

Review Article

Phytobotanical and compositional profiling of *Pereskia aculeata* and optimization of extraction processes for its bioactive fractions

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Abstract

Pereskia aculeata (Cactaceae) is a well-known plant species commonly found and used in South America, due to its therapeutic and pharmacological properties. This review consolidates existing knowledge on *Pereskia aculeata* phytobotanical, chemical composition and extraction processes. The phytochemical analysis revealed the presence of flavonoids, alkaloids and terpenoids, which are very essential for the plant's bioactivity. The phytobotanical and compositional profiling of *Pereskia aculeata* and optimization of extraction processes for its bioactive fractions have been documented. Evidence abounds on the traditional uses of this plant in pain management, wounds and inflammatory conditions. This review underscores *Pereskia aculeata* potential for developing phytochemical constituents that could be used in the treatment of various diseases.

Keywords: *Pereskia aculeata*, Phytobotanical properties, Phytochemical analysis, Therapeutics

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INTRODUCTION

Pereskia aculeata (*P. aculeata*) Miller, also known as Ora-pro-nobis (OPN) in tropical America, is a climbing cactus plant which belongs to the Cactaceae family and the subfamily of Pereskioideae [1]. It is native to South America and also well cultivated in some low-altitude regions of southern China [2]. In other regions, such as in Thailand and currently in Nigeria, the plant is known as Barbados gooseberry, lemon vine or blade apple cactus.

The leaves of *P. aculeata* are non-toxic and they contain high nutritional properties, which include 23 % protein, 31 % carbohydrate, 14 % minerals, 8 % lipids and 4 % soluble dietary fibers [3–5]. Due to its availability and high protein content, it is also known as the meat of the poor [6]. Some of the bioactive compounds present in *Pereskia aculeata* include phenolic acids, flavonoids, carotenoids and terpenes [7]. The application of *Pereskia aculeata* OPN leaves in folk medicine has also been reported in the treatment of renal diseases, cancer, inflammatory conditions and as

an effective emollient [8]. Researchers have also documented some of the biological activities of *Pereskia aculeata* ora-pro-nobis leaves, such as their antinociceptive effect, acute and chronic anti-inflammatory effect, wound healing activity, in vitro antioxidant effect and antimicrobial properties [9].

In Minas Gerais, *Pereskia aculeata* ora-pro-nobis leaves are used in various sweet and savory dishes. The leaves can be used in the preparation of salads, soups, omelets and pies, while the leaf flour can serve as an enriching element in the formulation of breads, cakes and pastas [10]. The role of *Pereskia aculeata* ora-pro-nobis as an anti-inflammatory, antinociceptive and antioxidant agent has been documented [11]. There are 17 (seventeen) species of *Pereskia* that occur both in the arid and semi-arid regions. The two species that are common in the Atlantic Forest include the *Pereskia aculeata* and *Pereskia grandifolia* [11]. According to the standard established by the Organisation for Economic Co-operation and Development, *P. aculeata* is classified under class 5, which is the lowest toxicity class [12]. Some of the species of the genus *Pereskia* include *P. aculeata*, *P. guamacho*, *P. grandifolia*, *P. horrida*, *P. marcanoi*, *P. nemorosa*, *P. portulacifolia* and *P. sacharosa* [13].

Pereskia flowers are of the perigynous type and they also possess a hypanthium with needles. The fruit is pomaceous with a juicy hypanthium pericarp and seeds immersed in a yellowish gelatinous mass. The seed is exotestal and also develops from the amphitropous ovule. Table 1

illustrates the proximate composition of *Pereskia aculeata* species.

Geographical location has an effect on the composition of *P. aculeata* leaves. In Malaysian traditional medicine, the *P. grandifolia* leaves are used in the treatment of cancer, diabetes, hypertension, rheumatism and inflammatory diseases [13].

Extraction of the bioactive compounds of *P. aculeata* and *P. grandifolia*

There are different techniques and solvents used in the preparation of ora-pro-nobis extracts. The best procedures involve those that combine different strategies for the maximal recovery of the desired active principles. Table 2 shows the extraction methods and bioactive/functional characterization of *P. aculeata* and *P. grandifolia* extracts [14]

Small molecular weight bioactives of *P. aculeata* and *P. grandifolia*

Some of the small molecules found in *Pereskia* sP. extracts of hydroalcoholic and ethyl acetate include: phenolic compounds, alkaloids, carotenoids, triterpenoids and steroids. There are several bioactive compounds found in *Pereskia* ora-pro-nobis, and they include hordenine, petunidin, quercetin, cis-caffeic acid, trans-caffeic acid, caffeic acid, rutin, isorhamnetin and glycosylated derivatives. Table 3 shows the identified molecules present in *P. aculeata* and *P. grandifolia* as reported in the literature [15].



Figure 1: *Pereskia aculeata* Miller (A); flower and leaves of *Pereskia aculeata* (B); fruit of *Pereskia aculeata* (C). Adapted from Francelin et al [6]

Figure 2 shows the representative structures of polyphenolic compounds found in *Pereskia aculeata*. Sequential extraction of *P. aculeata* leaves with organic solvents with increasing polarity consisting of petroleum ether < chloroform < methanol was used as a strategy for attributing biological activities of groups of substances with different polarities [15].

The result obtained for antibacterial screening carried out with the different extracts of hydroalcoholic and ethyl acetate indicated that the petroleum ether extract inhibited the growth of all tested strains and exhibited potent antibacterial activity against *Escherichia coli*. Also, the result documented by [5] showed that caftaric acid as the main phenolic constituent followed by quercetin-3-O-rutinoside and isorhamnetin-O-pentoside-O-rutinoside.

The topical anti-inflammatory activity of the hexane fraction obtained from a methanolic extract of *P. aculeata* leaves was evaluated in mice [16]. The results from the extracts showed inhibitory activity against the tested bacteria.

models of both acute and chronic ear dermatitis

Table 1: Proximate composition of *Pereskia aculeata* species

<i>P. aculeata</i> Species and samples	Moisture (%)	Total Proteins (%)	Lipids (%)	Ash (%)	Carbohydrates (%)	Ref
<i>P. aculeata</i> fresh leaves	89.5±0.2	28.4±0.4	4.1±0.3	16.1±0.1	Not applicable	[8]
<i>P. aculeata</i> (dry basis) leaves	8.3±0.01	23.0±0.01	4.0±0.00	16.6±0.01	43.7±0.01	[9]
<i>P. aculeata</i> (dry basis) leaves	12.46±0.47	28.99±0.59	5.07±0.15	14.81±0.18	29.53±1.28	[10]
<i>P. grandifolia</i> (dry basis) leaves	10.94±0.78	32.02±0.46	6.72±0.30	18.8±0.92	29.86±1.32	[11]
<i>P. grandifolia</i> fresh leaves	86.50±0.13	14.64±0.87	2.97±0.86	Not applicable	24.47±0.35	[12]
<i>P. aculeata</i> fruit	87.37±0.26	Not applicable	0.23±0.05	0.93±0.01	11.47±0.22	[13]

Table 2: Extraction methods and bioactive/functional characterization of *P. aculeata* and *P. grandifolia* extracts

<i>Pereskia</i> sP. plant part	Extraction technique	Extraction solvent	Bioactive characterization	Ref
<i>P. aculeata</i> leaves	Hot extraction and precipitation	Water	Mucilage: emulsifier	[10]
<i>P. aculeata</i> green fruit	Pressing and precipitation	Water	Mucilage: emulsifier	[11]
<i>P. aculeata</i> fruits	Homogenization with water	Water	Fruit pulp: antioxidant activity (DPPH, ABTS, ORAC, and total phenolic compounds), total carotenoids, total chlorophylls	[12]
<i>P. aculeata</i> leaves	Simple stirring	Water, ethanol, and acetone	Bioactive extract: in vitro antioxidant and anti-hemolytic activities	[13]
<i>P. aculeata</i> leaves	Sequential solvent extraction and hydro-distillation.	Petroleum ether followed by chloroform and methanol.	Bioactive extracts and essential oil: antimicrobial (<i>Staphylococcus aureus</i> and <i>Bacillus cereus</i>)	[14]
<i>P. grandifolia</i> leaves	Simple stirring	Ethanol and water	Bioactive extract: antioxidant activity (DPPH, FRAP) and antibacterial activity (<i>Staphylococcus aureus</i> and <i>Pseudomonas aeruginosa</i>)	[14]
<i>P. grandifolia</i> leaves	Maceration	Ethanol and water, hexane, dichloromethane and chloroform	Bioactive extract: antioxidant activity (DPPH, FRAP) and antibacterial activity (<i>S. aureus</i> , <i>Escherichia coli</i> , <i>Bacillus subtilis</i> , and <i>Pseudomonas aeruginosa</i>).	[14]

DPPH: 2,2-Diphenyl-1-picrylhydrazyl, ABTS: 2,2'-Azino-bis(3-ethylbenzothiazoline-6-sulfonic acid), ORAC: Oxygen Radical Absorbance Capacity

Table 3: Major components found in *P. aculeata* and *P. grandifolia*

<i>P. aculeata</i> Species	Extraction solvent	Extraction technique	Compounds identified	Ref
<i>P. aculeata</i> leaves	Ethanol: water (60:40)	stirring	Phenolic compounds: caftaric acid; chicoric acid; caffeoyl-hexaric acid; coumaroyl-hexaric acid.	[10]
<i>P. aculeata</i> leaves	Supercritical water	stirring	Phenolic compounds: caftaric acid isomers; quercetin-O-pentoside-O-rutinoside; pentoside-O-rutinoside; quercetin-glucoside; kaempferol-3-O-rutinoside.	[11]
<i>P. aculeata</i> leaves	Ethanol: water (70:30)	stirring	Phenolic compounds: caftaric acid; trans-caftaric acid; caffeic acid derivative; quercetin-O-pentoside-O-rutinoside; quercetin-O-pentoside-O-hexoside.	[12]
<i>P. grandifolia</i> leaves	methanol	stirring	Decane; 4,5-dimethyl-2,6-octadiene; undecane; nerolidol; 1-methoxy-p-tolyl-propan-2-ol; neophytadiene; methyl palmitate; palmitic acid; linolenic acid methyl ester.	[13]

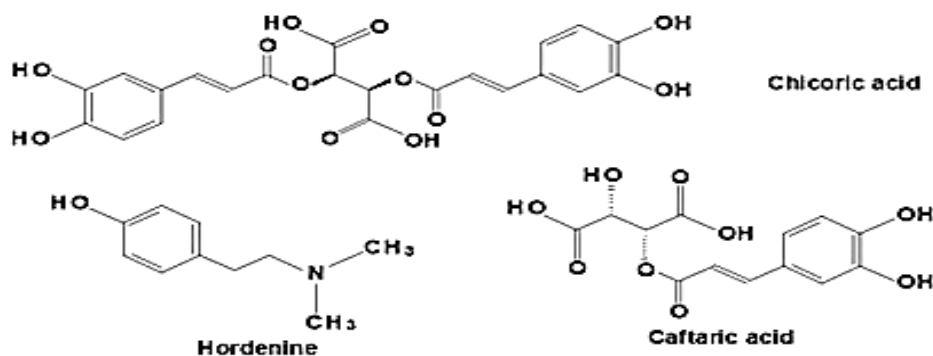


Figure 2: Representative structures of polyphenolic compounds. Adapted from Teixeira et al [1]

Chemical composition of *Pereskia aculeata*

Pereskia aculeata stands out for its nutritional value, comprising an average of 15.02 % (w/w) of proteins, 8.87 % (w/w) of moisture, 3.40 % (w/w) of ash, 56.8 % (w/w) of carbohydrates, and 15.84 % (w/w) of lipids, expressed on a dry basis [5]. *Pereskia aculeata* contains mucilage composed of an arabinogalactan biopolymer. In film production, combining reconstituted bacterial cellulose with arabinogalactan (AG) extracted from *P. aculeata* and xyloglucan showed that the incorporation of 30 – 40 % (w/w) of AG resulted in better film stability [7]. Ora-pro-nobis mucilage (MOPN) is a hydrocolloid rich in complex polysaccharides combined with proteins, with techno-functional properties such as thickening, gelling and emulsifying [8–10]. These characteristics demonstrate the potential use of *Pereskia aculeata* in the food and pharmaceutical industries [12].

CONCLUSION

Pereskia aculeata is backed by a rich phytochemical profile and pharmacological evidence. Its new traditional uses, especially in South America, are substantiated by scientific studies highlighting its potential in managing related disease disorders. Further research is warranted to explore its clinical applications, safety and bioactive compound isolation, paving the way for innovative treatments.

DECLARATIONS

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Figure 1 and Figure 2 were adapted from previously published sources and modified for clarity.

Ethical approval

None provided.

Use of Artificial intelligence/Large language models

We also declare that we did not use Generative artificial intelligence (AI) and AI-assisted technologies in proofreading the manuscript.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Conflict of interest

No conflict of interest is associated with this work.

Contributions of authors

We declare that this work was done by the author(s) named in this article, and all liabilities pertaining to claims relating to the content of this article will be borne by the authors.

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