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Proceeding Paper

Chaco Prickly Pear (*Cereus forbesii* Otto ex C.F. Först): An Ancient Source of Antioxidants and Dietary Fiber in the Diet of Indigenous Populations and Its Potential Application as an Ingredient in Derived Products †

Jennifer López, Rocío Villalba, Silvia Caballero, Eva Coronel, Patricia Piris, Adeline Friesen and Laura Mereles *

Facultad de Ciencias Químicas, Universidad Nacional de Asunción, San Lorenzo P.O. Box 1055, Paraguay
* Correspondence: lauramereles@qui.una.py
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Abstract: In regions with a majority population of people belonging to indigenous peoples, the solutions to nutritional challenges such as overweight and obesity can go through the implementation of public policies that encourage the use of local and ancestral crops, which would also entail the protection of food traditions. However, these foods can also be added to diets as processed products with high nutritional value. This work describes the centesimal composition and antioxidant potential of a wild prickly pear (*Cereus forbesii* Otto ex C.F. Först) from the Paraguayan Chaco, ancestral food of indigenous peoples, and the jam of this native fruit, a derived product, with the aim of making its nutritional potential known, its potential application in feeding programs and its incorporation in minimally processed foods. These foods mainly show an interesting contribution of micronutrients, soluble sugars, dietary fiber, and antioxidants as anthocyanins with an attractive color, that can replace critical nutrients such as artificial additives and excess sugars in the diet of the regional population. Knowledge of the nutritional and technological properties of regional foods will help strengthen and develop national and regional policies and programs for the development and promotion of local and indigenous products, within the framework of food safety.

Keywords: autochthon foods; *Cereus forbesii*; composition; native fruit; nutritional value; prickly pear

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1. Introduction

Despite the potential use of wild food plants in food security and poverty reduction strategies, the Food and Agriculture Organization of the United Nations (FAO) World Biodiversity Status for Food and Agriculture warns that this diversity is rapidly disappearing, unless the conservation of useful plants takes place. Only 3.3% of useful plants are sufficiently conserved *ex situ* [1]. Wild plant species play an important role in local and traditional food systems in rural communities. Research on such foodstuffs may help to prevent loss of indigenous knowledge on potential dietary sources for needy households [2]. The development of value-added products to incorporate them into the diet in a modern context can be a strategy for their conservation and incorporation into diet as high-value products or ingredients. For example, microencapsulation on alginate hydrogel has been reported to provide greater stability to betacyanin of dragon fruit peel extract, which allows the extraction and application of beneficial compounds as healthy food ingredients [3]. The CELAC Food Security Plan is based on four pillars that seek to guarantee the four dimensions of food security: access, availability, use and stability of food [4]. Indigenous people have a large amount of knowledge of their ecosystems, including knowledge of native foods, knowing its value and function in the maintenance of health and the control of

different diseases with potential benefits for the welfare and health in the soil of the indigenous peoples, as well as for the industrialized populations [5]. The species *Cereus forbesii* is a perennial native tree distributed throughout Catamarca, Chaco, Córdoba, Formosa, Jujuy, La Rioja, Salta, Santa Fe, belongs to the Cactaceae family, considered synonymous with the species *Cereus validus* autc. Non Haw., *Piptanthocereus forbesii* (Otto ex C.F. Forst.) Riccob., nom. Illeg. [6] The pandemic opens up opportunities for a new paradigm of a food system that supports local self-sufficiency and domestic agricultural production and considers family and community gardens, traditional agroecosystems and farmers' markets as essential services. This work aims to describe the proximate composition and antioxidant potential of a wild prickly pear from Paraguayan Chaco and a derived product from them, marmalade.

2. Materials and Methods

2.1. Sampling

A sampling was carried out for the convenience of approximately 1000 kilos of tuna berries, harvested in Campo Loro, Misión Yalve Sanga, Kleefeld and Loma Plata, Philadelphia, Boquerón Department, Chaco, Paraguay at three harvest times, between December 2020 and January 2021. A random selection of fruits was carried out in good condition, approximately 1 kg per harvest. The samples were analyzed separately. From the same, 3 batches of marmalades made from whole fruits were prepared. The marmalade contained sugar and water addition.

2.2. Processing of the Samples

Once in the laboratory, the shell was separated from the pulp with seeds. These samples were freeze-dried for 10 days to eliminate the watery proportion, then they were ground in a food processor and kept frozen at −20 degrees centigrade until the moment of analysis. The morphological measurements of weight and size were carried out in the fresh sample. The analysis of the marmalades was carried out on fresh weight.

2.3. Analytical Methods

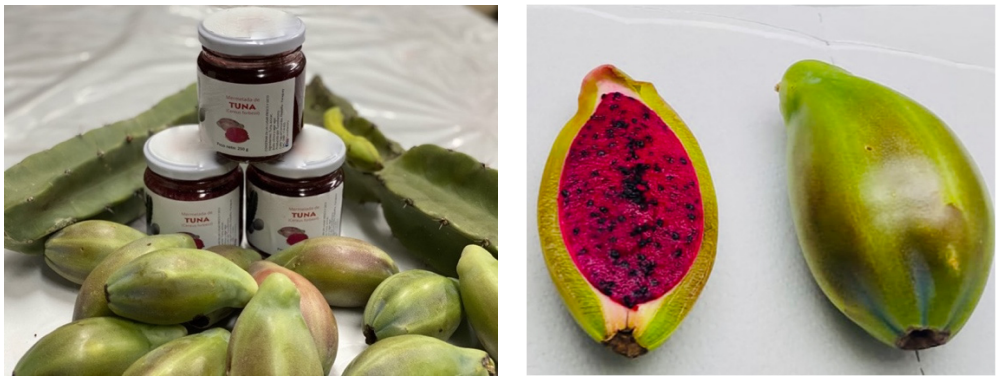
For morphological analysis, 30 whole fruits were taken, weight was measured in analytical balance (DNA, model HR 120), longitudinal and transversal diameter (measured in cm). For centesimal composition and vitamin C analysis, official AOAC techniques were used [7], dietary fiber AOAC 991.43 on pulp + seeds and AOAC 993.21 for marmalade, ash AOAC 940.26 method, total protein AOAC 920.152 method, carbohydrates by the Anthrone method [8] and the caloric value by the Atwater method. The total phenolic compounds (TCP) was carried out by the Folin–Ciocalteau method. The total antioxidant capacity (TAC) was carried out by the ABTS method described by Re et al. [9]. All reagents used were analytical-grade. All determinations were made in triplicate.

3. Results and Discussion

Physicochemical Characteristics and Antioxidants

The analyzed whole fruits of *Cereus forbesii* presented the following measurements: longitudinal diameter 9.44 ± 0.74 cm, transversal diameter 4.81 ± 0.35 cm and 104.7 ± 16.6 g of average weight (Figure 1). Table 1 summarizes the results of the analyzed samples. In its proximate composition, it highlights the high content of dietary fiber in pulp + seeds, as well as a great content of polyphenolic compounds with known antioxidant properties. In the marmalades, the composition of carbohydrates was the majority and the content of TPC was reduced by more than 80%. These results demonstrate the potential of the tuna del Chaco in the diets of indigenous communities, especially as fresh fruit in feeding programs. The incorporation in foods prepared at least as marmalades would be but a strategy to promote their consumption and as conservation systems and as a source of essential nutrients. The caloric contribution of wild food plants to the diets of people is generally low in comparison with basic foods. In the pulp samples with seeds, the caloric

value was less than 70 Kcal/g. However, these species contribute to the diversification of the diet in many geographic environments. Additionally, the local trade in wild species has the potential to empower communities and increase living standards in rural areas within the framework of food security and sustainability of food systems.



(**a**) (**b**)

Figure 1. Fruits of *Cereus forbesii*. (**a**). Whole fruit and marmalade (**b**). Cross section of a whole fruit.

Table 1. Physicochemical characteristics of fruits.

	Cereus forbesii **Pulp + Seeds**	***Cereus forbesii*** **PPeel**	***Cereus forbesii*** **PMarmalade**
Moisture (g/100 g)	85.9–90.4	93.1–93.4	38.2–38.6
Carbohydrates (g/100 g)	2.5–3.72	2.45–2.59	50.7–56.8
Total Lipids (g/100 g)	tz	tz	tz
Proteins (g/100 g)	1.41–1.54	0.67–0.74	0.368–0.376
Ash (g/100 g)	0.09–0.17	0.66–0.71	0.64–0.92
Dietary fiber (g/100 g)	4.07–4.09	1.13–1.45	0.53–1.07
Caloric value (Kcal/100 g)	62–70	23–27	205–228
Vitamin C (mg/100 g)	1.22–1.23	0.49–0.93	tz
TPC (mg GAE/100 g)	334.7–387.6	349.4–509.8	46.41–60.91
ABTS (mM TEAC/g)	3.52–5.15	7.70–7.76	4.35–4.89

Results are expressed as intervals of n = 3 and triplicates. Where TPC = Total Phenolics Compounds, and Tz = trace.

4. Conclusions

The pulp and seeds of tuna represent a source of dietary fiber and polyphenolic compounds. The analyzed foods, especially pulp and its derivatives, have attractive color characteristics and antioxidant potential. Research on their micronutrients and phytochemical compounds can be interesting for the replacement of critical ingredients as artificial coloring additives in the diet of the regional population.

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