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Houttuynia cordata Thunb: Ethnobotanical and availability notes in the Cu Chi district, Vietnam

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Abstract

Houttuynia cordata, a plant with a long history of traditional medicinal and culinary uses across different cultures, has shown effectiveness in treating various ailments in Southeast Asia. The Cu Chi district of southern Vietnam, is home to 35 out of the country's 54 ethnic minority groups, making it an ideal location to investigate the traditional uses and availability of *H. cordata* within the local community. The study findings reveal notable differences in leaf anatomy, thickness, and vascular bundles, which can be attributed to variations in soil conditions. The Phu My Hung area, characterized by lower soil moisture and nutrient content, indicates more pronounced drought conditions. *H. cordata* from this region exhibits higher antioxidant capacity and develops lignified cells as an adaptation to dry conditions, thereby enhancing water use efficiency. The findings of this study highlight the significant implications of the distinct populations of *H. cordata* belonging to the same species. These populations have undergone morphological and physiological adaptations in response to their specific ecological conditions. Notably, the H. cordata population from drought-prone areas such as Phu My Hung exhibits remarkable potential for medicinal applications. This suggests that the unique environmental pressures in these regions have influenced the plant's composition and properties, making it a valuable resource for medicinal research and potential therapeutic developments. The identification and utilization of such adaptations in *H. cordata* populations could have far-reaching implications in the field of medicine, offering new avenues for drug discovery and the treatment of various ailments.

Keywords

availability; ethnobotanical; *Houttuynia cordata*; medicinal plant

Introduction

Houttuynia cordata Thunb, commonly referred to as "dokudami" or "fish mint," is a highly valued herbaceous perennial plant that has a rich history of traditional use across various cultures (1). It originates from East Asia, including Vietnam, and is renowned for its medicinal and culinary properties. The plant's roots, young shoots, leaves, and sometimes the whole plant are traditionally utilized to cure a wide range of human diseases throughout Southeast Asia (2). Additionally, *H. cordata* is listed in the Chinese Pharmacopoeia and is widely recognized as a traditional medicinal material in China and Japan (2). Recent scientific studies have explored the ethnobotanical aspects of *H. cordata.* Located in the southern

region of Vietnam, the Cu Chi district is known for its rich biodiversity and cultural heritage and is home to 35 out of the 54 ethnic minority groups in the country. The Hoa (Chinese), Cham, and Khmer communities are the largest ethnic groups in the district, making it an ideal location to investigate the traditional uses and availability of *H. cordata* within the local community (3).

The main objective of this study was to investigate the morphological variations and antioxidant activity of two distinct populations of *H. cordata* in response to their specific ecological conditions. Additionally, the study aimed to compare and document the ethnobotanical uses of *H. cordata* in the Cu Chi district, Vietnam. This included examining its traditional medicinal applications and culinary uses in the region. By exploring the plant's traditional knowledge, availability, and antioxidant potential, the study aimed to gain a deeper understanding of its value and potential applications within the local community. The findings from this research contribute to the existing body of knowledge on *H. cordata*, supporting its conservation, sustainable utilization, and potential contributions to traditional medicine and human health.

Materials and Methods

The studied sites

This study focused on two distinct populations of *H. cordata*, which were selected from different regions in Cu Chi, Vietnam. Phu My Hung (11.116589, 106.460293) and Tan Thong Hoi (10.939827, 106.507478) (Fig. 1) were chosen as the study sites. The area experiences two distinct seasons, namely the rainy season from May to November and the dry season from December to April. During the dry season, there is a significant temperature difference between day and night, ranging from 8 to 10°C. The average humidity in the air is 79.5%, with the highest levels occurring in July and August at 80-90% and the lowest levels in December at 70.1% (4).

Questionnaire survey

To collect ethnobotanical information, a comprehensive form was created. It comprised eight closed-ended questions, categorized into two sections. The initial section focused on six questions that gathered demographic data, such as the individual's name, gender, age, and ethnic group. The subsequent section aimed to understand how *H. cordata* is utilized, with three questions specifically directed toward the plant part used, the method of use, and the types of ailments treated with *H. cordata.*

Ecological, botanical, and antioxidant activity features

For each population of *H. cordata*, we established 10 randomly selected plots measuring 10 m x 10 m. Within each plot, we set up 3 sampled plots, each measuring 5 × 5 m. Within each sampled plot, we randomly placed ten quadrats, each measuring 1 × 1 square meter. Therefore, the data was collected over a total area of 300 m^2, calculated by multiplying the number of quadrats (10 quadrats) by the number of sampled plots (3 sampled plots) and the number of random plots (10 random plots). Subsequently, the habitat's soil characteristics, specifically pH, soil water content, and nitrogen content were concurrently analyzed for each quadrat. The soil samples underwent a drying procedure at a temperature of 105°C for a duration of 24 h to obtain the soil water content values. The soil pH value was analyzed by creating a soil suspension with a soil-water ratio of 1:2.5 (w/v), followed by using a glass electrode to measure the pH value (5). The quantification of NH_4^+ content and NO_3^- content was

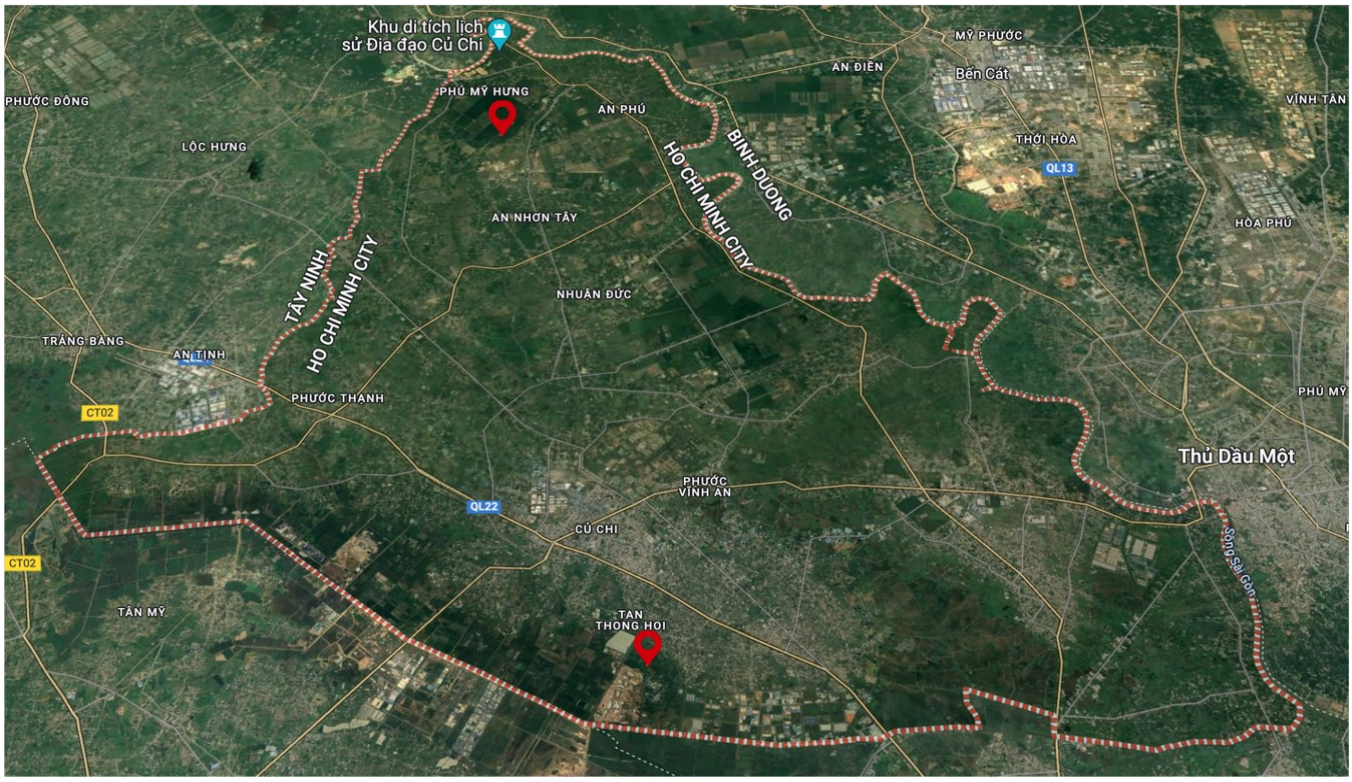

Fig. 1. The locations of the study area in Cu Chi in Vietnam (survey locations are marked in red)

carried out through the employment of the indophenol blue colorimetric method and phenol sulfonic acid colorimetric method, respectively (6, 7). Additionally, ten individuals were randomly selected from each population to analyze their morphological characteristics.

Cross-sectional analyses of leaves and stems were conducted by obtaining sections that were 500 µm in thickness using a free-hand sectioning method. Subsequently, the sections underwent clearing with a 5% sodium hypochlorite solution for 15 minutes, followed by a rinse with distilled water. The sections were then treated with 5% acetic acid for 5 minutes and washed with distilled water thrice. Subsequently, the sections were stained with carmine-iodine dye for a duration of 3 minutes. Finally, the sections were washed repeatedly with water until all excess dye was removed (8). The sections were then observed under a light microscope to facilitate visual examination.

To assess the antioxidant activity of the sample using the DPPH scavenging assay, 500 mg of dried powdered leaf sample and immersed in 2.5 mL of methanol. The mixture should be shaken for about 3 hours at 60°C and then centrifuged at a speed of 10000 rpm for 10 minutes. After this, the supernatant is to be concentrated. Next, in a sample tube, 3 mL of DPPH solution should be mixed with 100 µL of diluted extract. Once this is done, the tubes should be left in the darkness for 30 minutes, following which the absorbance should be measured at 517 nm. The antioxidant percentage can then be calculated using Baliyan's (2022) formula (9).

Statistical analysis

The data collected was subjected to ANOVA analysis. To establish the variations between means at a 5% probability level, a T-test was executed on SPSS 20.0. The presentation of results was done by providing the mean and standard deviation values.

Results and Discussion

Occurrence and availability

The majority of *H. cordata* populations were observed in areas that were shaded and well-moistened, specifically beneath the canopy of horticultural trees or along the periphery of garden fencing. Moreover, the species accounted for a higher percentage of overall stand density in Tan Thong Hoi, compared to Phu My Hung.

Ecological, botanical, and antioxidant activity features

The two distinct populations of *H. cordata* share similar botanical characteristics. The stems grow in a creeping manner and root in whorls at the nodes, while the tips grow straight and can be smooth or hairy. The leaf blades are broadly ovate to cord-shaped, with long and smooth leaf stalks. The underside of the leaves is typically purple, featuring a short, pointed tip and 5-7 veins. The basal or innermost pair of veins arises approximately five veins above the base. Nonetheless, *H. cordata* in the Tan Thong Hoi area exhibit greater height, larger leaves, and higher plant weight compared to those in the Phu My Hung area. Additionally, the stem in the Phu My Hung area has a darker red coloration than those in Tan Thong Hoi (Table 2, Fig. 2). Further analysis of leaf anatomy, specifically beyond the midrib and leaf blade, reveals that leaves in the Tan Thong Hoi area have greater thickness and wider vascular bundles (Table 2). These differences can be attributed to variations in soil conditions between the two areas. Soil analysis indicates that the soil in the Tan Thong Hoi area is nearly neutral, while the soil in the Phu My Hung area is highly alkaline (pH of 5.57). Moreover, the Tan Thong Hoi area has higher soil moisture levels (82.67%), whereas the Phu My Hung area experiences lower soil moisture (67.67%). Similarly, the nitrate levels in the soil of the Phu My Hung area are significantly lower compared to the soil in the Tan Thong Hoi area, measuring 33.49 and 47.15 mg/kg soil, respectively. In contrast, there is no significant difference in ammonium content between

Table 1. Soil characteristics of *Houttuynia cordata* in two different sites

Studied sites	Tan Thong Hoi	Phu My Hung	T-Test
Soil pH	6.37 ± 0.15	5.57 ± 0.12	+
Soil water content (%)	82.67 ± 2.52	67.67 ± 3.06	+
NH_4^+ content (mg/kg)	10.23 ± 2.67	9.93 ± 2.17	ns
NO_3^- content (mg/kg)	47.15 ± 4.33	33.49 ± 2.82	+

(+), indicating a significant difference at a level of $p \leq 0.05$ (T-Test)

Table 2. Plant characteristics of *Houttuynia cordata* in two different sites

Studied sites	Tan Thong Hoi	Phu My Hung	T-Test
Height plant (cm)	17.20 ± 0.75	12.70 ± 0.17	+
Fresh weight (g)	6.40 ± 0.38	4.42 ± 0.15	+
Leaf thickness (µm)	285.00 ± 13.23	180.75 ± 5.02	+
Vascular bundle width (µm)	1821.67 ± 48.56	508.00 ± 13.11	+
IC 50 value (mg/mL)	243.33 ± 15.28	150.00 ± 30.52	+

Values with different letters in a column are significantly different with Duncan's test (p=0.05)

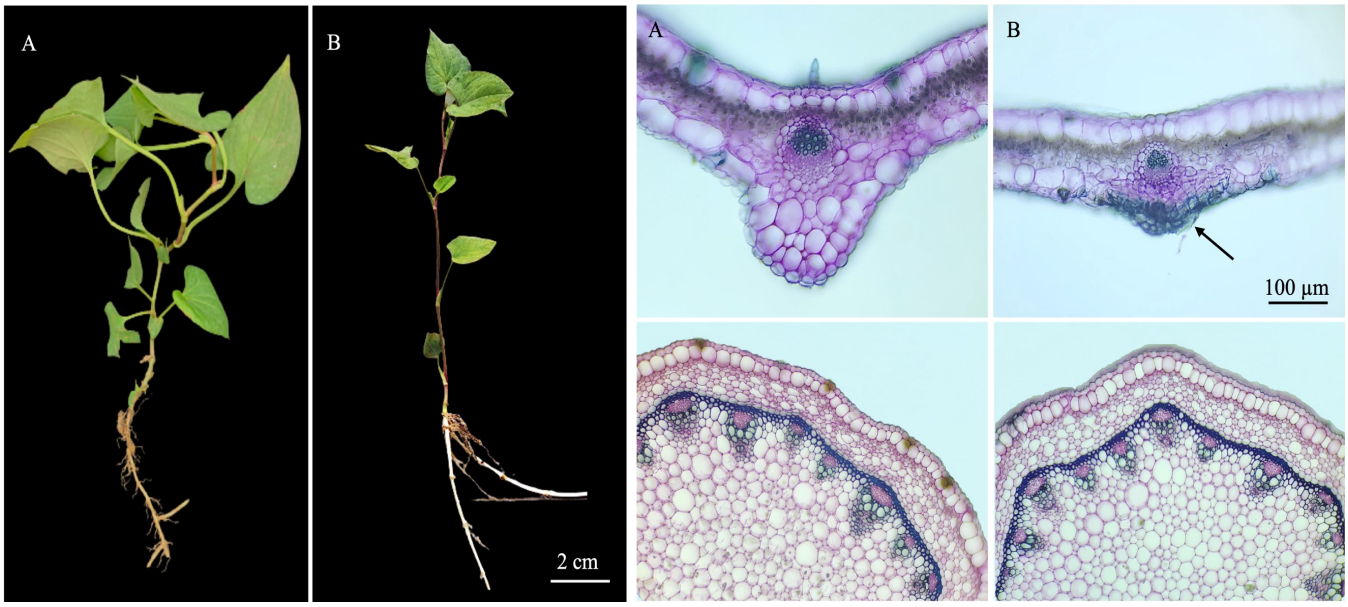

Fig. 2. Morphological characteristics and anatomical structures of leaves and stems of *H. cordata* were examined in two areas, Tan Thong Hoi (A) and Phu My Hung (B) in Cu Chi, Vietnam. The arrow indicates the region of lignified cells in the lower epidermis of the leaf.

these two locations, with ammonium values ranging around 9-10 mg/kg soil (Table 1). This suggests that the Phu My Hung area is subjected to more pronounced drought conditions compared to Tan Thong Hoi. During drought conditions, crops tend to grow at a slower rate or synthesize substances to adapt to water scarcity. Indeed, the IC50 value measured by the DPPH method reveals that *H. cordata* in the Phu My Hung area possesses significantly higher antioxidant capacity than those in the Tan Thong Hoi area (Table 2). *H. cordata* leaves in the dry conditions of Phu My Hung also develop lignified cells in the lower epidermis (Fig. 2). The formation of these cells and the reduction in vascular bundle size and thickness enhance water use efficiency, minimizing water loss due to the water-repellent properties of lignin (10, 11). However, there are no significant differences observed in the anatomical structure of the stem between the two areas.

The analysis above illustrates that despite belonging to the same plant species, the *H. cordata* in these two distinct ecological regions exhibit certain morphological and physiological adaptations. Notably, the increased antioxidant activity in *H. cordata* from drought-prone areas such as Phu My Hung highlights their potential for medicinal purposes. This demonstrates that the utilization of crops varies among ethnic groups and that indigenous people are influenced not only by their cultural heritage but also by the ecological conditions of their respective regions.

Ethnobotanical uses

The survey results indicate that both areas, Tan Thong Hoi and Phu My Hung, utilize almost all parts of *H. cordata,* but with varying percentages. In Tan Thong Hoi, 47% of the plant parts used are from *H. cordata*, while in Phu My Hung, it is 35%. However, there is a noticeable difference in the usage of certain parts, such as the stem, seed, and flower, which are used to a lesser extent in both areas, comprising less than 10% of the overall usage. The utilization of H. cordata's roots and leaves also shows a significant contrast between the two areas. Tan Thong Hoi predominantly favors the usage of leaves, accounting for 39% of the parts used, whereas roots constitute only 9% of the usage. On the other hand, Phu My Hung is more inclined towards using the roots, with 32% of the parts used being roots, and leaves comprising 18% of the usage (Fig. 3A). In terms of the preparation method, eating fresh is common in both areas, accounting for 68% in Tan Thong Hoi and 48% in Phu My Hung. 23% of people in Phu My Hung tend to use H. cordata as an herbal tea, over three times higher than that of Tan Thong Hoi. About 14% of people in both areas use the plant to make medical liquor. Powdering, decoction, spitting and rubbing, and pickling are less cared for, even though Tan Thong Hoi does not use the pickled method (Fig. 3B).

H. cordata is a plant that has been utilized in various traditional practices across different cultures. It is renowned for its therapeutic properties and is believed to possess anti-inflammatory, antimicrobial, antiviral, and antioxidant effects (12). In traditional medicine, it is utilized to treat respiratory ailments such as coughs, bronchitis, and asthma, as well as gastrointestinal issues including diarrhea and food poisoning (13). *H. cordata* is also employed topically to aid in wound healing and relieve skin conditions such as dermatitis and eczema (14). In the Cu Chi district, *H. cordata* is widely used for treating disease in the two areas. The most common function used by both areas in treated diseases is digestive disorders (indigestion, stomachaches, constipation), with 32% in Tan Thong Hoi and 29% in Phu My Hung. The second most common function used is respiratory issues, with about 23% for both. In comparison, high blood pressure is less likely to be used in diseases treated in both sizes (just 9% in Tan Thong Hoi and 7% in Phu My Hung). In terms of skin conditions (insect bites, skin inflammation, rashes), they were used wildly in Tan Thong Hoi, with 23%, compared to just 14% in Phu My Hung. Similarly, there is an opposition in the two areas, occurring in arthritis and joint pain. Particularly, Tan Thong Hoi takes 14%, while Phu My Hung nearly doubles in the figure (Fig. 3C).

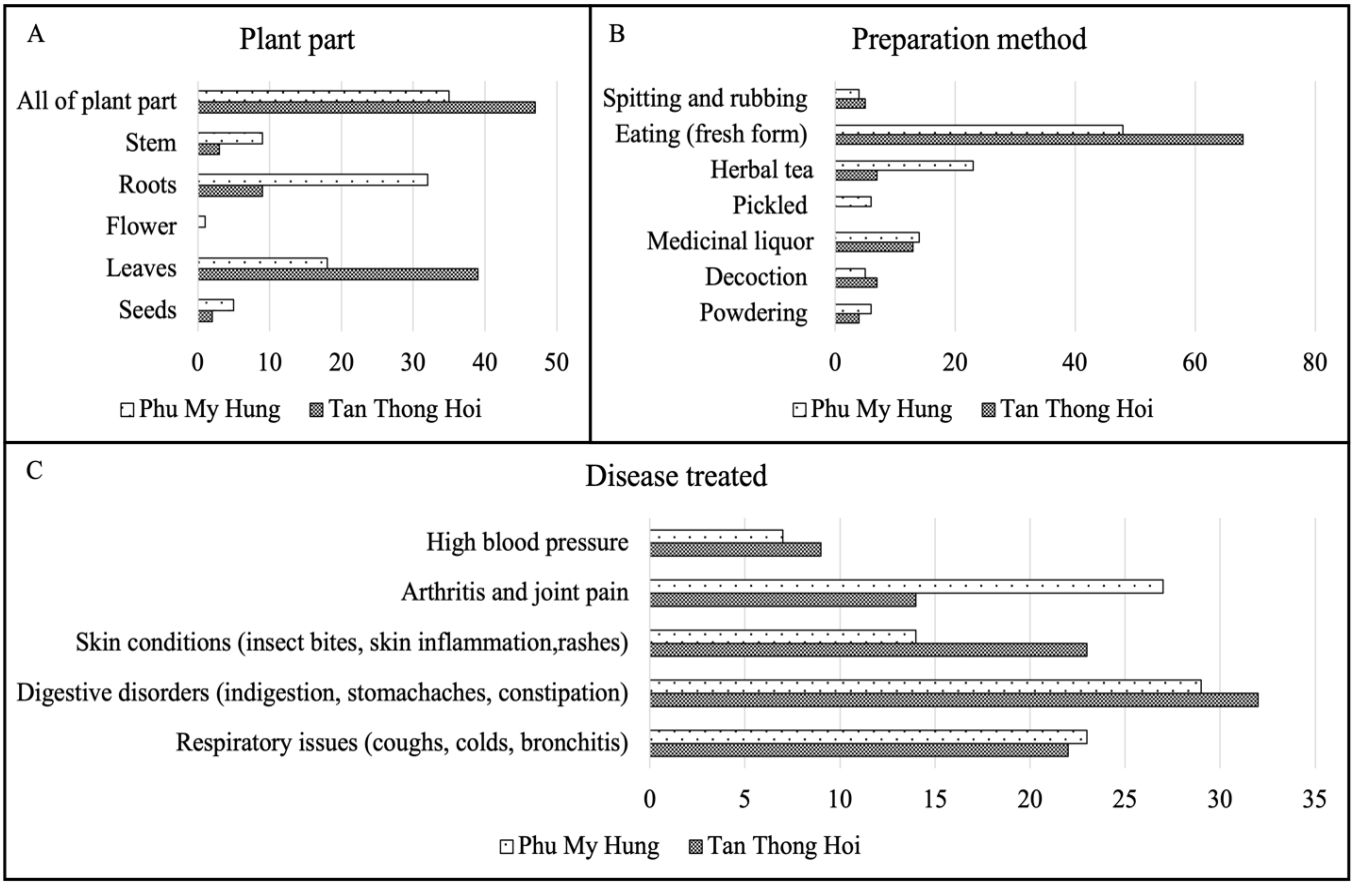

Fig. 3. The percent of plant part (A), preparation method (B), and disease treatment (C) of *H. cordata* used in two areas, Tan Thong Hoi and Phu My Hung in Cu Chi, Vietnam.

Conclusion

H. cordata is a species of leafy vegetable that has garnered considerable attention due to its extensive use as a food source and medicinal remedy by the natives of the Cu Chi region of Vietnam. Notably, the plant is of immense value to both the food and medicine industries. Given the significance of this plant species, there is a pressing need to establish a systematic approach to its management and utilization. To this end, a comprehensive strategy must be devised to ensure that *H. cordata* is sustainably cultivated, harvested, and distributed. This approach should take into account various factors, including the plant's growth requirements, optimal harvesting techniques, and post-harvest handling protocols. Furthermore, the utilization of *H. cordata* must be optimized to maximize its value to the food and medicine industries.

Authors' contributions

TTT and TTTN carried out the experiments and drafted the manuscript. TTT and TTTL conceived the study and participated in manuscript editing, its design, and coordination. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

Ethical issues: None.

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