 3-25 method and the refraction index by method Cc 7-25. The density corresponds to the magnitude that expresses the relationship between mass and volume. 1 mL of kurugua seed oil, black and red peel, was weighed, and later the mass-volume relationship was calculated. Kurugua seeds have been subjected to a cold extraction with a hydraulic press from dried whole seeds, and the ISO and AOCS standard methods were used for analytical determinations.

2.4. 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. Proximal Composition

The *S. odorifera* seeds of the analyzed varieties have similar shapes; they are flat oval and brown in color. Unlike the seeds of the black variety, which is uniform in color over the entire surface, the seeds of the red variety have a light brown interior and a darker brown halo on the edges. These characteristics are distinctive (Figure 1). In dry seeds, the major components in the centesimal composition of kurugua seeds were lipids (greater than 34%), dietary fiber (greater than 34%), and proteins (greater than 17%), as observed in Table 1.

Figure 1. *S. odorifera* seeds from (a) black fruits and (b) reddish fruit.

Table 1. Centesimal composition and caloric value of *S. odorifera* kurugua seeds.

Parameter	Black Kurugua Seeds	Red Kurugua Seeds
Moisture (g/100 g)	10.63 ± 0.23 ^a	7.70 ± 0.26 ^b
Ash (g/100 g)	2.48 ± 0.14 ^a	2.64 ± 0.02 ^b
Total protein (g/100 g)	17.40 ± 0.81 ^a	18.55 ± 0.55 ^a
Total lipids	34.50 ± 0.28 ^a	36.3 ± 0.49 ^a
Total carbohydrates (g/100 g)	2.78 ± 0.06 ^a	3.40 ± 0.32 ^a
Dietary fiber (g/100 g)	34.75 ± 0.27 ^a	39.94 ± 0.08 ^a
Caloric Value (Kcal/100 g)	391 ± 2.57 ^a	415 ± 4.67 ^b

The values expressed on dry weight, as the average of three repetitions ± DS. Different lowercase letters in each row indicate significant difference between the means (Student's *t*, $p \leq 0.05$).

3.2. Characterization of the Oil and Fatty Acid Profile of the Seeds

The Characterization of the oil from the seeds of *S. odorifera* are observed in the Table 2. On the other hand, the profile of the major fatty acids of the seeds oil are presented in Table 3. Eight different fatty acids were identified in the oil by GC/MS. Unsaturated fatty acids predominated in the seed oil with an average of 82.2%. The dominant fatty acid was C18: 3 omega 3 linolenic acid in both varieties (32.8–38.08%), together with C18: 2 omega 6 linoleic acid (28.62–29.52%) and acid oleic C18: 1 omega 9 (12.77–19.09%).

Table 2. Characterization of the oil from the seeds of *S. odorifera*.

Variety	Iodine Value (gI ₂ /100 g)	Saponification Index (mg KOH/g)	Density (g/mL), 25 °C	Refractive Index ND, 25 °C
Black fruit seeds	132.76 ± 2.29 ^a	166.88 ± 0.30 ^a	0.87 ± 0.02 ^a	1.479 ± 0.33 ^a
Reddish fruit seeds	130.58 ± 2.00 ^a	182.42 ± 0.00 ^b	1.09 ± 0.00 ^b	1.478 ± 0.00 ^a

Values are the mean ± SD of three determinations on oil seeds. Different lowercase letters in each column indicate significant difference between the means (Student's *t*, $p \leq 0.05$).

Table 3. Fatty acids profile of *S. odorifera* seeds oil.

Fatty Acids		Reddish Fruit Seeds (g/100 g Oil)	Black Fruit Seeds (g/100 g Oil)
Polyunsaturated	Linolenic (ω -3)	32.80 ± 0.13^a	38.08 ± 0.06^b
	Linoleic (ω -6)	28.62 ± 0.17^a	29.51 ± 0.21^b
	8.11 octadecadienoic Acid.	1.26 ± 0.03^a	1.18 ± 0.01^a
Monounsaturated	Oleic (ω -9)	19.39 ± 0.11^a	13.16 ± 0.55^a
	Palmitoleic (ω -7)	0.09 ± 0.01^a	0.06 ± 0.01^a
TOTAL		82.16	81.99
Saturated	Miristic (14:00)	0.12 ± 0.02^a	0.12 ± 0.01^a
	Palmitic (16:00)	10.98 ± 0.17^a	10.93 ± 0.08^a
	Estearic (18:00)	6.74 ± 0.07^a	6.96 ± 0.17^a
TOTAL		17.84	18.01

Values are the mean $\pm$ SD of three determinations on oil seeds.

4. Discussion

At a moisture level below 11%, the total lipid content in *S. odorifera* seeds observed is higher than that reported in seeds of fruits of the same family of Cucurbitaceae such as squash *Cucurbita maxima* (30.66 g/100 g) [5].

The oils presented iodine, saponification, and refractive indices characteristic of preferentially polyunsaturated oils. The iodine value indicates the degree of unsaturation of the fatty acids in an oil. According to these results, kurugua seeds would have the presence of unsaturated fatty acids, and classifies it as a “semi-drying oil”. Our results for black and red kurugua seeds were similar to *Cucurbita moschata* Duch “zucchini or long-necked squash” (132.7 gI₂/100 g). However, the saponification index of the analyzed kurugua seeds (166.88 ± 0.30 and 182.42 ± 0.01 mg KOH/g, in black and red *Sicana sp.* seed oils, respectively), was higher than that reported for *C. moschata* (122.90 mg KOH/g) [6].

The fatty acid composition of the seeds depends on their genetic characteristics, but the latitude and climatic conditions of cultivation also have a strong influence on fatty acid biosynthesis. The observed values of the content of these fatty acids are lower than those reported for chia seeds, recognized as a source of essential fatty acids [7]. Although the oil from kurugua seeds has not been previously characterized in the light of our knowledge, the seeds of *S. odorifera* that grow in Paraguay can provide essential fatty acids such as omega 3 and omega 6. These results demonstrate their nutritional qualities, with potential for use as a food ingredient in healthy prepared food preparations.

5. Conclusions

S. odorifera seeds have a lipid content with good nutritional characteristics, preferably polyunsaturated fatty acids, where omega 3 linolenic acid was the majority. Future studies on stability and sensory analysis for food applications are suggested, with potential applications, on food safety framework.

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