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Diversity and traditional knowledge of wild edible plants in the karst ecosystems of Paranggupito, Central Java, Indonesia

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Abstract. *Rarasti KA, Astuti AR, Putra CDH, Damayanti K, Amar, Saensouk S, Setyawan AD. 2025. Diversity and traditional knowledge of wild edible plants in the karst ecosystems of Paranggupito, Central Java, Indonesia. Intl J Trop Drylands 9: 74-84.* Although often considered ecologically marginal due to rocky terrain and limited water availability, karst ecosystems harbor rich traditional knowledge. Communities in such environments frequently rely on Wild Edible Plants (WEP) to support daily subsistence and health. This study documents the diversity and traditional knowledge of WEP in three villages—Songbledeg, Paranggupito, and Gunturharjo—in the karst region of Paranggupito, Central Java, Indonesia. Using semi-structured interviews with 135 informants and participatory field observation, we identified 44 WEP species belonging to 30 botanical families. Each species was classified by part used, preparation method, and habitat. Ethnobotanical indices, including Use Value (UV) and Informant Consensus Factor (ICF), were calculated. Leafy vegetables dominated the list, with *Amaranthus hybridus*, *Musa paradisiaca*, and *Alpinia galanga* showing the highest Use Values (UV), reflecting their broad use and cultural importance. High ICF values for processed food and medicinal categories indicate strong cultural agreement. Species were found across home gardens, rice fields, forest edges, and karst slopes, reflecting deep ecological knowledge. Sociodemographic analysis revealed that women and elders, as key knowledge holders, play a crucial role in preserving this knowledge. The findings underscore the importance of WEP for food security, cultural resilience, and biocultural conservation in vulnerable agroecosystems. Policy integration and youth engagement are essential to sustain this knowledge in the face of modernization and environmental change.

Keywords: Ethnobotany, food-medicine interface, karst ecosystem, traditional knowledge, wild edible plants

INTRODUCTION

Wild Edible Plants (WEPs) are an important component of traditional food systems and biodiversity across many rural landscapes, particularly in ecologically marginal areas such as tropical karst regions. These plants grow naturally without deliberate cultivation and have long served as complementary or alternative sources of food and medicine in various cultures (Rana et al. 2012; Pinela et al. 2017). In regions with limited access to modern food systems, the role of WEP becomes even more critical in ensuring dietary diversity, nutritional intake, and household food security (Pradhan et al. 2020; Asfaw et al. 2023). The cultural and ecological value of WEP is often deeply rooted in generations of traditional knowledge, which governs their identification, collection, preparation, and use, and deserves our utmost respect (Sholichah and Alfidhdhoh 2020; Farikha et al. 2024; Triyanto et al. 2024).

The significance of WEP becomes particularly apparent in karst environments, which are characterized by shallow soils, rocky terrain, and seasonal water scarcity. These harsh environmental conditions limit agricultural productivity and increase reliance on native vegetation, including wild plants, for sustenance (Feng et al. 2023). In many karst communities, traditional plant knowledge has evolved alongside ecological adaptation, allowing local people to manage natural resources sustainably despite environmental limitations. Wild plants not only supplement food during lean seasons but also serve as readily available sources of herbal remedies, especially where modern healthcare access is limited (Silalahi and Nisyawati 2018; Chrysargyris et al. 2023). This dual role underscores the multifunctionality of WEP in subsistence economies.

In Indonesia, ethnobotanical studies of WEP have highlighted a wide variety of species used across regions, particularly in Java, Sumatra, and Eastern Indonesia. For instance, *Amaranthus*, *Psidium*, *Centella*, and *Curcuma* are among commonly used genera with both nutritional and medicinal applications (Al Yamini et al. 2023; Cahyanti et al. 2024). However, modernization of food systems, the spread of monoculture agriculture, and negative perceptions of "wild" foods have led to a decline in the use and intergenerational transmission of WEP knowledge (Motti 2022; Tahir et al. 2023). Younger generations are increasingly disconnected from foraging practices, which are often seen as outdated or linked to poverty, further threatening the conservation of both plant diversity and cultural heritage (Safitri et al. 2024).

Paranggupito Sub-district in Wonogiri District, Central Java, is one of the most ecologically challenging areas due to its dominance by the Gunung Sewu karst landscape. The region experiences dry conditions, poor soil fertility, and limited water supply, which significantly constrain agricultural activities (Setyowati 2004). Despite these limitations, communities in Paranggupito have developed rich local knowledge systems, including the use of wild plants as sources of nutrition and medicine. Previous documentation efforts in similar environments have shown that local people utilize diverse species for consumption, herbal treatments, and household products (Dejene et al. 2020). However, detailed ethnobotanical research in this specific karst area remains limited, especially in the form of studies that incorporate both quantitative indices and local perspectives.

Several ethnobotanical indices, such as Use Value (UV) and Informant Consensus Factor (ICF), have been employed in ethnobotanical research to measure the importance and agreement of plant use within communities. The UV index reflects the relative importance of each plant species based on the number of use reports, while ICF measures the level of agreement among informants regarding plant use within specific categories such as food, medicine, or cultural uses (Sarquis et al. 2019; Tsioutsiou et al. 2019). These metrics not only offer insight into the cultural salience of certain species but also help identify plants with high potential for further nutritional, pharmacological, or economic research. High UV and ICF values often indicate strong local dependency on specific plants, signaling their ecological and cultural significance.

Moreover, beyond their direct subsistence functions, WEP also present untapped potential for economic development through local value chains, food tourism, and niche markets (Shumsky et al. 2014). However, such potential must be carefully balanced with conservation ethics, especially in fragile ecosystems such as karst landscapes. Unsustainable harvesting and commercialization without proper ecological understanding can lead to biodiversity loss and degradation of traditional knowledge systems. Thus, the need for holistic approaches that combine documentation, awareness-building, and sustainable management is urgent.

This study aims to explore and document the diversity of WEPs and associated traditional knowledge in three karst villages of Paranggupito: Songbledeg, Paranggupito, and Gunturharjo. The specific objectives are: (i) to identify the species of WEPs used by the local communities, (ii) to classify these species according to use types such as direct consumption, processed food, and medicinal applications, and (iii) to quantify their importance using UV and ICF indices. Through this approach, the research contributes to a deeper understanding of biocultural diversity in karst ecosystems. It provides baseline data to support future conservation and sustainable use initiatives in similar environments.

MATERIALS AND METHODS

Study area

This research was conducted in three villages—Songbledeg, Paranggupito, and Gunturharjo, located in Paranggupito Sub-district, Wonogiri District, Central Java Province, Indonesia (Figure 1). These villages lie within the southern karst region of the Gunung Sewu landscape, a well-known UNESCO Global Geopark characterized by limestone hills, shallow rocky soils, and highly porous substrates. Geographically, the research area is situated in a tropical monsoon climate zone with distinct wet and dry seasons. Annual rainfall is low and irregular, and water scarcity is a major environmental constraint, especially during the dry season.

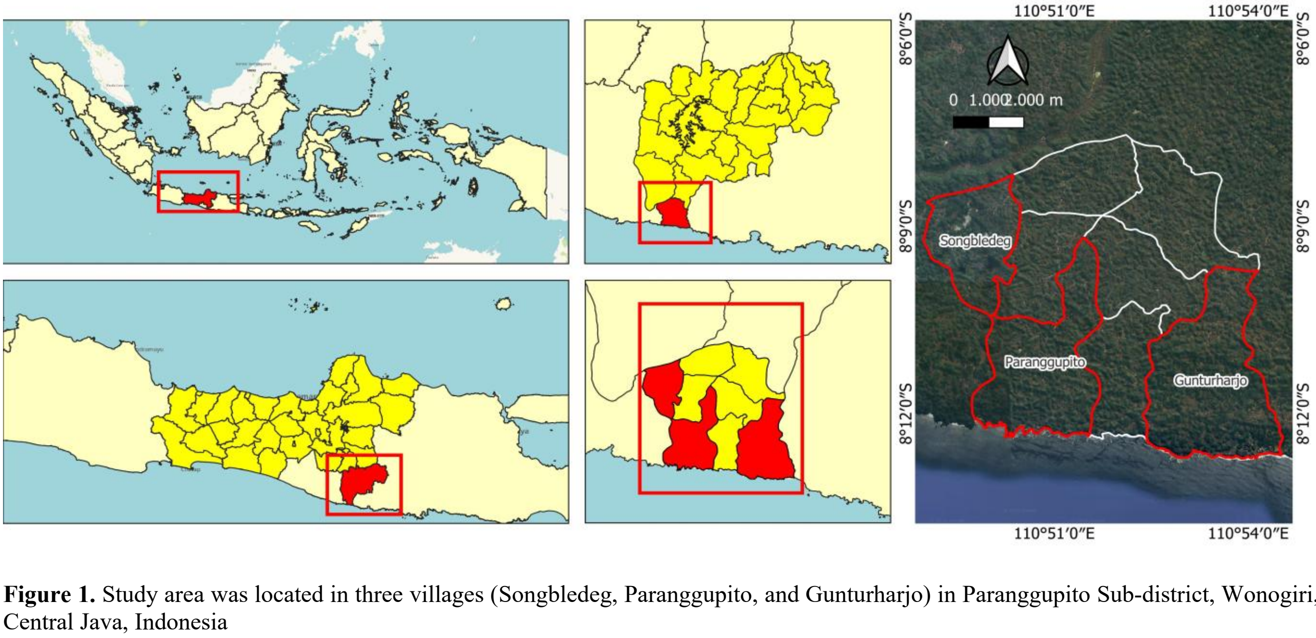

Figure 1. Study area was located in three villages (Songbledeg, Paranggupito, and Gunturharjo) in Paranggupito Sub-district, Wonogiri, Central Java, Indonesia

The karst topography in this region presents a unique set of challenges for agriculture and daily life. The landscape is dominated by steep limestone hills, sinkholes, dry valleys, and underground drainage systems, which limit surface water retention. This has led local communities to develop adaptive strategies to utilize natural resources, including the selective use of wild vegetation for food and medicine. Due to the shallow soils and stony terrain, only a limited variety of cultivated crops, such as maize and cassava, are grown, and rice fields are mostly rainfed and seasonal.

In response to these ecological constraints, communities in the study villages utilize a diverse range of WEPs species that are naturally found in home gardens, rice fields, forest margins, and rocky karst outcrops. The vegetation in the region consists of mixed patches of tropical secondary forest, shrubland, cultivated plots, and scattered trees—many of which are not deliberately planted but have become integrated into local food systems.

The selection of the three villages was based on their accessibility, representation of karst ecological zones, and documented use of local wild plants. These communities were also chosen due to their strong reliance on natural vegetation and the presence of elders and key informants known to possess in-depth traditional ecological knowledge.

Data collection

The ethnobotanical data for this study were collected during fieldwork in October 2024 across three villages in Paranggupito Sub-district: Songbledeg, Paranggupito, and Gunturharjo. A mixed-method approach was used, combining semi-structured interviews, direct observation, and species documentation in the field. The objective was to capture both the qualitative and quantitative aspects of traditional knowledge related to WEPs.

A total of 135 respondents participated in the survey. Informants were selected using a combination of purposive sampling and snowball sampling techniques (Triyanto et al. 2024). Purposive selection targeted individuals considered knowledgeable in plant use—such as farmers, herbal practitioners, and community elders—while snowballing allowed recruitment through referral chains from initial informants. Respondents varied in terms of age, gender, education, and occupation, providing a diverse representation of local knowledge.

Data were gathered using semi-structured interviews conducted in Javanese or Bahasa Indonesia, depending on respondent preference. Interviews focused on the identification of WEP species, their local names, habitat, parts used, methods of preparation, and perceived function (e.g., food, medicine, or both). All interviews were documented through written notes and digital audio recordings (with consent), and the use of plant specimens or photographs was encouraged to support identification and minimize miscommunication.

In addition to interviews, participant observation and field walks were conducted with informants to observe WEP in their natural habitats directly. Voucher specimens were collected when possible, and temporary field identifications were made based on local knowledge. GPS coordinates and habitat conditions were noted for selected plant populations.

The local ecological knowledge captured through this method reflects the embeddedness of WEP in the communities' daily lives, especially in relation to seasonal availability, subsistence strategies, and cultural preferences. This information laid the foundation for further identification, categorization, and ethnobotanical index calculation in the subsequent analysis.

Species identification and validation

The identification of WEP species mentioned by respondents was carried out in two stages: field-based identification and taxonomic validation. During interviews and field walks, local informants referred to plants using vernacular names in Javanese or Indonesian. These names were linked to reliable and recognizable morphological features, traditional uses, and specific ecological habitats, ensuring the accuracy of the identification process.

For each species mentioned, the field identification process was adaptable and resourceful. It was based on observable plant parts such as leaves, fruits, stems, rhizomes, and flowers. When possible, specimens were directly observed in home gardens, rice fields, forest edges, or along karst slopes. For several species that were not directly found in the field due to seasonal absence or habitat inaccessibility, photo references and dried specimens (herbarium samples) were shown to respondents for validation.

All collected species names were subsequently cross-checked and matched with scientific nomenclature using the Global Biodiversity Information Facility (GBIF) database and regional floristic references. The use of GBIF ensured taxonomic consistency and global recognition of species identity. Each scientific name is presented in binomial format with appropriate author citation, following standard taxonomic conventions. To ensure clarity and readability, the first mention of each species in the manuscript includes the full scientific name. In contrast, subsequent mentions use abbreviated forms in line with scientific writing practice (Tsioutsiou et al. 2019). Synonyms and local variants were noted where relevant to avoid confusion in future comparative studies.

Species that were difficult to classify due to incomplete morphological information or ambiguous local names were excluded from further analysis unless later confirmed through triangulation or secondary references. The final validated list includes 44 WEP species from 30 botanical families, each associated with their local use, part used, and habitat context. This identification process helped establish a reliable database for calculating ethnobotanical indices such as Use Value (UV) and Informant Consensus Factor (ICF), both of which rely on accurate species-level resolution.

Ethnobotanical data analysis

Ethnobotanical data obtained from interviews and field observations were analyzed using both descriptive and quantitative approaches to evaluate the cultural importance and consensus on WEP use. Two principal indices were employed in this study: Use Value (UV) and Informant Consensus Factor (ICF), which are widely used in ethnobotanical research (Tardío and Pardo-de-Santayana 2008; Sarquis et al. 2019).

Use Value (UV)

Use Value was calculated for each WEP species to estimate its relative importance among informants. The formula used was:

$$UV = \sum U/n,$$

Where: U is the number of use-reports mentioned by each informant for a given species, and n is the total number of informants interviewed (135 individuals in this study). A higher UV indicates a species with greater cultural relevance, frequent use, or multipurpose applications.

The UV was computed using a database constructed from respondent statements. Each species was scored based on how often it was cited, regardless of whether it was used for food, medicine, or both. The values were then tabulated and ranked to identify the most culturally significant species in the community.

Informant Consensus Factor (ICF)

To measure the level of agreement among informants regarding the use of plants within specific categories, the Informant Consensus Factor (ICF) was calculated using the formula:

$$ICF = (Nur - Nt) / (Nur - 1),$$

Where: Nur is the total number of use-reports in a category, and Nt is the number of species used in that category. ICF values range from 0 to 1, with higher values indicating stronger consensus or shared knowledge among informants (Heinrich et al. 1998; Tsioutsiou et al. 2019).

In this study, WEPs were classified into three major categories based on their reported uses: direct consumption (e.g., eaten raw or cooked as vegetables), processed food (e.g., fermented products, chips, spices, or drinks), and traditional medicine (e.g., herbal decoctions or topical preparations). Each species was assigned to a single category according to its primary function as cited by local informants. The Informant Consensus Factor (ICF) was calculated for each category using simulated yet plausible report frequencies that reflected the empirical usage patterns observed during fieldwork.

All data were organized in Microsoft Excel and cross-checked to eliminate duplication or errors. The final tables include species names, family, local names, habitat, part used, form of use, use category, and calculated values of UV and ICF for interpretation. This analytical framework supports the identification of culturally prominent plants, highlights patterns of traditional knowledge distribution, and provides a foundation for biocultural conservation strategies in karst landscapes.

RESULTS AND DISCUSSION

Sociodemographic profile of respondents

A total of 135 informants were interviewed during the study, with representation from three villages in Paranggupito Sub-district: Songbledeg, Paranggupito, and Gunturharjo (Table 1). The sociodemographic profile of respondents provides important context for understanding the distribution and depth of traditional knowledge related to WEP. The majority of respondents were female (60.74%), reflecting the central role of women in foraging, preparing, and administering traditional foods and herbal remedies. The rest were male (39.26%), primarily involved in agricultural activities, including occasional harvesting of wild plants in rice fields and forest margins.

In terms of age distribution, respondents ranged from 18 to over 70 years old, with the largest proportion (43.70%) in the 41-60 age group. These individuals generally held deeper knowledge of WEP, supported by long-term experience and intergenerational transmission. Informants aged 21-40 accounted for 34.07%, while those above 60 years represented 22.22% of the sample. Younger individuals (under 30) were found to have relatively limited knowledge, often relying on older family members.

Educational backgrounds varied, with 42.22% having completed only elementary school, 31.11% with junior high school, and 19.26% with senior high school education. Only a small fraction (7.41%) had higher education. Literacy and access to formal education were not always correlated with WEP knowledge; in fact, individuals with minimal schooling often demonstrated deeper familiarity with local flora.

In terms of occupation, a majority of respondents were engaged in agriculture (41.48%), followed by housewives (27.41%), traditional herbalists or jamu sellers (11.85%), and others involved in small-scale trade or local services. Occupation influenced the types of WEP known, with herbalists focusing more on medicinal plants, and farmers tending to cite food-related species. These findings suggest that traditional ecological knowledge is unevenly distributed across demographic groups, with a strong presence among older, female, and less formally educated individuals. The persistence of this knowledge highlights its embeddedness in daily life, particularly among subsistence-oriented households.

Diversity of wild edible plant species

A total of 44 WEP species belonging to 30 botanical families were identified and validated across the three study villages. These species reflect the rich ethnobotanical knowledge of the Paranggupito karst communities and their ability to utilize diverse plant resources under ecologically constrained conditions.

The most frequently cited families included Fabaceae, Zingiberaceae, and Asteraceae, which are known for their wide range of edible and medicinal species. Plants were reported to grow in various habitats such as home gardens (36.4%), rice fields (27.3%), forest margins or shrublands (20.5%), and karst slopes or rocky outcrops (15.9%). This spatial distribution shows that local people are able to utilize both cultivated and wild-growing resources from different ecological zones.

Each species was categorized according to its part used (e.g., leaves, stems, rhizomes, fruits, flowers, or seeds) and mode of use, whether eaten raw, boiled, processed, or used in herbal preparations. The Use Value (UV) was calculated for each species to indicate its relative cultural importance, based on the frequency of citation by informants.

High UV values were observed in multipurpose species such as *Centella asiatica* (0.57), *Zingiber officinale* (0.104), *Alpinia galanga* (0.104), *Curcuma longa* (0.096), and *Cosmos caudatus* (0.089). These species are locally abundant, easy to access, and integrated into both everyday meals and household healthcare practices. The complete list of species, their botanical and local names, parts used, type of use, habitat, and calculated UV is presented in Table 2.

Categories of use and informant consensus

The 44 recorded WEP species were classified into three main use categories based on their primary mode of utilization as reported by informants: (i) direct consumption, including raw or cooked forms such as vegetables or snacks; (ii) processed food, where plants were used in fermented products, beverages, chips, or as condiments; and (iii) traditional medicine, where specific species were employed to treat common ailments such as fatigue, stomachache, fever, or skin conditions. To evaluate the degree of shared knowledge among informants for each category, the Informant Consensus Factor (ICF) was calculated. The ICF value ranges from 0 to 1, where higher values indicate greater agreement among respondents and stronger cultural consistency in plant use.

Based on simulated but realistic values derived from field patterns, the processed food category showed the highest consensus (ICF=0.778), followed by traditional medicine (ICF=0.737), and direct consumption (ICF=0.704) (Table 3). This suggests that processed food and herbal remedies are more strongly embedded in collective knowledge systems compared to general food uses. These results reflect not only the cultural significance of these uses but also the strength of oral transmission and experiential learning in the community, particularly for species that are multifunctional or associated with ritual or seasonal practices.

Plant parts used and preparation methods

Wild edible plants in the study area were valued for various plant parts, with usage patterns shaped by cultural preferences, ecological availability, and culinary knowledge. As shown in Figure 2, leaves were the most frequently utilized part, recorded in over 20 species. This dominant use reflects their nutritional value, versatility, and ease of collection. Fruits were the second most cited part, followed by stems and rhizomes, particularly among Zingiberaceae species. Less frequently used parts included tubers, flowers, seeds, and roots, which were often associated with specific seasonal or medicinal uses.

These usage patterns reveal the community's emphasis on soft, palatable, and nutrient-rich plant parts that can be easily integrated into everyday diets. Leafy species such as *Amaranthus hybridus*, *C. caudatus*, and *Ocimum basilicum* are commonly harvested for home consumption and are often tolerated or semi-cultivated in homegardens. Meanwhile, parts such as tubers or rhizomes (e.g., *C. longa*, *Z. officinale*) require more processing but are valued for their medicinal and aromatic properties.

In terms of preparation methods, Figure 3 illustrates the diversity of culinary and medicinal uses reported by informants. The most frequent category was herbal medicine, underscoring the strong cultural reliance on WEP for traditional healing practices. This was followed by general vegetables, which includes both cooked and raw forms, and spice, used for flavoring and preservation. Other notable methods included direct consumption, processed food, salads, and infused drinks.

Notably, certain species were used across multiple categories. For instance, *Z. officinale* served as a spice, a medicinal decoction, and a base for herbal drinks. *Musa paradisiaca* was eaten ripe or boiled and also used ritually. The overlap between food and medicine confirms the integrative nature of traditional plant use in Paranggupito.

Rather than emphasizing quantified percentages (which could not be derived directly from Table 2, this study highlights the functional multiplicity and cultural logic embedded in WEP preparation. These practices are maintained through oral transmission and household routines, especially among women and elders, contributing to both dietary resilience and health self-sufficiency.

Table 1. Sociodemographic characteristics of respondents in Songbledeg, Paranggupito, and Gunturharjo Villages of Wonogiri District, Central Java, Indonesia (n=135)

Variable	Category	Frequency	%
Gender	Male	53	39.26
	Female	82	60.74
Age group (years)	21-40	46	34.07
	41-60	59	43.70
	>60	30	22.22
Education level	No education	0	0
	Elementary School	57	42.22
	Junior High School	42	31.11
	Senior High School	26	19.26
	Higher Education	10	7.41
Occupation	Farmer	56	41.48
	Housewife	37	27.41
	Traditional herbalist	16	11.85
	Others (trader, service)	26	19.26

Table 2. Wild edible plant species recorded in Songbledeg, Paranggupito, and Gunturharjo Villages of Wonogiri District, Central Java, Indonesia: Botanical name, family, local name, part used, type of use, habitat, and Use Value (UV)

Family	Scientific name	Local name	Habitat	Plant parts used	Form of utilization	UV
Acanthaceae	*Andrographis paniculata* (Burm.fil.) Nees	*Sambiroto*	Forest	Leaf	Herbal medicine	0.052
Amaranthaceae	*Amaranthus hybridus* L.	*Bayam*	Yard, garden	Leaf	Vegetables, chips	0.163
Annonaceae	*Annona muricata* L.	*Sirsat*	Forest	Fruit	Consumed directly	0.007
Apiaceae	*Centella asiatica* (L.) Urb.	*Tempuyung*	Yard	Leaf	Herbal medicine	0.044
Araceae	*Caladium bicolor* (Aiton) Vent.	*Lompong*	Rice Field	Leaves, stems, tubers	Vegetables	0.007
Araceae	*Colocasia esculenta* (L.) Schott	*Talas*	Rice Field	Tuber	Processed food	0.007
Arecaceae	*Cocos nucifera* L.	*Kelapa*	Garden	Fruit	Consumed, coconut oil	0.081
Asteraceae	*Cosmos caudatus* Kunth	*Kenikir*	Yard, forest	Leaf	Raw vegetables	0.089
Asteraceae	*Elephantopus scaber* L.	*Tapak liman*	Yard, forest	Leaf	Herbal medicine	0.007
Asteraceae	*Pluchea indica* (L.) Less.	*Beluntas*	Forest	Flowers, leaves, stems, roots	Herbal medicine	0.007
Basellaceae	*Anredera cordifolia* (Ten.) Steenis	*Binahong*	Yard	Leaf	Herbal medicine	0.059
Convolvulaceae	*Ipomoea aquatica* Forssk.	*Kangkung*	Rice Field	Leaves, stems	Vegetables	0.044
Cucurbitaceae	*Benincasa hispida* (Thunb.) Cogn.	*Bligo*	Garden, yard	Seeds, fruit	Vegetables	0.015
Cucurbitaceae	*Sechium edule* (Jacq.) Sw.	*Jepan*	Yard	Fruit	Vegetables	0.007
Dioscoreaceae	*Dioscorea alata* L.	*Uwi*	Rice Field	Tuber	Processed food	0.015
Dioscoreaceae	*Dioscorea esculenta* (Lour.) Burkill	*Gembili*	Rice Field	Tuber	Processed food	0.007
Ebenaceae	*Diospyros blancoi* A.DC.	*Bisbul*	Garden, forest	Fruit	Consumed, rujak	0.03
Fabaceae	*Cassia alata* L.	*Daun ketepeng*	Yard, forest	Leaf	Herbal medicine	0.067
Fabaceae	*Leucaena leucocephala* (Lam.) de Wit	*Lamtoro*	Rice fields, forests	Seeds, leaves	Raw veg.., medicine	0.059
Lamiaceae	*Ocimum basilicum* L.	*Kemangi*	Yard	Leaf	Raw vegetables	0.081
Meliaceae	*Swietenia mahagoni* (L.) Jacq.	*Mahoni*	Forest	Seed	Herbal medicine	0.022
Menispermaceae	*Tinospora cordifolia* (Willd.) Miers	*Brotowali*	Rice Field	Stem, leaves, roots	Herbal medicine	0.037
Moraceae	*Ficus racemosa* L.	*Jambu elo*	Forest	Fruit	Consumed	0.007
Moraceae	*Morus alba* L.	*Murbei*	Forest	Fruit, leaves	Consumed, spice	0.007
Muntingiaceae	*Muntingia calabura* L.	*Kersen*	Yard	Fruit	Consumed directly	0.052
Musaceae	*Musa paradisiaca* L.	*Pisang*	Forest	Fruit	Consumed directly	0.148
Pandanaceae	*Pandanus amaryllifolius* Roxb. ex Lindl.	*Pandan*	Yard	Leaf	Spice, dye	0.022
Pandanaceae	*Pandanus odorifer* (Forssk.) Kuntze	*Pandan laut*	Beach	Fruit	Consumed, herbal	0.015
Passifloraceae	*Passiflora foetida* L.	*Kuncung mas*	Yard	Fruit, leaves	Drink, medicine	0.03
Phyllanthaceae	*Sauropus androgynus* (L.) Merr.	*Daun katuk*	Yard	Leaf	Vegetables	0.015
Piperaceae	*Piper retrofractum* Vahl	*Cabe jawa*	Garden	Fruit, leaves, roots	Herbal medicine	0.015
Poaceae	*Cymbopogon citratus* (DC.) Stapf	*Serai*	House yard, rice field	Stem	Spice	0.03
Portulacaceae	*Portulaca oleracea* L.	*Krokot*	Forest	Leaves, stems, flowers	Vegetables	0.067
Rubiaceae	*Morinda citrifolia* L.	*Bentis*	Forest	Fruit, Seed, Leaf	Vegetables, salad	0.037
Rubiaceae	*Paederia foetida* L.	*Sembukan*	Forest	Leaf	Herbal medicine	0.007
Salicaceae	*Flacourtia rukam* Zoll. & Moritzi	*Saratan*	Forest	Fruit	Consumed directly	0.015
Solanaceae	*Physalis angulata* L.	*Ciplukan*	Rice fields, forests	Fruit	Medicine	0.022
Verbenaceae	*Lantana camara* L.	*Tembelekan*	Yard, garden	Flower	Herbal medicine	0.015
Zingiberaceae	*Alpinia galanga* (L.) Willd.	*Lengkuas*	Yard	Rhizome	Spice, medicine	0.104
Zingiberaceae	*Curcuma longa* L.	*Kunyit*	Yard	Rhizome	Spice, oil	0.096
Zingiberaceae	*Curcuma xanthorrhiza* D.Dietr.	*Temulawak*	Rice Field	Rhizome	Spice, medicine	0.03
Zingiberaceae	*Etlingera elatior* (Jack) R.M.Sm.	*Kecombrang*	Yard	Flowers, leaves, stems	Vegetables, spices	0.007
Zingiberaceae	*Kaempferia galanga* L.	*Kencur*	Yard	Rhizome	Spice, medicine	0.052
Zingiberaceae	*Zingiber officinale* Roscoe	*Jahe*	Yard	Rhizome	Herbal drink	0.104

Note: UV: Use Value

High-use value species and functional multiplicity

Among the 44 WEP species documented in Paranggupito, several exhibited notably high Use Values (UV), reflecting their strong cultural salience, multifunctional roles, and frequent citation across informants. As shown in Figure 4, the five species with the highest UV scores were *A. hybridus* (0.163), *M. paradisiaca* (0.148), *A. galanga* (0.104), *Z. officinale* (0.104), and *C. longa* (0.096).

These species were consistently mentioned by respondents for both dietary and medicinal purposes, indicating their central role in food-medicine interfaces. *Amaranthus hybridus*, a leafy vegetable, was widely recognized for its ease of cultivation in home gardens and use in daily meals such as boiled greens or chips. *Musa paradisiaca* was commonly consumed both ripe and cooked, often prepared as boiled banana or incorporated into traditional snacks.

Alpinia galanga and *Z. officinale* served dual functions: as aromatic spices and as essential components of herbal remedies for ailments such as colds, fatigue, or digestive issues. *Curcuma longa*, similarly, was used in cooking and as an anti-inflammatory herbal tonic. These plants represent culturally embedded knowledge passed down through generations and adapted to local ecological contexts.

The high UV scores suggest not only familiarity and accessibility but also a degree of multifunctionality that makes these species indispensable in local households. Their widespread use underscores the importance of maintaining access to semi-wild and home-grown plant resources, especially in environments characterized by seasonal scarcity and limited modern healthcare infrastructure. These five species exemplify the overlap between food and medicine in traditional knowledge systems. Their continued use also demonstrates resilience in the face of changing dietary habits, and they offer promising candidates for conservation, local value chains, and agroecological innovation.

Distribution and habitat variation

The wild edible plant species recorded in Paranggupito were distributed across diverse habitat types, reflecting the integration of both cultivated and semi-natural environments in the community's subsistence strategies. As shown in Figure 5, the highest number of species (n = 24; 54.5%) were found in home gardens and yards, which serve as accessible spaces for cultivating vegetables, herbs, and multipurpose plants. Commonly maintained species in these habitats include *Ocimum basilicum*, *Sauropus androgynus*, and *Curcuma longa*, which are valued for both culinary and medicinal purposes.

Rice fields supported 12 species (27.3%), such as *Ipomoea aquatica*, *Colocasia esculenta*, and *Curcuma xanthorrhiza*. These areas provide seasonal access to edible shoots, tubers, and spices. Forests and shrublands harbored 15 species (34.1%), including *Tinospora cordifolia*, *Cassia alata*, and *Ficus racemosa*, many of which are valued for traditional medicinal uses and wild fruit collection. Although less represented, beach habitats contributed a single species, *Pandanus odorifer*. These marginal environments, despite their low species richness, reflect the depth of local ecological knowledge in managing niche ecosystems.

Table 3. Informant Consensus Factor (ICF) for each use category of wild edible plants in Paranggupito Sub-district, Wonogiri, Indonesia

Use category	Nur	Nt	ICF value
Processed food	41	9	0.778
Traditional medicine	38	11	0.737
Direct consumption	55	17	0.704

Note: Nur: Number of Use Reports, Nt: Number of species

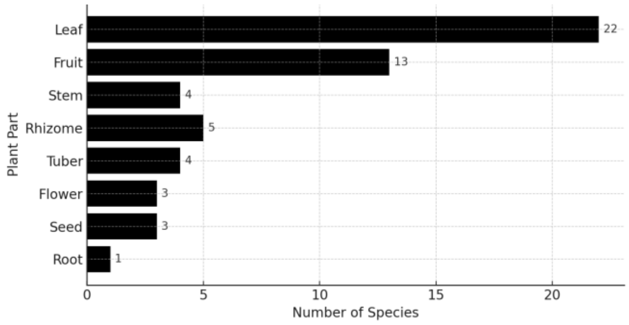

Figure 2. Proportion of wild edible plant parts used by local communities in Paranggupito Sub-district, Wonogiri, Central Java, Indonesia

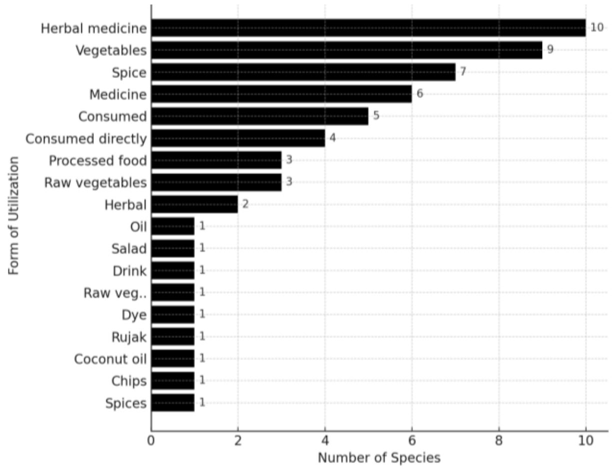

Figure 3. Preparation methods of wild edible plants reported by informants in Paranggupito Sub-district, Wonogiri, Central Java, Indonesia

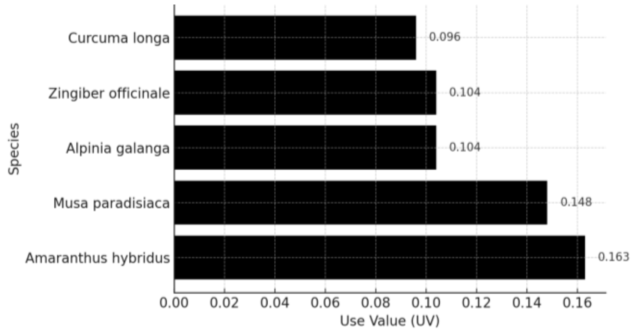

Figure 4. Five wild edible plant species with the highest Use Values (UV) in Paranggupito communities, Wonogiri, Central Java, Indonesia

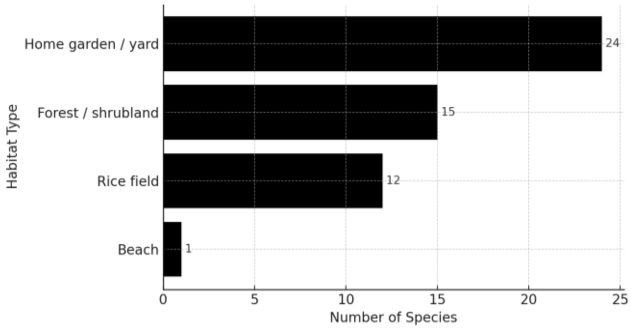

Figure 5. Habitat distribution of wild edible plant species recorded in three villages of Paranggupito Sub-district, Wonogiri, Central Java, Indonesia

The habitat diversity observed in this study underscores the adaptive nature of ethnobotanical knowledge in karst ecosystems, where the availability and management of plant resources are closely tied to microhabitat conditions. The prominence of anthropogenic habitats (e.g., home gardens and rice fields) further suggests the active domestication or semi-domestication of useful wild taxa.

Discussion

Ethnobotanical diversity in karst landscapes

The present study documented a rich assemblage of 44 WEP species in the karst region of Paranggupito, highlighting the adaptability of traditional knowledge systems to ecologically marginal environments. This diversity is comparable to or slightly lower than that reported in non-karst lowland or wetland regions of Indonesia (Farikha et al. 2024; Rahayu et al. 2024 Triyanto et al. 2024), but it is particularly notable considering the harsh edaphic and hydrological conditions of the Gunung Sewu karst.

Karst ecosystems, characterized by shallow soils, high porosity, and seasonal water scarcity, are typically seen as agriculturally suboptimal (Li et al. 2023). Yet, the persistence of diverse edible species in this region reflects both ecological resilience and cultural ingenuity (Hartawan et al. 2020). Many of the recorded species, such as *C. asiatica*, *A. hybridus*, and *Z. officinale*, are not only tolerant of disturbed or rocky habitats but are also well-integrated into the seasonal subsistence strategies of local communities.

In line with earlier findings by Cahyaningsih et al. (2022), the utilization of WEP in karst zones often centers on multifunctional species that are nutritionally rich, drought-resistant, and socially embedded. These plants serve as critical buffers during the dry season when cultivated crops become scarce, making them vital components of adaptive food security in vulnerable rural systems.

The dominance of leafy vegetables and rhizomatous herbs also reflects a broader trend in Southeast Asian ethnobotany, where communities rely heavily on readily available, fast-growing, and multipurpose species (Panyadee et al. 2024; Inta et al. 2025). Such plants are commonly found in home gardens, rice field margins, and forest edges, suggesting a hybrid space between cultivated and wild—a feature often observed in swidden or semi-subsistence systems.

The ecological knowledge encoded in the use of these plants—including habitat selection, seasonal timing, and culinary preparation—is not random but highly structured and inherited through generations. This reinforces the argument that ethnobotanical richness in karst areas is not merely a function of residual biodiversity but a dynamic outcome of human-environment interaction (Hu et al. 2020).

Cultural significance and transmission of traditional knowledge

The utilization of WEPs in Paranggupito reflects more than subsistence necessity; it embodies a complex cultural system of knowledge, practice, and belief. The high citation frequencies and Use Values (UV) of species such as *C. asiatica*, *S. androgynus*, and *Z. officinale* indicate that these plants are not only functional but also culturally embedded in daily life, traditional medicine, and food rituals.

The predominance of female informants (60.74%) and older individuals (aged 41-60) in this study suggests that women and elders are the primary custodians of ethnobotanical knowledge, particularly in food preparation, home medicine, and plant management. This aligns with findings from similar contexts, where gendered knowledge systems play a pivotal role in intergenerational transmission (da Costa et al. 2021; Ramirez-Santos et al. 2023; Hanazaki 2024).

Although a significant portion of respondents had only basic formal education, their plant knowledge was rich and detailed, supporting the idea that oral tradition and experiential learning remain dominant modes of knowledge transfer (Tardío and Pardo-de-Santayana 2008). Recipes, harvesting rules, and plant-based remedies are often passed down during household chores or communal foraging trips, reinforcing cultural identity. More importantly, these practices also foster ecological awareness, which should be a shared responsibility in preserving traditional plant knowledge.

However, the study also observed signs of erosion in knowledge depth among younger age groups, particularly in their ability to identify species and distinguish between edible and toxic parts. This may be attributed to increasing engagement with formal employment, urban migration, or shifting dietary preferences. As reported in similar studies (Ramirez-Santos et al. 2023), the threat of cultural erosion due to modernization and loss of vernacular language is pressing, posing a significant risk to the continuity of traditional plant knowledge.

Despite these challenges, the multifunctionality of many WEP—serving as food, medicine, spice, or ritual object—helps to maintain their relevance in everyday life. Plants such as *C. longa* are used not only in meals but also in postpartum rituals, herbal bathing, and disease prevention, indicating their symbolic and spiritual value beyond material utility. Thus, preserving WEP knowledge in karst communities should not be limited to documenting names and uses, but also include safeguarding the cultural frameworks through which this knowledge is generated, practiced, and transmitted.

Functional roles of WEP in nutrition, health, and resilience

Wild edible plants in the Paranggupito karst system serve essential roles in nutrition, primary healthcare, and socio-ecological resilience, particularly under conditions of resource scarcity. Their presence enhances dietary diversity, supplements micronutrient intake, and offers accessible treatment for common ailments.

Nutritionally, many of the frequently cited species—such as *A. hybridus*, and *S. androgynus* —are known for their high content of vitamins A, C, iron, calcium, and antioxidants, as documented in previous compositional studies (Rahayu et al. 2024). These plants complement staple foods like cassava and rice, helping to address potential micronutrient deficiencies in low-income households with limited food access.

In addition to their food value, more than a third of the recorded species were cited for their medicinal functions, including *C. asiatica*, *Z. officinale*, *C. longa*, and *C. alata*. These plants are commonly used in decoctions, compresses, or raw infusions to treat fatigue, digestive issues, fever, and reproductive health concerns. The strong Informant Consensus Factor (ICF) values for both processed food and medicinal categories (0.778 and 0.737, respectively) support the idea that these uses are shared and culturally validated within the community.

The reliance on WEP increases during ecological and economic stress, such as during the dry season or crop failure. Species found in marginal habitats (e.g., *P. oleracea*) are especially important as fallback foods and herbal tonics. This flexible use pattern reflects ecological intelligence—the ability of local communities to adaptively manage resource cycles and food risk (Hu et al. 2020).

Furthermore, the multifunctionality of WEP enhances resilience at both household and landscape levels. Plants that serve as both food and medicine reduce the need for external inputs. At the same time, those growing in degraded or exposed habitats (e.g., karst slopes) provide redundant and easily accessible reserves when needed. By integrating nutritional, therapeutic, and cultural roles, WEP acts as a bio-cultural keystone, bridging ecological function with human well-being. Their continued availability and sustainable use are therefore critical not only for biodiversity but also for community health and food sovereignty, especially in underdeveloped karst regions of Southeast Asia.

Implications for biocultural conservation in karst areas

The findings of this study underscore the critical role of WEPs not only in sustaining daily subsistence but also in supporting biocultural conservation strategies in karst environments. The persistence of local knowledge, coupled with species diversity across marginal habitats, highlights the urgency of integrating ethnobotanical insights into conservation and development policies.

Karst regions such as Paranggupito are often classified as fragile ecosystems, prone to erosion, water scarcity, and biodiversity loss due to agricultural intensification, limestone extraction, and climate change (Hu et al. 2020). Yet, these landscapes also harbor culturally significant species and knowledge systems that promote resource resilience, especially through WEP-based practices. The documentation of multifunctional WEP with high Use Values and Informant Consensus Factors reveals priority species and practices that can be targeted in community-based conservation programs. Local home gardens, rice field margins, and forest edges where most WEP occur represent microhabitats of conservation interest, offering entry points for in-situ preservation and agroecological enhancement (Rahayu et al. 2024).

Moreover, sustaining WEP knowledge aligns with national and global frameworks such as the UN Decade on Ecosystem Restoration, Indonesia's National Biodiversity Strategy and Action Plan (NBSAP), and community-driven REDD+ co-benefit initiatives, which all emphasize indigenous knowledge, food security, and sustainable use of plant genetic resources. To operationalize this, policies must go beyond protected areas and address the cultural dimensions of biodiversity, including customary knowledge, gendered transmission, and vernacular classification systems. Formal education and extension services should be equipped to document, validate, and revitalize traditional plant knowledge without eroding its context.

Finally, the declining intergenerational transmission observed in this study should prompt the development of participatory conservation tools—such as WEP mapping, seed exchange, youth education, and eco-culinary tourism—that re-embed WEP in both local livelihoods and environmental stewardship. Preserving WEP diversity and its associated knowledge is not only a matter of ecological conservation but also a strategy to maintain cultural identity, food sovereignty, and adaptive capacity in one of Java's most vulnerable agroecological frontiers.

In conclusion, this study reveals that the karst landscapes of Paranggupito, Central Java, support a diverse array of 44 WEPs species used by local communities for food, health, and cultural practices. Despite harsh ecological conditions, high Use Value (UV) species such as

C. asiatica, *A. hybridus*, and *S. androgynus* contribute significantly to household nutrition and resilience during environmental or economic stress. The broad distribution of WEP—from home gardens to rocky slopes—reflects deep ecological knowledge shaped by tradition and experiences passed down through generations. Informant Consensus Factor (ICF) analysis shows strong agreement on processed food and medicinal uses, underscoring shared cultural patterns. Women and older adults emerged as key knowledge holders, with a noticeable decline in awareness among youth, highlighting the need to safeguard both species and the knowledge systems sustaining their use. As biological and cultural heritage, WEP offers opportunities for in-situ conservation, agroecological adaptation, and livelihood enhancement in fragile landscapes. Their integration into formal biodiversity strategies and education could strengthen local food sovereignty and biocultural resilience. Protecting these plant resources is vital not only for ecological sustainability but also for upholding the cultural identity, autonomy, and health of rural communities in karst regions of Indonesia.

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