

## Chemical and Nutritional Composition of the Aromatic Plant Extracts *Pseudelephantopus Spicatus*

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### ABSTRACT

*Pseudelephantopus spicatus*, known as “hierba golpe,” is a medicinal plant native to the Amazon whose nutritional and chemical composition remains largely unexplored. This study characterized an aromatic product derived from the plant by determining its composition through proximate analysis and gas chromatography coupled with mass spectrometry (GC–MS). A total of 31 compounds were identified, including fatty acids such as linolenic acid (14.73%) and palmitic acid (11.64%), as well as saponins, flavonoids, terpenes, and other secondary metabolites. The protein content was 18.92 g/100 g, while the dietary fiber content reached 50.36 g/100 g, most of which was insoluble. Relevant levels of minerals such as iron, calcium, and zinc were also detected, along with low levels of saturated fat. These results demonstrate the product’s functional and antioxidant potential, suggesting its possible application in the food and pharmaceutical industries. Furthermore, they support local initiatives, such as ASMUECH, in the development of sustainable food security strategies.

**Keywords:** *Pseudelephantopus spicatus*; chemical characterization; bioactive compounds; nutritional profile; food safety.

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### INTRODUCTION

The Colombian Amazon, recognized for its extraordinary biodiversity, is home to a wide variety of plant species with nutritional and therapeutic potential. This richness has been the subject of numerous studies in response to the growing demand for sustainable and functional foods that contribute to food security and public health. In this context, native plants have gained particular relevance due to their bioactive compounds with antioxidants, anti-inflammatory, and antimicrobial properties, which are of interest to the food and pharmaceutical industries.

In Colombia, the ancestral use of medicinal plants has enabled rural communities to identify and utilize species with healing properties, often without scientific validation. Among these, *Pseudelephantopus spicatus* (*P. spicatus*) stands out for its traditional application in the treatment of inflammatory and infectious conditions (Odonne et al., 2011; Passero et al., 2021; Sathyaseelan et al., 2020). However, its chemical composition and biological activity remain poorly explored, limiting its incorporation into specialized markets. Several studies (Ali et al., 2024; Ragasa and Rideout, 2001; Yang et al., 2007) have identified secondary metabolites such as flavonoids, saponins, and terpenes in related species. In addition, potential glycemic regulatory effects have been reported (Correa et al., 2024), along with

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Page:

antimicrobial, anti-inflammatory, antioxidant, antifungal, and antiulcer properties in species of the same genus (Dogra et al., 2018; Odonne et al., 2011; Pumallanqui Ortiz and Salazar Pérez, 2021; Quiming et al., 2019), reinforcing its pharmacological potential. However, information on its chemical and nutritional composition in the Colombian Amazon is still limited, particularly in the department of Caquetá. Some preliminary reports suggest a balanced lipid profile and a significant content of essential minerals such as calcium and iron, positioning this species as a potential nutritional source for vulnerable populations. Therefore, the aim of this study was to chemically characterize and evaluate the nutritional profile of *P. spicatus* to determine its potential as an alternative source of nutrients and bioactive compounds. The findings contribute to the scientific understanding of this species and open new opportunities for its application in the development of physiotherapeutic products and its integration into national and international markets.

## MATERIALS AND METHODS

### Study Location and Plant Material.

The research was conducted at the processing plant of the Association of Women Entrepreneurs Cimientos del Hogar (ASMUECH), located in San Juan de El Doncello, Caquetá, as well as in the laboratories of the University of the Amazon, Florencia campus.

ASMUECH, founded in 2015 by rural and urban women in the municipality, promotes the sustainable use of aromatic plants to generate income through the *Amativa Origen de Vida* brand, which commercializes essential oils and herbal infusions. In this study, plant material of the species *Pseudelephantopus spicatus*, supplied directly by the association, was used.

### Processing of Plant Material

*Receiving, Selecting and Preparing Sheets.* Upon receipt of the plant material, the leaves were manually separated from the stems under standardized criteria to ensure sample representativeness. The leaves were selected by discarding those showing signs of insect damage, discoloration, desiccation, or contamination with other species. Subsequently, the material was washed with potable water and disinfected by immersion in an aqueous solution of 5% acetic acid (w/v) for 1 minute. The leaves were then air-dried at room temperature to remove surface moisture prior to initial weighing.

*Drying and crushing.* A total of 200 g of leaves were evenly distributed on trays lined with parchment paper and dried in a temperature-controlled oven. Different drying conditions were evaluated: 35 °C for 3 h, 40 °C for 3 h, 50 °C for 2 h, 60 °C for 1.5 h, and 70 °C for 1 h. The optimal result, in terms of texture (crispness), color

(olive green), and organoleptic characteristics, was obtained at temperatures between 40 °C and 50 °C for 2 hours. The dried leaves were initially ground using a mill and subsequently processed in a blender due to the low volume of dry matter obtained. The resulting material was sieved using a conventional mesh, yielding 20 g of dry powder, while the remaining mass corresponded to losses due to moisture reduction and material retained during sieving.

*Final Packaging.* The plant powder was sieved to obtain a uniform particle size (0.025 mm), identified as optimal for ensuring homogeneous distribution within cellulose filters and maintaining the target unit weight. An automatic heat-sealing machine was used to package the material into 1 g primary cellulose filter bags, followed by secondary plastic wrapping. The equipment was calibrated for 1 hour and 20 minutes prior to continuous operation. During packaging, the unit weight was monitored using a precision balance. Particle size uniformity was identified as the main factor influencing weight consistency. Additionally, stainless steel thimbles were fitted into the tray compartments to stabilize the volume and ensure consistent filling weight.

*Phytochemical Analysis.* A methanolic extract was prepared by macerating 100 g of dried plant material in 200 mL of methanol for 48 hours. The extract was then filtered and concentrated to dryness using a rotary evaporator. Subsequently, qualitative phytochemical screening assays were performed to detect the presence of alkaloids, saponins, flavonoids, flavanol's, reducing sugars, amino acids, proteins, carbohydrates, anthraquinones, coumarins, cyanogenic glycosides, terpenes, and sterols, following standardized protocols (Brindha and Saraswathy, 1981; Kalaichelvi and Dhivya, 2016; Nag et al., 2013).

*Chemical Composition.* For the identification of chemical compounds, Soxhlet extraction was performed using 5 g of dried plant material and 250 mL of methanol as the solvent for 12 hours. The extract was subsequently preconcentrated to 10 mL using a rotary evaporator. The analysis was carried out by gas chromatography coupled with mass spectrometry (GC-MS) using an Agilent Technologies 7890A gas chromatograph coupled to a 5975C mass spectrometer. Chromatographic separation was performed on an HP-5 capillary column (30 m × 0.25 mm × 0.25 μm). The oven temperature program was set to start at 50 °C (held for 2 min), followed by an increase of 4 °C/min up to 280 °C, where it was maintained for 5 minutes. Helium was used as the carrier gas at a flow rate of 1.2 mL/min. The injection volume was 1 μL in split mode (50:1), with the injector temperature set at 250 °C. Compound identification was performed by comparison with reference spectra, and the relative percentage composition was calculated based on the integration of chromatographic peak areas.

**Nutritional Analysis.**

The analyses were carried out at the Institute of Food Science and Technology (INTAL) using validated methods, as described below:

**Fats:** PS-O-027 LAE method for total fat content and PS-O-021 LAE for fatty acid profile (FAMES), determined by gas chromatography with a flame ionization detector (GC-FID).

**Dietary Fiber:** AOAC Method 991.43, differentiating between soluble and insoluble fractions.

**Sugars:** PS-O-026 LAE method, used to quantify fructose, galactose, glucose, sucrose, lactose, and maltose.

**Minerals (Na, Ca, Fe, Zn):** PS-O-001 LAE method, involving microwave digestion followed by analysis using flame atomic absorption spectrometry (FAAS), with results expressed in mg/100 g.

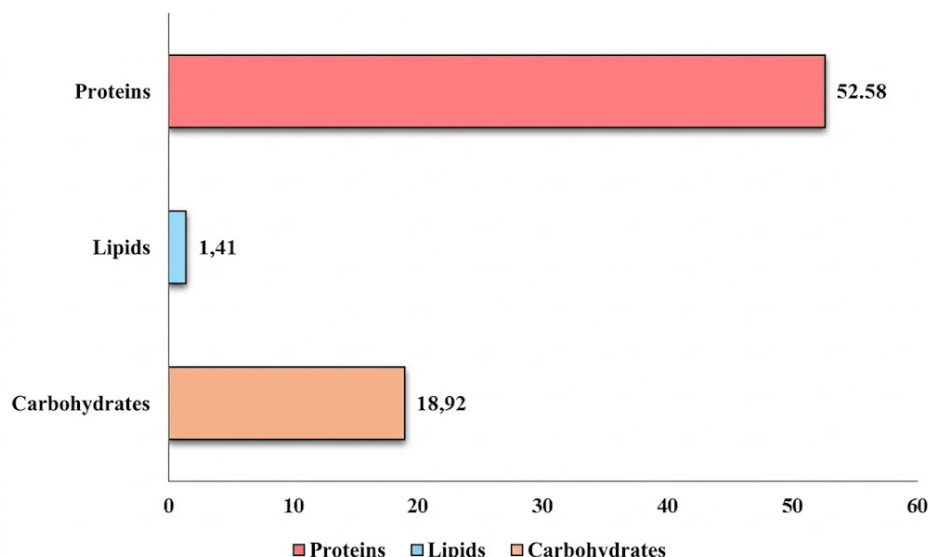
**Total Protein:** PS-O-101 LAE method, expressed as a percentage of dry weight, following standardized protocols.

**RESULTS AND DISCUSSION**

**Table 1.** Phytochemical Methanolic Extract March of Aromatic Product *Pseudelephantopus spicatus*.

Testing	Secondary Metabolite	Result (*)
Mayer	Alcaloides	-
Wagner		+
Bouchardat		-
Dragendoff		+
Modified Dragendoff		+
Sunshine		+
Water	Saponins	+
Gelatin Assay	Tannins	+
FeCl <sub>3</sub>		+
Shinoda	Flavonoids	+
Fluorescencia	Coumarins	+
Erlich		-
Guignard	Cyanogenic glycosides	-
Lieberman Burchard	Terpenes and Sterols	+
Fehling	Reducing sugars	+
Benedict		+
Burette	Proteins	-
Benzene	Anthraquinones	+
Molish	Carbohydrates	+
Ninihydrin	Amino acids	+
NaOH 10%	Flavonoles	-

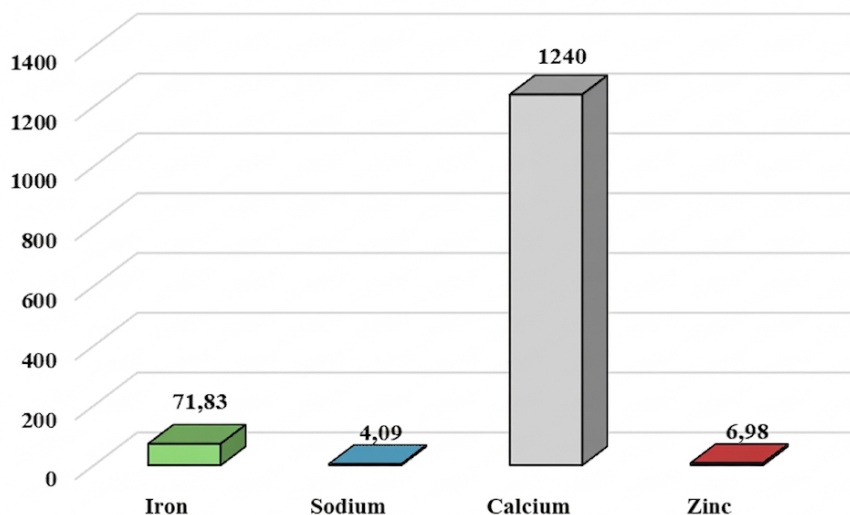
(+) Presence; (-) Absence.



**Figure 2.** Macronutrient content (g/100 g) of the aromatic product of *Pseudelephantopus spicatus*.

**Table 2.** Chemical Composition of Methanolic Extracts of *Pseudelephantopus spicatus*

Number	Metabolite	Concentration (%)
1	2,6-diterbutylhydroquinone	1,78
2	2,4-diterbutyl-thiophenol	1,70
3	Fluoresceina	1,37
4	1-tertbutyl2,6-dinitro-3,4,5-trimethylbenzene	1,09
5	Alstonilina	0,78
6	Diethylptalate	8,78
7	Triethyl Citrate	2,11
8	Neophytadine	2,14
9	Version	1,11
10	Caffeine	1,44
11	Acetato de Z,Z-3,15-octadecodien-1-ol	2,06
12	Z-cis-9-octadeceniloxietanol	1,29
13	Palmitic acid	11,64
14	6,9,12,15-docosatetraenoic acid	1,03
15	Phytol	1,93
16	Linolenic acid	14,73
17	Dipalmitina	6,59
18	2-methyl-1-hexadecanol	5,45
19	Benzoic Acid Pentadecyl Ester	1,77
20	Tetrahydroaraucarolone	0,99
21	Fluoxymesterona(androfluorona)	1,43
22	17-acetoxy-3B-metoxo-4,4-dimetil-8,14-seco-3,19-epoxyandrostano-8,14-diona	2,53
23	Tetradecil ester del acidobenzoico	3,27
24	Testosterone 11-oxo-9-thiocyanate	2,10
25	Ethyl-alcoholate	0,92
26	Demethyl stearate(2-phenyl-1,3-dioxalan-4-yl)	1,62
27	3-beta-metoxo-6,19-cycloandrostane-3,7-diol	0,63
28	24,25-dihidroxycholecalciferol	1,45
29	Tribehenin	0,32
30	Stigmasterol acetate	1,06
31	4,4-dimethyl-cholesta-22,24-dien-5-ol	1,61



**Figure 3.** Mineral content (mg/100 g) of the aromatic product of *Pseudelephantopus spicatus*.

This study highlights the extraordinary potential of the Amazonian plant *Pseudelephantopus spicatus* as a sustainable functional food and pharmaceutical resource. Our findings reveal a remarkable nutritional profile, featuring high dietary fiber, significant plant-based protein, and calcium levels that far exceed traditional sources. This research provides a scientific foundation for utilizing regional biodiversity to combat nutritional deficiencies and support local sustainable bio-economies.

#### Physicochemical analysis.

The qualitative analyses performed on the aromatic product derived from *Pseudelephantopus spicatus* enabled the identification of several groups of secondary metabolites with pharmacological relevance. Among the detected compounds were saponins, tannins, flavonoids, terpenes, and sterols, as well as reducing sugars, anthraquinones, carbohydrates, and amino acids.

In contrast, cyanogenic glycosides, proteins, and flavanols were not detected in the samples analyzed. In the case of alkaloids and coumarins, the results were inconsistent, with both positive and negative test outcomes, suggesting a low likelihood of these compounds being present in significant concentrations in the final product (Table 1).

The metabolites identified in this study have been reported in the scientific literature to exhibit various relevant biological activities. Compounds found in *P. spicatus* have been documented to possess antileishmanial properties (Odonne et al., 2011), cytotoxic activity (Khatun et al., 2014; Yang et al., 2007), antidiabetic effects (Correa et al., 2024), antifungal activity (Ragasa and Rideout, 2001), and antibacterial capacity (Quiming et al., 2019). These findings support

the pharmacological potential of the aromatic product derived from this plant species.

#### Chemical Composition

The chromatographic analysis enabled the identification of 31 metabolites present in the *Pseudelephantopus spicatus* sample, as shown in Table 2. Among the detected compounds, two fatty acids stand out due to their high concentrations and biological relevance.

Linolenic acid was the most abundant metabolite, with a concentration of 14.73%. This essential fatty acid plays a key role in various physiological functions, including growth, body maintenance, and the integrity of cell membranes, to which it confers flexibility and selective permeability. Its presence has been associated with benefits for cardiovascular health, the prevention of visual impairments, and neurological development in children (Feliu et al., 2021).

Additionally, a significant concentration of palmitic acid (11.64%) was identified. This saturated fatty acid has been reported in some studies to contribute to the regulation of cholesterol levels, suggesting a potential role in the nutritional context (Serna and Betancourt, 2015).

#### Lipid profile

The analysis of the lipid profile of *Pseudelephantopus spicatus* (Figure 1) reveals a low content of saturated fat (279 mg/100 g), which represents a nutritional advantage over other plant sources such as coconut (14 g/100 g) and palm oil (47 g/100 g) (USDA 2021). Whereas high saturated fat intake is associated with an increased risk of cardiovascular disease (Sacks et al., 2017). Its low content of this species suggests a

beneficial contribution to a balanced diet. For trans fats, *P. spicatus* contains less than 10 mg per 100 g, a virtually negligible amount. Since trans fats are recognized for their negative impact on cardiovascular health, even in small amounts (Islam et al. 2019; Mozaffarian et al. 2006), the minimal presence of these fats in *P. spicatus* reinforces its healthy potential.

In terms of unsaturated fats, *P. spicatus* contains 53 mg/100 g of monounsaturated fats, in a lower proportion than foods such as olive oil (14 g/100 g) or avocado (16 g/100 g) (USDA 2021), but enough to contribute in a complementary way to cardiovascular health (Faridy et al. 2020). The content of polyunsaturated fats (684 mg/100 g) is remarkable compared to foods recognized for their nutritional value such as walnuts (14 g/100 g) and flaxseeds (27 g/100 g) (USDA 2021). These fats fulfill essential functions in the body, including maintaining brain, cardiovascular and immune health (Akbar et al. 2017; Sacks et al. 2017; Simopoulos 2002).

Overall, *Pseudelephantopus spicatus* shows a favorable lipid profile as it has low saturated and trans fats, and a significant proportion of unsaturated fats (737 mg/100 g). These nutritional characteristics position this Amazonian species as a promising option within the development of functional foods and diets aimed at integral well-being.

### Protein Content

The analysis of *Pseudelephantopus spicatus* revealed a crude protein content of 18.92 g/100 g of sample (Figure 2), positioning it as a relevant plant-based protein source. This value is particularly noteworthy when compared to other legumes commonly consumed for their protein content (Faridy et al., 2020; Margier et al., 2018). For example, beans (*Phaseolus vulgaris*) contain between 20 and 25 g/100 g, lentils (*Lens culinaris*) between 23 and 25 g/100 g, chickpeas (*Cicer arietinum*) around 19 g/100 g, and soybeans (*Glycine max*), widely recognized for their high protein content, reach approximately 36 g/100 g.

These results suggest that *P. spicatus* may represent a viable and nutritious alternative within plant-based diets, providing a complementary protein source that contributes to dietary diversification. Although its crude protein content does not reach the levels observed in soybeans, it remains comparable to many legumes and cereals commonly used in sustainable nutritional strategies worldwide. Furthermore, its presence in the Amazon region and its association with local production systems enhances its strategic value for food security programs and the promotion of functional food agribusiness with a territorial approach.

### Carbohydrates and Dietary Fiber

The analysis of carbohydrates and dietary fiber in *Pseudelephantopus spicatus* reveals a highly favorable nutritional profile. The plant contains less than 0.5 g/100 g of simple sugars (fructose, galactose, glucose, sucrose, lactose, and maltose) and a total dietary fiber content of 50.36 g/100 g, comprising 2.22 g of soluble fiber and 48.14 g of insoluble fiber. This value is considerably higher than that reported for legumes such as beans (15.7 g/100 g), lentils (7.9 g/100 g), and chickpeas (17.4 g/100 g) (Anderson et al., 2009; Jukanti et al., 2012; Thavarajah and Thavarajah, 2012).

The high fiber content in *P. spicatus* may contribute to improved gastrointestinal health, glycemic regulation, and a reduced risk of chronic diseases such as type 2 diabetes and cardiovascular disorders. Soluble fiber has been associated with decreased absorption of sugars and cholesterol, while insoluble fiber promotes intestinal motility (Anderson et al., 2009; Barber et al., 2020; He et al., 2022; Jukanti et al., 2012; Merenkova et al., 2020). Therefore, this plant represents a promising natural source of dietary fiber with potential benefits for digestive and metabolic health.

### Minerals

The mineral composition of *Pseudelephantopus spicatus* stands out for its high nutritional value (Figure 3). Its iron content (71.83 mg/100 g) greatly exceeds that reported for legumes such as beans and lentils (5–10 mg/100 g), as well as quinoa (4.57 mg/100 g) (Jukanti et al., 2012). Regarding calcium, it reaches 1240 mg/100 g, significantly higher than values reported for spinach (99 mg/100 g) and soybeans (277 mg/100 g) (Anderson et al., 2009; Thavarajah and Thavarajah, 2012).

Similarly, its zinc content (6.98 mg/100 g) is comparable to that of foods rich in this mineral, such as pumpkin seeds (7.81 mg/100 g) (Anderson et al., 2009). This mineral profile suggests that *P. spicatus* may contribute to the prevention of nutritional deficiencies, particularly in plant-based diets or in contexts of food insecurity.

These attributes, combined with its protein and lipid profile, position this species as a promising candidate for functional food development, with potential applications in human nutrition.

### CONCLUSIONS

Phytochemical analysis of *Pseudelephantopus spicatus* revealed a diverse range of metabolites with potential therapeutic and nutritional relevance, including saponins, tannins, flavonoids, terpenes, sterols, reducing sugars, anthraquinones, carbohydrates, and amino acids. The chromatographic analysis identified 31 compounds, highlighting linolenic acid (14.73%) and palmitic acid (11.64%) due to their physiological relevance.

Regarding its nutritional profile, the high crude protein content (18.92 g/100 g) positions this species as a relevant plant-based protein source, suitable for vegetarian, vegan, or supplementary diets. Its low total lipid content (1.41 g/100 g), along with reduced levels of saturated and trans fats, further supports its potential as a healthy food option. In addition, the significant contribution of carbohydrates (52.58 g/100 g) and dietary fiber (50.36 g/100 g) may support digestive function and energy metabolism. Overall, *P. spicatus* stands out for its comprehensive phytochemical and nutritional profile, with promising applications in nutrition and public health. Its utilization may contribute to the development of more balanced and sustainable diets, while also promoting the valorization of Amazonian biodiversity as a strategic source of functional resources.

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