# ASSESSMENT OF THE POTENTIAL OF "PEIXINHO DA HORTA" DEHYDRATED AS A SOURCE OF PROTEINS AND PHENOLIC COMPOUNDS

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## ABSTRACT

Worldwide awareness of healthy eating has increased in recent years, resulting in a growing interest in adopting dietary habits that promote health and well-being. Within this context, this study aimed to produce and characterize dehydrated "peixinho da horta" leaves (DPHL) for incorporation into various food products, providing a viable path to diversify and enhance healthy dietary habits. Leaves were dehydrated in oven with forced air circulation and characterized regarding water activity, pH, titratable acidity, color parameters, moisture content, proteins, and total phenolic compounds. Samples exhibited low values of water activity (0.40) and moisture content (7.3±0.3%), pH values close to neutral (6.32), and titratable acidity of 3.50 mg/100g, which are ideal characteristics for incorporation into new products. Color parameters indicated a tendency towards light green. As expected, they proved to be a good source of total phenolic compounds (23.37 mg GAE/g of DPHL), with a high protein content (12.7±0.6%). Thus, peixinho da horta leaves emerges as a promising alternative source of vegetable protein and phenolic compounds. These findings indicate an opportunity for the development of food products that meet demands for health and sustainability.

**Keywords:** Active compounds. UFP (Unconventional Food Plants). New product development.

## 1 INTRODUCTION

Lifestyle changes are intricately connected to dietary preferences and consumption behaviors, consequently influencing the demand for convenient meal options[1]. This dynamic compels the food industry to innovate and create increasingly convenient food products, aligning with consumers' growing interest for healthier and nutritionally balanced alternatives.

Within this framework, Unconventional Food Plants (UFP), have garnered interest due to their ability to diversify diets and provide significant nutritional benefits[2]. An example is *Stachys byzantina*, commonly known as "peixinho da horta," considered a source of active compounds and macronutrients[3].

Peixinho da horta is recognized as a promising vegetable protein source, particularly in the pursuit of more sustainable and nutritious food option[4], and integrating it into dietary practices can provide nourishing alternatives. A practical solution involves dehydrating leaves for their use in a variety of food items, including bread, cakes, hamburgers, cookies, among others[2].

Thus, the use of non-traditional vegetables in food production, not only expands the variety of protein options available to consumers, but also promotes the valorization of underutilized and low cost food resources, contributing to food waste reduction and sustainable agriculture practices promotion. This approach aligns with the United Nations Sustainable Development Goal of Zero Hunger[5], which aims to ensure access to sustainable food systems and promote agriculture in an environmentally responsible manner.

Considering these factors, the main objective of this study was to produce and characterize dehydrated "peixinho da horta" leaves aiming their future application in the manufacture of various food products.

## 2 MATERIAL & METHODS

"Peixinho da horta" (*Stachys byzantina*) was collected at the College of Agricultural Sciences of São Paulo State University (FCA – UNESP), Botucatu Campus (-22.851407934962936, -48.43180876902406), and used to produce dehydrated leaves. Initially, the leaves were manually separated from the stems and cleaned with sodium hypochlorite (2.5%) for 15 minutes, then rinsed with running water. Subsequently, they underwent drying in a forced-air oven (Marconi MA 035) at 60°C for 24 hours. The dried samples were ground in a knife mill (Grindomix GM 300) to obtain the DPHL (Figure 1).

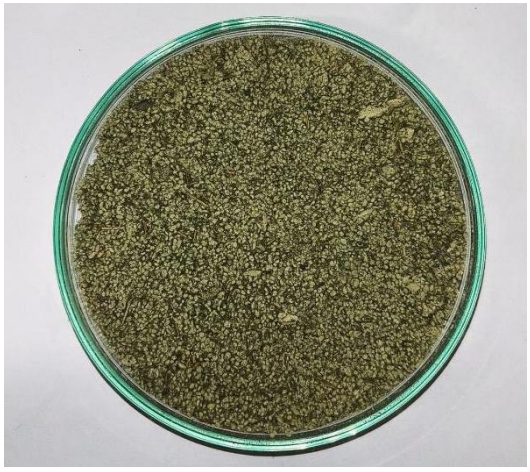

**Figure 1** Dehydrated and ground “peixinho da horta” leaves.

Samples water activity was determined directly, at 25 ± 2°C, using a water activity analyzer (Meter, AquaLab, Series 3TE, USA). Samples (2 g) were mixed in 100 mL of distilled water and kept under magnetic stirring (150 rpm at 25ºC) for a period of 30 minutes for pH measurement, after 1 minute of contact with the solution. Titratable acidity was determined according to AOAC (2000)[6]. Color parameters were instrumentally evaluated using a colorimeter (Minolta Chroma Meter CR 410), with color expressed by the CIELAB system. The determined parameters were lightness (L*), chroma a*, and chroma b*.

Samples moisture and protein content were determined according to Analytical Standards of the Adolfo Lutz Institute (2008)[7]. For total phenolic compounds determination, the DPHL were solubilized in ethanolic solution (ethanol:water, 70:30 v/v) and phenolic compounds concentration determined by the Folin-Ciocalteau method[8], at 740 nm.

## 3 RESULTS & DISCUSSION

Table 1 presents the results of water activity, pH, titratable acidity, moisture content, protein content, color parameters, and total phenolic compounds of dehydrated “peixinho da horta” leaves. It was observed that the water activity was 0.40, suggesting a product less conducive to microbial growth. This characteristic is crucial for food safety, as water activities below 0.60 reduce the possibility of microbial growth[9]. Therefore, this parameter indicates that the DPHL can be considered a safe raw material, providing greater stability and quality to the food. The low moisture content (7.3%) observed, reinforces its probable high stability against microbial deterioration[11].

pH and titratable acidity are important parameters influencing the sensory perception and microbiological safety of products, directly influencing its acceptability[4]. For this study, the samples exhibited a pH close to neutrality (Table 1), which is favorable for sensory perception. The titratable acidity of 3.50 g/100g (Table 1) contributes to pathogen preservation and microbiological stability. Similar results were reported by Borges et al.[10] for green banana peel flour, which presented a pH of 5.30 and titratable acidity of 0.63 g/100 g.

Regarding the color parameters, positive values of lightness (51.46) and chroma b* (16.35), and negative values of chroma a* were observed (Table 1). These results suggest a tendency towards a green coloration, as evidenced in Figure 1.

**Table 1** Water activity, pH, titratable acidity, color parameters, moisture content, proteins, and total phenolic compounds of dehydrated “peixinho da horta leaves”.

| Analysis | Peixinho da horta |
|---|---|
| Water activity | 0.40±0.01 |
| pH | 6.32±0.03 |
| Titratable acidity (g/100g) | 3.50±0.44 |
| Lightness | 51.46±0.51 |
| a* | -6.43±0.07 |
| b* | 16.35±0.20 |
| Moisture (%) | 7.3±0.3 |
| Proteins (%) | 12.7±0.6 |
| Total phenolic compounds (mg GAE/g sample) | 25.37±0.05 |

The DPHL showed a high protein content of 12.7% (Table 1). conferring significant nutritional value, making “peixinho da horta” leaves a healthy and versatile option for various food applications[12].

The results revealed a considerable content of total phenolic compounds (25.37 mg GAE/g DPHL), corroborating the importance of “peixinho da horta” as a relevant source also as bioactive compounds[13]. According to Bahadori et al.[3], tea obtained from “peixinho da horta” leaves of the species *S. byzantina* showed the highest total phenolic compound content compared to the species *S. inflata* and *S. lavandulifolia*. The authors[3] reported total phenolic compound values ranging from 52.16 to 58.06 mg GAE/g decoction, with the main compounds being gallic acid, catechin, and chlorogenic acid.

## 4 CONCLUSION

The findings demonstrate that dehydrated “peixinho da horta” leaves are promising nutritive ingredient for incorporation into food products, standing out for their high protein and phenolic content, suggesting their relevance as a nutritious Unconventional Food Plant. Their neutral pH enhances sensory acceptance in various products. Additionally, their low water activity, appropriate moisture content and low titratable acidity indicate high stability and lower susceptibility to microbiological reactions, positive characteristics for their inclusion in new products. Thus, when included in food production, they not only offer nutritious options but also promote the valorization of underutilized food resources, contributing to waste reduction and the promotion of a sustainable food system.

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