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Ethnobotanical assessment of edible plant diversity in homegarden of Semarang District, Central Java, Indonesia

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Abstract. *Kusuma LA, Rahmadhani SE, Anam ZK, Nadhira S, Yasa A, Saensouk S, Setyawan AD. 2025. Ethnobotanical assessment of edible plant diversity in homegarden of Semarang District, Central Java, Indonesia. Asian J Ethnobiol 8: 116-139.* This study aims to document and analyze the diversity, utilization patterns, and cultural importance of edible plants maintained in home gardens as a foundation for preserving local knowledge and supporting community-based biodiversity conservation. The research was conducted across three villages in Semarang District, Central Java, Indonesia, using semi-structured interviews with 120 respondents. A total of 64 plant species from 34 families were recorded. The findings reveal a dominance of herbs (46.88%) and shrubs (35.94%), with Zingiberaceae as the most represented family (12.5%). Plants were grouped into six main utilization categories: fruits (32.8%), spices (25%), vegetables and beverages (each 12.5%), medicines (12.5%), and staple foods (4.7%). The most frequently used parts were fruits (51.6%) and leaves (21.9%), followed by tubers, stems, seeds, flowers, and rhizomes. Key species such as *Zingiber officinale*, *Syzygium polyanthum*, and *Aloe barbadensis* showed high cultural significance, indicated by their Use Value (UV) of 0.03 each, Relative Frequency of Citation (RFC) values of 0.15, 0.14, and 0.13 respectively, and Index of Cultural Significance (ICS) scores of 112, 66, and 33. The Informant Consensus Factor (ICF) values were highest in the spice (0.71) and medicinal (0.65) categories, reflecting strong agreement among respondents regarding their ethnobotanical roles. Women, particularly housewives (35.83%), played a central role in selecting, using, and transmitting knowledge about plants. Preparation methods such as raw consumption (46.9%) and boiling (18.8%) reflected traditional practices, while most plants were intentionally cultivated (89.1%), highlighting a strong culture of home-based plant management. Despite pressures from modernization and land-use change, the integration of traditional knowledge into daily household practices continues to support food security, health resilience, and cultural continuity. The study emphasizes the need for revitalization efforts and community-based conservation strategies to sustain this living ethnobotanical heritage. These findings highlight the importance of integrating traditional plant knowledge into local development and biodiversity policies to enhance food security, public health, and community resilience.

Keywords: Biodiversity, cultural significance, edible plants, home gardens, medicinal plants, traditional knowledge

INTRODUCTION

Indonesia, recognized as one of the world's biodiversity hotspots, is home to more than 7,000 species of medicinal plants, emphasizing the critical role of biodiversity in fulfilling human health and subsistence needs. Historically, Indonesian communities have relied on wild and semi-cultivated plants for both nutritional and therapeutic purposes, showcasing a deep-rooted ethnobotanical tradition (Hamiyati et al. 2019). Among these are edible plants commonly found in or around residential areas, such as fruits, roots, and leaves, which contribute not only to daily diets but also to local healthcare practices (Ojelel et al. 2019; Nasution et al. 2023).

In recent decades, home gardens have emerged as multifunctional agroecosystems that integrate cultural practices, food production, and ecological sustainability. Defined as cultivated land surrounding residences (Sukenti et al. 2019), home gardens typically combine ornamental, culinary, and medicinal plant species, forming an integral part of household livelihoods. These gardens are often modest in size but rich in biodiversity, and may include decorative plots, herbal sections, or vertical planting systems (Novita et al. 2023).

The significance of home gardens transcends aesthetics and nutrition—they also serve as centers of cultural knowledge and informal conservation. Their composition reflects sociocultural factors, local preferences, education levels, and environmental conditions (Afon and Adebara 2022). Plants cultivated in these gardens fulfill multiple roles, including sources of food, medicine, fuel, dyes, construction materials, and even income through local market sales (Yang et al. 2020). What were once considered 'subsistence-only' plants are now gaining commercial and medicinal value, particularly due to their rich micronutrient profiles and recognized health benefits (Duguma 2020; Radha et al. 2021).

Globally, the World Health Organization (WHO) reports that 80% of rural populations in developing countries rely on traditional herbal medicine as their primary healthcare source (Hu et al. 2020). However, this increasing dependence—combined with urban expansion and shifting land use—has contributed to a loss of biodiversity, threatening many indigenous plant species (Yeşil et al. 2019). Thus, sustainable management of local plant resources is now a pressing need, especially within rapidly changing socioecological landscapes.

Central Java, Indonesia, represents a compelling case for homegarden ethnobotany. Despite ranking second nationally in food security with an index of 82.95% (Badan Pusat Pangan 2022), certain regions such as Semarang District face unequal distribution of food availability, which remains at 80.95%, slightly lower than affordability (89.50%) and utilization (87.93%) rates (Tono et al. 2022). These disparities highlight persistent vulnerabilities, particularly in rural and peri-urban communities. Moreover, the poverty rate in Central Java remains significant at 10.46%, affecting approximately 3.7 million people, although recent data shows slight improvement (BPS 2024). In this context, home gardens provide an accessible and low-cost strategy to improve household food security, diversify diets, and reinforce traditional knowledge systems. The presence of diverse edible plants—ranging from vegetables to spices and medicinal herbs—demonstrates their vital contribution to local resilience.

Traditional herbal practices such as the use of jamu (a blend of boiled plant ingredients) remain prevalent among Central Java's rural populations (Surya et al. 2023). This not only supports public health but also preserves cultural heritage. The integration of local ecological knowledge into dietary and healthcare systems aligns with Sustainable Development Goal 2: Zero Hunger, which emphasizes improved access to safe, nutritious food and enhanced sustainability in food production systems (Li and Siddique 2020; UNDP 2022).

Despite a growing number of ethnobotanical studies in Indonesia, there remains a notable gap in understanding how homegarden plant diversity supports both food sovereignty and health outcomes at the village level. In particular, few studies quantitatively analyze the cultural significance, frequency of use, and preparation methods of homegrown species. Moreover, existing literature often overlooks the nuanced interactions between socio-demographic factors, plant management strategies, and ecological variation across different rural communities.

This study addresses those gaps by exploring the diversity and use of edible and medicinal plants in home gardens across three villages in Semarang District—Karangjati, Lerep, and Susukan. These locations were selected for their contrasting ecological and sociocultural profiles. By employing ethnobotanical indices, this research aims to assess both the importance of individual plant species and the collective ethnobotanical knowledge of local communities. Ultimately, this study contributes to the broader discourse on sustainable food systems, biodiversity conservation, and community-based healthcare, providing evidence-based insights to inform policy and community engagement in rural Indonesia.

MATERIALS AND METHODS

Study area

This study was conducted in September 2024, in three selected villages within Semarang District, Central Java, Indonesia, i.e.: Karangjati (Bergas Sub-district), Lerep (West Ungaran Sub-district), and Susukan (East Ungaran Sub-district) (Figure 1). These villages were purposively chosen based on preliminary assessments indicating high homegarden activity and diverse plant utilization (Figure 2). Karangjati Village, is known for cultivating vegetables and fruits in compact residential plots. Lerep Village presents a more ornamental and multifunctional garden composition, while Susukan Village emphasizes edible and medicinal plants within a greener agroecological matrix.

These three locations exhibit a representative profile of rural homegarden management in Java, reflecting varying ecological conditions, cultural practices, and socio-economic characteristics. Such diversity allows for a comparative understanding of plant use patterns in different community settings. The local population is predominantly Javanese, renowned for its deep-rooted traditions in utilizing herbal remedies and edible plants for everyday health and nutritional needs.

Local ethnobotanical knowledge in the study area is influenced by geographic proximity to plant-rich ecosystems such as Mount Ungaran and Mount Merbabu, as well as cultural familiarity with jamu (traditional medicine) derived from locally available flora. Semarang District spans approximately 95,020 hectares, accounting for 2.92% of Central Java Province, and features altitudes ranging from 100 to 2,000 meters above sea level. This elevation gradient supports a wide range of plant biodiversity that is directly accessible to rural households.

Data collection procedures

This research employed a mixed-method approach combining qualitative and quantitative techniques, with data obtained through direct observation and structured interviews. A total of 120 respondents were purposively sampled across the three villages (40 from each location), ensuring representation of local knowledge holders, primarily women and elderly individuals who are often responsible for homegarden management.

Structured interviews focused on a comprehensive set of ethnobotanical parameters, including local plant names, categories of utilization (such as food, medicine, spices, beverages, staple foods, and ornamentals), parts of the plant used (e.g., leaves, roots, stems, fruits, flowers, seeds, rhizomes), methods of preparation (such as raw consumption, boiling, cooking, drying, juicing, or topical application), perceived efficacy based on traditional knowledge, frequency of use in daily or seasonal contexts, exclusivity of use within the household or community, cultivation status (cultivated vs. wild), sources of planting material, and transmission of knowledge across generations. Data collection was supported by visual documentation, field notes, and GPS mapping of garden locations. The researchers carried out all observations directly in the field, allowing for contextual understanding and firsthand data validation.

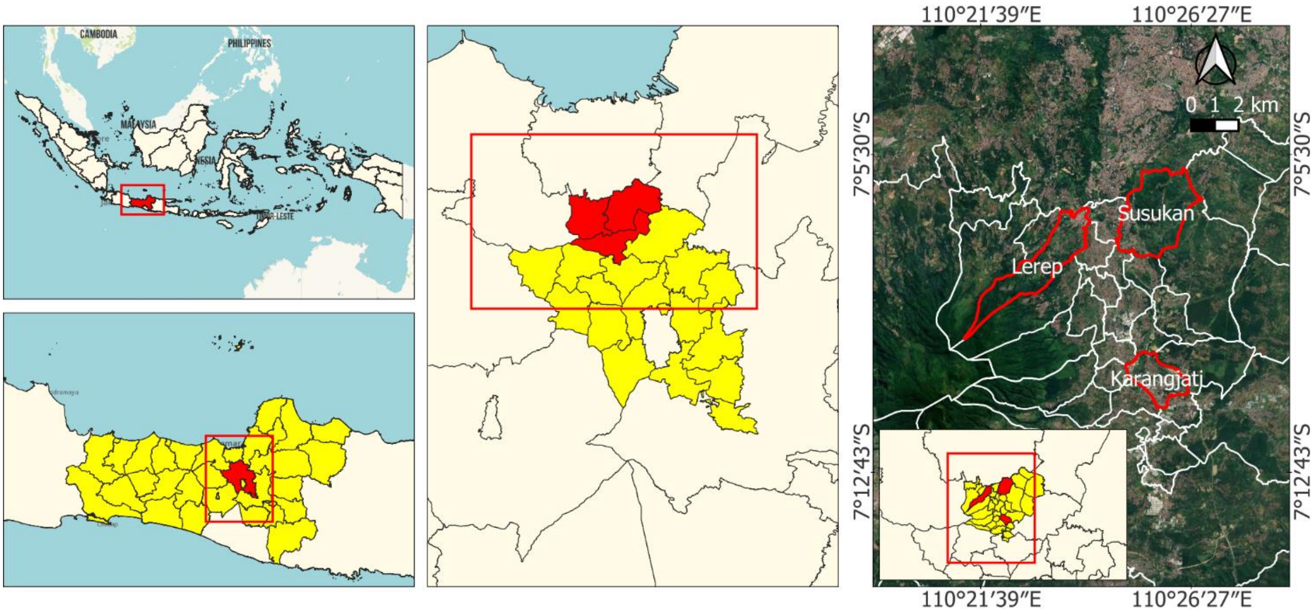

Figure 1. The study areas in Karangjati Village, Bergas Sub-district, Lerep Village, West Ungaran Sub-district, and Susukan Village, East Ungaran Sub-district, Semarang District, Central Java, Indonesia

Figure 2. Utilization of home gardens for cultivating edible plants in Semarang District, Central Java, Indonesia

To complement interview data, respondents were also asked to point out and describe the plant species currently cultivated or utilized in their home gardens. These in situ observations enabled the researchers to directly record species characteristics and usage contexts, while simultaneously verifying reported uses and terminologies. This integration of visual observation with respondent input strengthened the reliability of the data and ensured consistency between claimed practices and actual garden composition.

Plant identification was conducted through a combination of field-based morphological observation and vernacular knowledge obtained from key informants. Species were initially recognized by observing distinctive morphological traits such as leaf shape, stem and bark characteristics, flower and fruit structures, and growth habit. Local names provided by informants were carefully recorded and cross-checked to ensure consistency across villages. To validate scientific names and resolve synonymy, multiple botanical references were consulted, including Backer and van den Brink (1965) and Heyne (1987). When necessary, species identities were further verified through online taxonomic databases such as Plants of the World Online (https://powo.science.kew.org), The Plant List (http://www.theplantlist.org), and Tropicos (https://www.tropicos.org). This triangulated approach ensured that plant identifications were accurate, culturally contextualized, and taxonomically valid.

Table 1. Summary of ethnobotanical indices used in this study

Index	Formula	Purpose	Source
Relative Frequency Citation (RFC)	RFC = FC / N	Measures how frequently a species is mentioned by informants, indicating its familiarity or popularity.	Bano et al. (2014)
Use Value (UV)	UV = ∑Ui / N	Assesses the relative importance of a species based on the number of different uses cited by informants.	Zenderland et al. (2019)
Informant Consensus Factor (ICF)	ICF = (Nur – Nt) / (Nur – 1)	Evaluates the agreement among informants on plant use within specific categories (e.g., medicinal, food).	Pujinisa et al. (2023)
Index of Cultural Significance (ICS)	ICS = q × i × e	Integrates frequency, quality, and exclusivity of use to assess a plant's cultural relevance.	Helida et al. (2015)

Note: FC: number of informants citing a species, N: total number of informants, Ui: number of use-reports per species, Nur: total use-reports in a category, Nt: number of species used in that category, q, i, e: assigned scores for quality, intensity, and exclusivity of use

Quantitative ethnobotanical indices

To evaluate the cultural and practical relevance of each plant species, four ethnobotanical indices were used: Relative Frequency Citation (RFC), Use Value (UV), Informant Consensus Factor (ICF), and Index of Cultural Significance (ICS) (Table 1). These indices offer standardized methods to quantify traditional knowledge and plant importance within local communities. These indices were calculated to support comparative analysis and provide quantitative insights into plant use patterns and cultural values across the study sites.

Data analysis

Data analysis was conducted in two stages: classification and index computation. First, species data were categorized by family, growth habit, use category, parts used, and preparation methods. Next, each species was scored using the four ethnobotanical indices described above (RFC, UV, ICS, and ICF) to determine their prominence within the communities. Quantitative analysis was performed using Excel and SPSS for cross-tabulation, frequency analysis, and basic descriptive statistics.

To enhance interpretability of the index results, selected species were further visualized using heatmaps and radar (spider) charts. These graphical tools were used to depict the relative importance and multidimensional relevance of key species across use frequency, cultural significance, and versatility dimensions. Normalized index values were used in radar charts to facilitate comparison, while heatmaps highlighted prominent species patterns. Visualizations were generated using Python (v3.x) with Matplotlib and Seaborn libraries to ensure clarity and publication-ready quality.

In addition to quantitative analysis, qualitative insights were coded thematically based on field notes and open-ended interview responses. By integrating statistical metrics with ethnographic depth and visual exploration, this approach provided a nuanced understanding of how and why certain species are more culturally embedded and ecologically favored. The methodology offers a replicable framework for future community-based ethnobotanical research.

RESULTS AND DISCUSSION

Socio-demographic characteristics of respondents

The study involved 120 respondents equally distributed across Karangjati, Lerep, and Susukan Villages. The majority of respondents were women (53.33%), which can be attributed to their presence at home during the data collection period. Many of these women were housewives (35.83%), a group traditionally responsible for managing household resources, including home gardens. The availability of women and their active participation in garden-related activities position them as key holders and transmitters of local ethnobotanical knowledge. Their daily engagement with edible and medicinal plants enables them to maintain, apply, and pass on traditional practices to the next generation.

In terms of age, the dominant group was between 41-50 years old (35%), followed by 51-60 years (23.33%). These age groups represent a mature demographic, often serving as custodians of cultural traditions and having long-established experience in gardening and plant-based remedies. Meanwhile, only 2.5% of respondents were under 20, reflecting limited engagement among younger individuals in homegarden activities, which may signal the need for youth-focused education and awareness programs to sustain ethnobotanical heritage in the long term.

The educational background of respondents varied, with the largest proportion having completed senior high school (60%). This level of education suggests that the majority of participants had sufficient literacy to understand and apply basic agricultural, health, and ecological knowledge. Moreover, 10.83% had tertiary education, while a small percentage (2.5%) had no formal education at all. The combination of formal education and traditional experience contributes to a community-based knowledge system that blends scientific understanding with indigenous wisdom. Such integration is particularly valuable in the sustainable management and use of edible and medicinal plants.

Occupationally, besides housewives, the respondents included private employees (19.17%), traders (15%), farmers (8.33%), and a mix of civil servants, retirees, and others. While farmers directly engage in cultivation and plant care, housewives play a more holistic role in the daily application and preparation of plant-based resources. The occupational diversity suggests that ethnobotanical knowledge is not limited to agricultural professions but is shared across various segments of society. This finding aligns with research by Kujawska and Łuczaj (2015), which emphasizes the role of non-farming occupations, especially women in domestic roles, in maintaining and transmitting ecological knowledge.

The socio-demographic composition of the respondents reflects a community that is deeply embedded in plant-based practices, shaped by gender roles, age distribution, education levels, and livelihoods. These factors significantly influence the diversity of plant species found in home gardens, the methods of their use, and the sustainability of traditional practices in Semarang District (Table 2).

Diversity of edible plant species

This study recorded a total of 64 edible plant species, belonging to 52 genera and 34 families, indicating substantial biodiversity within home gardens in Semarang District. Among these, the Zingiberaceae family was the most represented with 8 species (12.5%), highlighting its central role in both culinary and traditional medicinal practices. Species such as *Z. officinale* (ginger), *Curcuma longa* (turmeric), and *Alpinia galanga* (galangal) are well known for their aromatic qualities and pharmacological benefits (Cao et al. 2020). Other highly represented families included Rutaceae with 6 species (9.4%), Myrtaceae with 5 species (7.8%), and Fabaceae with 4 species (6.3%) (Figure 3). These families are notable for their contributions to fruit, spice, and medicinal plant categories—such as *Citrus* spp. (Rutaceae), *Syzygium* spp. (Myrtaceae), and *Vigna unguiculata* (Fabaceae), which are commonly found in home gardens across all three study villages. Beyond these dominant families, most other families were represented by only one or two species, indicating a more selective or specialized use. This pattern suggests that while a few plant families provide multiple versatile species, the majority contribute unique or niche species that fulfill specific household needs, whether for nutrition, medicine, or beverages.

The most cited species across all sites was *Capsicum frutescens* (cayenne pepper), as reflected by its highest RFC value (0.20), highlighting its indispensable role in Javanese cooking and medicinal applications. Similarly, *Carica papaya* (RFC = 0.17) and *Aloe barbadensis* (aloe vera)(RFC = 0.13) were frequently encountered, valued not only for their edible parts but also for their therapeutic uses, such as digestive remedies and skin treatments (Table 3; Figure 4). These commonly found species across the three villages underscore their staple role in household diets and healthcare routines. Furthermore, the presence of multifunctional species such as *S. polyanthum* (Indonesian bay leaf) and *Z. officinale* illustrates the strong integration of food and health systems at the household level. These plants are consumed daily and simultaneously used to treat ailments like coughs, colds, and indigestion.

From an ecological perspective, the structural composition of these gardens—comprising herbs, shrubs, trees, lianas, and grasses—supports agroecosystem resilience. As described by Yang et al. (2020), such vertical layering not only optimizes space but also improves microclimatic conditions, enhances biodiversity, and contributes to pest regulation and soil stability.

Table 2. Socio-demographics of respondents

Variable		Total	Percentage (%)
Gender	Man	56	46.67
	Woman	64	53.33
Age	<20	3	2.50
	21-30	12	15.00
	31-40	19	15.83
	41-50	42	35.00
	51-60	28	23.33
	>60	16	13.33
Education	No education	3	2.50
	Elementary school	11	9.17
	Junior high school	21	17.50
	Senior high school	72	60.00
	University	13	10.83
Occupation	Private employee	23	19.17
	Trader	18	15.00
	Housewife	43	35.83
	Driver	1	0.83
	Farmer	10	8.33
	Retiree	2	1.67
	Self-employed	6	5.00
	Teacher	4	3.33
	Police officer	2	1.67
	Civil servant	4	3.33
	Student	5	4.17
	Not currently employed	2	1.67

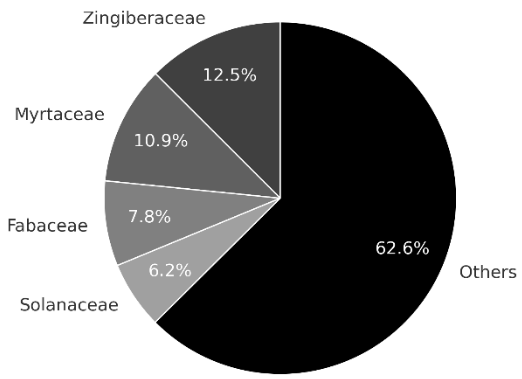

Figure 3. Distribution of major plant families contributing to total recorded species, with Zingiberaceae as the most represented

Table 3. List of edible plants in Semarang District, Central Java, Indonesia

Family & scientific name	Local name	Plant habits	Utilization categories	Parts used	Preparation	Growth status	Village			UV	RFC	ICS
							Karangjati	Lerep	Susukan			
Acanthaceae												
Strobilanthes crispa (L.) Blume	*Kejibeling*	Shrubs	Medicines	Leaf	Boiled	Planted			●	0.01	0.01	9
Acoraceae												
Acorus calamus L.	*Dlingo bengle*	Herbs	Medicines	Fruit	Pounded	Planted	●			0.01	0.01	12
Amaranthaceae												
Amaranthus caudatus L.	*Bayam*	Shrubs	Vegetables	Leaf	Cooked	Wild	●			0.01	0.03	8
Allium cepa L.	*Bawang merah*	Herbs	Spices	Tuber	Cooked	Planted	●		●	0.02	0.08	80
Mangifera foetida Lour.	*Bacang*	Tree	Fruits	Fruit	Raw	Planted			●	0.01	0.01	40
Mangifera indica L.	*Mangga*	Tree	Fruits	Fruit	Raw	Planted	●	●	●	0.01	0.13	24
Annonaceae												
Annona muricata L.	*Sirsak*	Tree	Fruits	Fruit	Raw	Wild	●	●	●	0.02	0.04	17
Araceae												
Colocasia esculenta (L.) Schott	*Talas*	Tree	Staple Foods	Tuber	Boiled	Planted			●	0.01	0.01	6
Arecaceae												
Cocos nucifera L.	*Kelapa*	Tree	Drinks	Fruit	Raw	Planted	●		●	0.02	0.03	40
Livistona R.Br.	*Palem livistona*	Tree	Fruits	Fruit	Raw	Planted	●			0.01	0.01	0,25
Asphodelaceae												
Aloe barbadensis	*Lidah buaya*	Herbs	Medicines	Trunk	Raw	Planted	●	●	●	0.03	0.13	9,25
Basellaceae												
Anredera cordifolia (Ten.) Steenis	*Binahong*	Liana	Medicines	Leaf	Raw	Planted		●		0.01	0.01	1,5
Cactaceae												
Hylocereus undatus	*Buah naga*	Liana	Fruits	Leaf	Raw	Planted	●			0.01	0.01	8
Caricaceae												
Carica papaya L.	*Pepaya*	Tree	Fruits	Fruit	Raw	Planted	●	●	●	0.02	0.17	56
Convolvulaceace												
Ipomoea batatas (L.) Lam.	*Ubi jalar ungu*	Tree	Staple Foods	Tuber	Boiled	Planted	●		●	0.01	0.02	50
Cucurbitaceae												
Cucurbita ficifolia	*Labu*	Herbs	Vegetables	Fruit	Cooked	Planted		●		0.01	0.02	16
Momordica charantia L.	*Pare*	Liana	Vegetables	Fruit	Cooked	Planted		●		0.01	0.03	24
Euphorbiaceae												
Manihot esculenta Crantz	*Singkong*	Tree	Staple Foods	Tuber	Boiled	Planted	●		●	0.01	0.06	20
Fabaceae												
Tamarindus indica L.	*Asam jawa*	Tree	Spices	Fruit	Raw	Planted			●	0.01	0.02	30
Vigna unguiculata (L.) Walp.	*Kacang panjang*	Shrubs	Fruits	Fruit	Cooked	Planted	●	●		0.01	0.03	32
Parkia speciosa Hassk.	*Petai*	Tree	Vegetables	Seed	Cooked	Planted	●			0.01	0.01	8
Clitoria ternatea	*Telang*	Shrubs	Drinks	Flower	Boiled	Planted			●	0.01	0.03	24

Iridaceae												
Eleutherine bulbosa (Mill.) Urb.	*Bawang dayak*	Herbs	Spices	Tuber	Cooked	Planted			●	0.01	0.01	24
Lamiaceae												
Ocimum basilicum L.	*Kemangi*	Herbs	Vegetables	Leaf	Raw	Planted		●	●	0.01	0,03	72
Orthosiphon aristatus (Blume) Miq.	*Kumis kucing*	Shrubs	Medicines	Leaf	Boiled	Planted			●	0.01	0.01	9
Lauraceae												
Persea americana Mill.	*Alpukat*	Tree	Fruits	Fruit	Raw	Planted	●	●	●	0.02	0.15	32
Lythraceae												
Punica granatum L.	*Delima*	Tree	Fruits	Fruit	Raw	Planted		●		0.01	0.03	8
Malvaceae												
Durio zibethinus Murray	*Durian*	Tree	Fruits	Fruit	Raw	Planted	●	●	●	0.01	0.09	8
Moraceae												
Artocarpus heterophyllus Lam.	*Nangka*	Tree	Fruits	Fruit	Raw	Planted	●	●	●	0.01	0.08	32
Moringaceae												
Moringa oleifera Lam.	*Kelor*	Tree	Drinks	Leaf	Boiled	Planted	●		●	0.01	0.02	12
Muntingiaceae												
Muntingia calabura L.	*Kersen*	Tree	Fruits	Fruit	Raw	Planted		●		0.01	0.02	8
Musaceae												
Musa ×paradisiaca L.	*Pisang raja*	Tree	Fruits	Fruit	Raw	Wild	●	●	●	0.01	0.12	32
Myrtaceae												
Syzygium aromaticum (L.) Merr. & L.M.Perry	*Cengkeh*	Shrubs	Spices	Flower	Cooked	Planted			●	0.01	0.01	24
Eugenia uniflora L.	*Dewandaru*	Tree	Medicines	Leaf	Boiled	Planted		●		0.01	0.01	1,5
Syzygium aqueum (Burm.fil.) Alston	*Jambu air*	Tree	Fruits	Fruit	Raw	Planted	●		●	0.01	0.04	24
Psidium guajava L.	*Jambu biji*	Shrubs	Medicines	Leaf	Raw	Planted	●	●	●	0.02	0.11	12
Syzygium polyanthum (Wight) Walp.	*Salam*	Tree	Spices	Leaf	Cooked	Wild	●	●	●	0.03	0.12	66
Oxalidaceae												
Averrhoa carambola L.	*Belimbing*	Tree	Fruits	Fruit	Raw	Planted	●			0.01	0.01	8
Averrhoa bilimbi L.	*Belimbing wuluh*	Tree	Vegetables	Fruit	Raw	Planted			●	0.01	0.01	12
Pandanaceae												
Pandanus Parkinson	*Pandan*	Shrubs	Spices	Leaf	Boiled	Planted	●	●	●	0.03	0.07	66
Phyllanthaceae												
Sauropus androgynus (L.) Merr.	*Katuk*	Shrubs	Drinks	Leaf	Boiled	Planted	●			0.01	0.01	12
Piperaceae												
Piper ornatum N.E.Br.	*Sirih merah*	Liana	Drinks	Leaf	Boiled	Planted	●		●	0.01	0.02	9
Poaceae												
Cymbopogon citratus (DC.) Stapf	*Serai*	Herbs	Spices	Trunk	Cooked	Planted		●	●	0.02	0.11	39
Saccharum officinarum L.	*Tebu*	Tree	Drinks	Trunk	Raw	Planted			●	0.01	0.01	6

Rutaceae												
Citrus maxima (Burm.) Merr.	*Jeruk bali*	Tree	Fruits	Fruit	Raw	Planted			●	0.01	0.01	4
Citrus sinensis (Mill.) Pers., 1806	*Jeruk manis*	Tree	Fruits	Fruit	Raw	Planted			●	0.01	0.04	16
Citrus ×aurantiifolia (Christm.) Swingle	*Jeruk nipis*	Tree	Spices	Leaf	Burned	Planted		●	●	0.03	0.09	74
Citrus hystrix DC.	*Jeruk purut*	Shrubs	Fruits	Fruit	Raw	Planted	●			0.01	0.01	8
Murraya koenigii (L.) Spreng.	*Korokeling*	Tree	Medicines	Leaf	Boiled	Planted		●		0.01	0.01	1,5
Citrus ×limon (L.) Osbeck	*Lemon*	Shrubs	Drinks	Fruit	Raw	Planted		●		0.01	0.03	12
Sapindaceae												
Dimocarpus longan Lour.	*Kelengkeng*	Tree	Fruits	Fruit	Raw	Planted	●		●	0.01	0.10	8
Nephelium lappaceum L.	*Rambutan*	Tree	Fruits	Fruit	Raw	Planted	●	●	●	0.01	0.17	8
Sapotaceae												
Manilkara zapota (L.) P.Royen	*Sawo manila*	Tree	Fruits	Fruit	Raw	Planted		●		0.01	0.02	8
Solanaceae												
Capsicum frutescens L.	*Cabai rawit*	Shrubs	Spices	Fruit	Cooked	Planted	●	●	●	0.02	0.20	64
Solanum torvum Sw.	*Takokak*	Shrubs	Drinks	Fruit	Raw	Planted			●	0.01	0.01	15
Solanum melongena L.	*Terong*	Shrubs	Vegetables	Fruit	Cooked	Planted	●	●	●	0.01	0.08	84
Solanum lycopersicum L.	*Tomat*	Herbs	Vegetables	Fruit	Cooked	Planted	●		●	0.01	0.03	40
Zingiberaceae												
Zingiber officinale Roscoe	*Jahe*	Herbs	Spices	Rhizome	Cooked	Planted	●	●	●	0.02	0.13	112
Elettaria cardamomum (L.) Maton	*Kapulaga sejati*	Herbs	Spices	Seed	Cooked	Planted			●	0.01	0.01	30
Kaempferia galanga L.	*Kencur*	Herbs	Spices	Rhizome	Cooked	Planted		●	●	0.02	0.04	48
Alpina galanga (L.) Willd.	*Lengkuas*	Herbs	Spices	Rhizome	Cooked	Wild	●	●	●	0.01	0.13	89
Curcuma longa L.	*Kunyit*	Herbs	Spices	Rhizome	Cooked	Wild	●		●	0.02	0.04	84
Curcuma aeruginosa Roxb.	*Temu ireng*	Herbs	Spices	Rhizome	Cooked	Wild	●			0.01	0.01	12
Curcuma zanthorrhiza Roxb.	*Temulawak*	Herbs	Spices	Rhizome	Cooked	Planted		●	●	0.02	0.05	36

Note: Village: 1. Karangjati Village, 2. Lerep Village, 3. Susukan Village. ●: present

Figure 4. Several species of edible plants in the homegarden of Semarang District, Central Java, Indonesia. A. *Aloe barbadensis,* B. *Carica papaya,* C. *Capsicum frutescens*

Comparison among villages

Species diversity varied significantly across the study sites, influenced by ecological factors, yard size, and cultural practices. Susukan Village had the highest species richness, with 45 species (40.18%), which can be attributed to its more spacious yards and greener agroecological surroundings that support diverse plant cultivation. This village also retained strong traditions in medicinal plant use and self-sufficiency.

Karangjati Village followed with 36 species (32.14%), exhibiting a balanced mix of fruits, vegetables, and spices. The community in Karangjati actively manages compact residential plots, often using container gardening and intercropping strategies. In contrast, Lerep Village recorded the lowest diversity with 31 species (27.68%), though residents maintained multifunctional gardens that blend ornamental and edible plants—indicative of a peri-urban setting with aesthetic preferences.

As shown in Figure 5, the relative proportion of species per village highlights Susukan's biodiversity advantage. While some species were widely shared among sites—such as *C. papaya*, *A. barbadensis*, and *C. frutescens*—distinct patterns of species preference emerged. Karangjati respondents favored *Psidium guajava* (guava), known for both its vitamin-rich fruit and medicinal leaves. In Lerep, *C. frutescens* was especially dominant, likely reflecting a cultural preference for spicy foods and spice cultivation. Meanwhile, in Susukan, *A. galanga* was cited more frequently, signifying its importance in cooking and traditional medicine.

These differences demonstrate that plant selection is not random but is shaped by a combination of cultural preference, ecological suitability, and household priorities. Such patterns reinforce the value of home gardens as culturally responsive agroecosystems and suggest the need for localized conservation strategies that respect ecological and sociocultural diversity across villages.

Diversity of plant habits

The diversity of plant habits observed in the home gardens of Semarang District reflects the community's capacity to manage spatial, ecological, and cultural factors in the use of plant resources. Based on the inventory of 64 species presented in Table 3 and visualized in Figure 6, five main growth forms were identified: herbs (32.8%), trees (32.8%), shrubs (26.6%), lianas (6.3%), and grasses (1.6%). This distribution reveals a relatively balanced representation between herbs and trees, with shrubs following closely, suggesting that residents maintain a structurally and functionally diverse homegarden ecosystem.

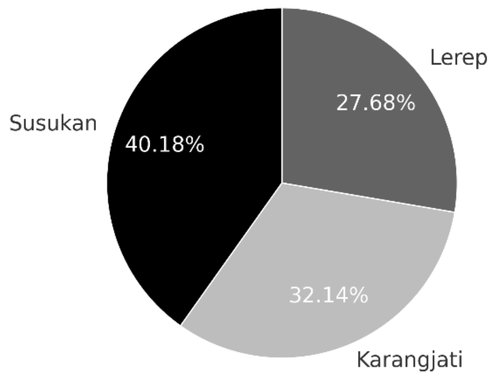

Figure 5. Species richness per village, showing the proportion of edible plant species found in Susukan, Karangjati, and Lerep

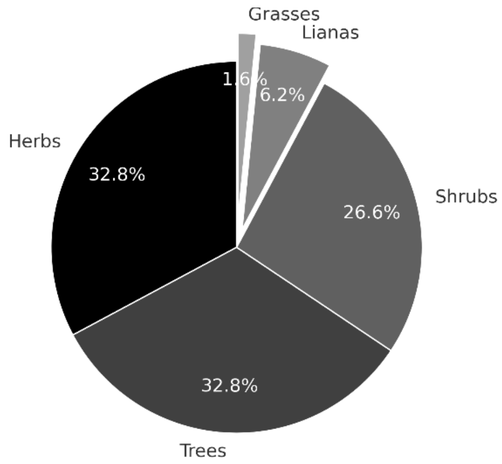

Figure 6. Habits of edible plants in Semarang District, Central Java, Indonesia

The prevalence of herbs in home gardens—accounting for approximately one-third of the recorded species—demonstrates their practicality and high cultural value. Herbs are favored due to their rapid growth, short life cycles, and versatility. Plants such as *Z. officinale*, *C. longa*, and *Kaempferia galanga* (aromatic ginger), all members of the Zingiberaceae family, are typically grown for their rhizomes, which serve culinary and medicinal purposes. Their small stature and ability to thrive in containers or narrow spaces make them ideal for intensive cultivation in limited landholdings, a feature common to semi-urban and peri-urban villages.

Trees, which also comprised 32.8% of the total, contribute to the vertical stratification of the garden and provide long-term benefits. Species like *Mangifera indica* (mango), *Persea americana* (avocado), and *C. papaya* are valued not only for their fruit yield but also for their role in creating microclimates, providing shade, and supporting soil conservation. While trees require more space and longer periods to mature, their inclusion signals a forward-looking gardening strategy aimed at sustainability and continual harvests.

Shrubs, contributing 26.6% of the total species, occupy an intermediate niche in both physical size and functional use. Examples include *P. guajava* (guava) and *C. frutescens* (cayenne pepper), which are commonly planted for their edible fruits and medicinal leaves. Shrubs are often preferred because they are relatively low-maintenance yet productive over several seasons. Their compact form allows them to coexist with other plant types, forming the mid-layer of garden vegetation.

Although less common, lianas such as *Momordica charantia* (bitter melon) and *Anredera cordifolia* (binahong) are functionally significant. These climbing plants are space-efficient because they utilize vertical structures like fences or stakes, thereby not competing for ground area. Lianas typically provide leafy vegetables or medicinal foliage, further enriching the garden's multifunctionality.

Grasses, represented minimally by species such as *C. citratus*, accounted for only 1.6% of the species documented. Despite their small number, grasses play specialized roles, such as acting as insect repellents or aromatic enhancers in traditional herbal teas and food.

The structural diversity of these plant habits reveals the ecological intelligence embedded in traditional homegarden design. Residents selectively cultivate species based on their practical value, ease of growth, and cultural relevance. Moreover, the habitus of each plant often correlates with the plant parts utilized (as shown in Figure 8), where herbs and shrubs dominate the categories of edible fruits, leaves, and rhizomes.

The distribution of plant habits in Semarang's home gardens is a reflection of local ecological adaptation and cultural preference. The coexistence of trees, shrubs, herbs, lianas, and grasses illustrates a multidimensional approach to land use that maximizes productivity, biodiversity, and household utility within the constraints of small-scale gardening.

Utilization categories

Edible plants identified in the home gardens were categorized into six major utilization groups: fruits (21 spp.; 32.8%), spices (16 spp.; 25%), vegetables (8 spp.; 12.5%), beverages (8 spp.; 12.5%), medicines (8 spp.; 12.5%), and staple foods (3 spp.; 4.7%), as illustrated in Figure 7. This classification helps to contextualize the multifunctional roles these plants play in household consumption and health maintenance.

Fruits were the most dominant category, reflecting their nutritional richness, economic value, and year-round demand. Species such as *C. papaya, M. indica,* and *P. guajava* are common due to their adaptability and high yield. These fruits not only serve as daily food sources but are also used in processed forms, such as juices and jams, contributing to household food security.

Spices came second in frequency, highlighting their central role in traditional cuisine. The Zingiberaceae family contributed significantly to this category, with widely cultivated species like *Z. officinale, C. longa,* and *K. galanga.* These spices are valued not only for flavor but also for their therapeutic benefits, such as anti-inflammatory and digestive properties.

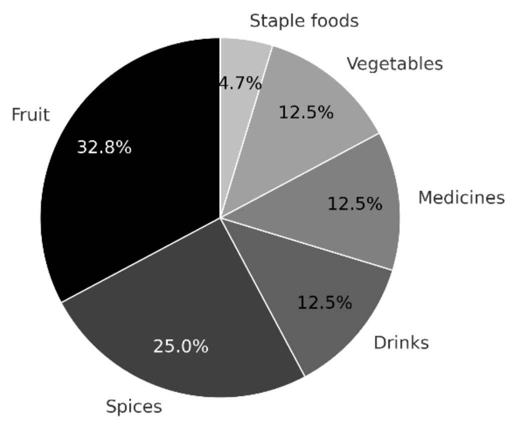

Figure 7. Utilization categories of edible plants in Semarang District, Central Java, Indonesia

The vegetables category included common leafy greens and fruit vegetables such as *Solanum melongena* (eggplant), *Amaranthus caudatus* (spinach), and *V. unguiculata* (long beans). These are essential daily food items and are often intercropped for efficient land use. Vegetables provide vitamins, minerals, and dietary fiber, contributing to the balanced nutrition of the household.

Beverage plants include *Clitoria ternatea* (butterfly pea), *Moringa oleifera*, and *C. citratus*. These species are commonly processed into herbal drinks or teas, providing refreshing and health-promoting beverages. For instance, butterfly pea flowers are known for their antioxidant properties and vibrant color, which is popular in traditional drinks.

The medicinal category comprised species like *P. guajava, A. barbadensis,* and *Strobilanthes crispa*, used to treat digestive issues, wounds, and infections. These plants underscore the community's reliance on traditional knowledge to address primary healthcare needs, especially in areas with limited access to modern medicine.

Lastly, staple foods, though few, included energy-rich crops like *Manihot esculenta* (cassava) and *Ipomoea batatas* (sweet potato). These are typically boiled or steamed and serve as carbohydrate sources, especially in food-insecure periods.

The categorization of edible plants by utilization highlights the diverse roles of homegarden species in meeting nutritional, cultural, and medicinal needs. The wide range of plant uses demonstrates not only ecological adaptability but also cultural richness and resilience in household food systems.

Parts used

The study revealed that the most frequently utilized plant part in the home gardens of Semarang District was the fruit (51.6%), followed by leaves (21.9%), and smaller percentages for tubers, stems, seeds, flowers, and rhizomes (Figure 8). This trend underscores the multifunctional role of plant species in daily life, reflecting their nutritional, medicinal, and cultural importance.

Fruits are highly favored due to their culinary versatility, immediate consumption, and nutritional value. Plants such as *C. papaya, M. indica* (mango), *C. frutescens* (cayenne pepper), and *P. guajava* (guava) are frequently consumed fresh, processed into beverages or jams, or used in traditional culinary preparations. Fruits often require minimal preparation and can be integrated into both main dishes and snacks, making them a practical and valuable part of the household diet.

Leaves, the second most utilized plant part, are often used in both food and medicine. For example, *P. guajava* leaves are widely used as a remedy for diarrhea due to their antibacterial properties. Similarly, *M. oleifera* leaves are rich in micronutrients and often prepared as herbal infusions or cooked as leafy greens. The frequent use of leaves indicates not only their availability but also the community’s knowledge in processing and preserving them for health benefits.

Tubers from species like *M. esculenta* (cassava) and *I. batatas* (sweet potato) are essential carbohydrate sources. These are typically prepared by boiling or steaming and provide energy during food-scarce periods. Tubers have long storage durations, making them important for food security strategies.

Stems and rhizomes, particularly from aromatic and medicinal species such as *Z. officinale* and *C. longa*, are commonly used as both seasoning and herbal medicine. These parts are typically sliced, pounded, or boiled to extract their active compounds. The strong association of rhizomes with traditional remedies underscores the role of home gardens as a primary source of household healthcare.

Seeds, such as those from *Parkia speciosa* (petai) and *Elettaria cardamomum* (cardamom), are used either as vegetables or spices. Flowers, including those of *C. ternatea*, are prized for their antioxidant-rich pigments, often used in beverages and as natural food coloring.

The pattern of plant part utilization also correlates with the habitus of plants described in earlier sections. Herbs and shrubs dominate the gardens, and their parts—leaves, rhizomes, and fruits—are more accessible for daily use. Figure 8 visually presents this distribution and confirms the emphasis on parts that are easy to harvest and integrate into food or medicine, a reflection of both practicality and cultural knowledge.

The wide variety of plant parts utilized in the study area reflects a complex, adaptive knowledge system that maximizes the use of each plant. This diversity in use not only enhances nutritional and medicinal coverage but also reinforces the importance of biodiversity in supporting sustainable household resilience.

Preparation method

The preparation methods of edible plants in Semarang District demonstrate a strong relationship between traditional knowledge and practical household needs. Based on the findings illustrated in Figure 9, the most common method of preparation is raw consumption (46.9%), followed by cooking (31.3%), boiling (18.8%), and pounding and burning (1.6% each). These diverse methods reflect both the characteristics of the plants themselves and the embedded culinary and medicinal practices in the local culture.

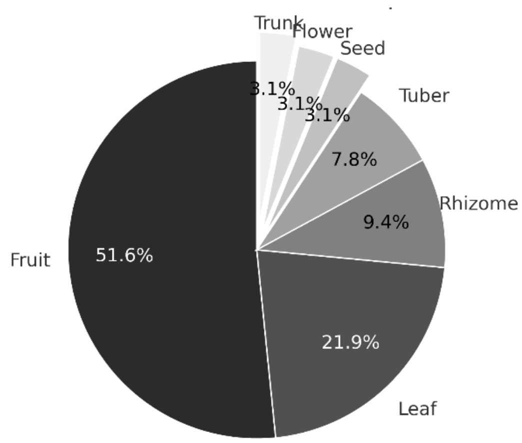

Figure 8. Plant part utilization of edible plants in Semarang District, Central Java, Indonesia

Raw consumption is predominantly associated with fruits, such as *C. papaya*, *P. guajava*, *Musa ×paradisiaca* (banana), and *Citrus* spp., which are often eaten fresh due to their palatable taste, high vitamin content, and minimal processing needs. Consuming fruits raw helps preserve heat-sensitive nutrients such as vitamin C, polyphenols, and antioxidants, contributing to the local diet's nutritional adequacy.

Cooking is the second most utilized preparation method, particularly for vegetables and spices. *C. frutescens* (cayenne pepper), *S. melongena*, *V. unguiculata* (long beans), and *A. caudatus.* are typically sautéed or stir-fried as part of daily meals. Cooking enhances flavor, softens texture, and in some cases improves the bioavailability of certain nutrients. Furthermore, cooking is a common method for spices like *Z. officinale* and *C. longa*, which are used as seasoning agents or in traditional dishes such as curries and herbal concoctions.

Boiling is a preferred method for medicinal and beverage plants. *Moringa oleifera* leaves, *P. guajava* leaves, and *S. crispa* are often boiled to extract their bioactive compounds. This method is common in preparing jamu—a traditional Indonesian herbal drink—and other decoctions. Boiling not only sterilizes the ingredients but also allows for the release of medicinal compounds into the water, increasing the therapeutic efficacy of the plants.

Less commonly used methods include pounding and burning (1.6% each). Pounding is primarily employed in preparing rhizomes and roots, such as *Curcuma* spp. and *K. galanga*, for cooking or topical application in traditional medicine. Burning is occasionally used for aromatic leaves or to soften tough plant parts, such as *Citrus ×aurantiifolia* (lime) leaves, prior to culinary use.

The variety of preparation techniques highlights the community's adaptive strategies to optimize plant utility. These methods are not only influenced by taste and usability but also by traditional medicinal practices passed down through generations. They form part of a functional ethnobotanical system that integrates health, nutrition, and cultural heritage.

The preparation methods reflect both pragmatism and cultural richness. As shown in Figure 9, the dominance of raw and cooked preparations underlines a preference for simplicity and efficiency, while the presence of boiling, pounding, and burning shows the depth of traditional processing methods used to enhance the benefits of local edible plants.

Source of plant material

The origin or source of plant material in Semarang District's home gardens reflects a strong culture of plant domestication and active management. Based on field data, 89.1% of the edible plant species were intentionally cultivated, while only 10.9% were sourced from the wild, as shown in Figure 10. This distribution highlights the central role of human agency in shaping plant diversity and sustaining ethnobotanical practices.

The dominance of cultivated species signifies a deliberate effort by the local communities to select, propagate, and manage plants that meet daily needs for food, health, and household economy. Cultivated plants such as *C. papaya*, *C. frutescens*, *Z. officinale*, and *P. guajava* are grown in designated plots or containers, often near kitchen areas or along home borders. These plants are easy to access and integrate into daily meals and remedies, which enhances their practical utility.

Cultivation practices observed include seed saving, vegetative propagation (e.g., rhizome division in *C. longa* or *K. galanga*), and selective planting based on household preferences. This indicates not only horticultural knowledge but also a deep cultural relationship with plant resources. Many families have developed their own varietal selections and plant arrangements, passed down through generations.

In contrast, the wild-sourced species (10.9%) play a more complementary role. These plants typically grow spontaneously in less-managed garden corners, along fences, or in nearby vacant land. Species like *S. crispa* and *A. cordifolia* are notable examples. These wild species are often collected as needed for specific medicinal uses or as emergency food sources, particularly in times of economic hardship or seasonal shortages.

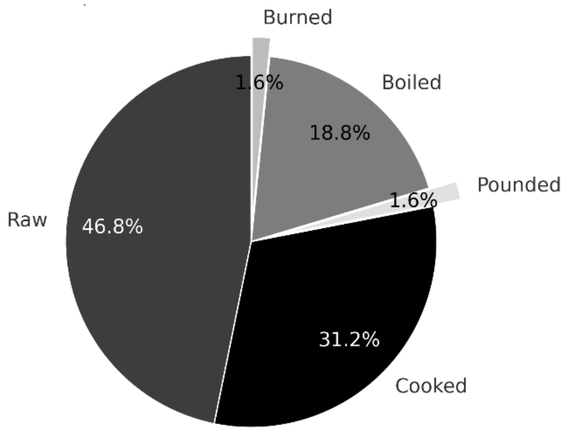

Figure 9. Preparation methods of edible plants in Semarang District, Central Java, Indonesia

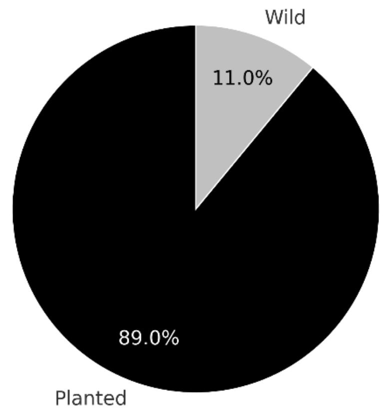

Figure 10. Source of edible plants in Semarang District, Central Java, Indonesia

The presence of both cultivated and wild plants points to a semi-domesticated agroecosystem, where biodiversity is maintained through a combination of intentional cultivation and ecological tolerance. It also suggests a continuum of human interaction, from actively grown crops to opportunistic harvesting of self-propagating species.

Figure 10 provides a visual representation of this proportion, emphasizing how cultivation is the predominant strategy for managing edible plant resources in the study area. The relatively small proportion of wild plants does not diminish their importance, as they contribute unique nutritional or medicinal properties not commonly found in cultivated species.

The pattern of plant sourcing in Semarang's home gardens underscores a well-established tradition of cultivation, supported by selective wild harvesting. This balance reflects a resilient ethnobotanical system that merges agricultural practice with ecological awareness and cultural continuity.

Quantitative ethnobotanical indices

Prior to the presentation of quantitative analyses, it is essential to recognize that the observed qualitative patterns—ranging from species diversity and parts utilized to preparation methods and plant sourcing—serve as a foundational context for assessing the functional integration of these species in everyday life. To reinforce and quantify their ethnobotanical relevance, this study employs three established indices: the Use Value (UV), Relative Frequency of Citation (RFC), and the Index of Cultural Significance (ICS). These analytical tools offer systematic insights into the degree of importance assigned to each plant species by the community, highlighting their roles in cultural practices, economic activities, and traditional healthcare systems. In Semarang's home gardens underscores a well-established tradition of cultivation, supported by selective wild harvesting. This balance reflects a resilient ethnobotanical system that merges agricultural practice with ecological awareness and cultural continuity.

Use Value (UV)

Use Value (UV) is a quantitative ethnobotanical index that reflects the relative importance of plant species based on the number of distinct uses reported by informants. A high UV indicates that a plant is not only well known but also utilized in multiple ways, underscoring its functional versatility and cultural integration within the community. In the present study, UV values derived from 64 plant species revealed considerable variation, ranging from 0.01 to 0.03 (Table 3).

Species with the highest UV scores include *Z. officinale*, *S. polyanthum*, and *A. barbadensis*, each with a UV of 0.03. These plants are widely employed across different contexts—culinary, medicinal, and even ritual—highlighting their multifunctionality. *Z. officinale,* for instance, is commonly used in cooking, as a base for herbal drinks (jamu), and in topical preparations for colds and muscle pain. Similarly, *S. polyanthum* is essential in Javanese cuisine and also cited for its antihypertensive properties. *A. barbadensis* (aloe vera) is another culturally salient species, widely cultivated for its use in skin treatment, digestion, and beverages.

Moderate UV values (0.02) were recorded for other frequently mentioned species such as *C. frutescens*, *C. papaya*, *C. longa*, *K. galanga*, and *C. citratus*. These plants are often cited for both culinary and medicinal uses, indicating their dual significance in food and health systems. Despite *C. frutescens* showing the highest RFC in the dataset, its UV was relatively lower than expected, suggesting its use is consistent but limited in variety—mainly as a spice.

At the lower end of the spectrum, species like *S. crispa*, *Colocasia esculenta* (taro), and *A. caudatus* had UVs of only 0.01. These plants may serve more specialized or occasional functions, or be known and used by fewer individuals. Their low UV values may also reflect a decline in traditional knowledge transmission or limited accessibility.

These findings demonstrate that UV is not necessarily correlated with popularity or frequency of mention (as captured by RFC), but rather with the diversity of applications. By identifying plants with both high and low UV scores, this analysis provides insights into which species are central to everyday life and which may be at risk of underutilization. Such information is vital for ethnobotanical conservation, local food security planning, and revitalization of culturally important plant species (Table 3).

Relative Frequency of Citation (RFC)

The Relative Frequency of Citation (RFC) is an ethnobotanical index used to determine the popularity or commonness of a species based on how often it is mentioned by informants, regardless of its number of uses. It is calculated by dividing the number of informants who cited a species by the total number of informants surveyed. In this study, RFC values ranged up to 0.20, with the highest RFC recorded for *C. frutescens*, followed closely by *C. papaya* (RFC = 0.17) and *Nephelium lappaceum* (RFC = 0.17) (Table 2).

The high RFC of *C. frutescens*, commonly known as cayenne pepper, indicates its ubiquity and essential role in daily culinary practices. This species is a staple ingredient in Indonesian cuisine and is used across various households regardless of socio-economic status. In addition to its flavor-enhancing properties, *C. frutescens* is also appreciated for its potential medicinal benefits, including promoting circulation and relieving congestion.

Carica papaya, another widely cited species, is valued for its nutritional and therapeutic benefits. Its ripe fruit is consumed fresh or processed, while the unripe fruit is used in traditional dishes such as *oseng-oseng* or *sayur asem*. Moreover, the latex and leaves are employed in traditional medicine to treat digestive issues and as natural dewormers, enhancing the species' utility and relevance in both food and health contexts.

Nephelium lappaceum (rambutan), a seasonal fruit tree, holds high cultural and economic importance. Although its harvest is limited to certain months of the year, its sweet and appealing flavor, combined with its role as a cash crop during harvest season, contributes to its frequent mention. Its RFC value underscores how even seasonal species can maintain high cultural significance when they are deeply embedded in community practices.

Species with lower RFC values may be underutilized or specialized in use, such as those used primarily for medicinal or ornamental purposes. The variation in RFC values provides insight into local familiarity and accessibility, offering a lens to assess which species are culturally ingrained and widely used across the population.

RFC analysis emphasizes the importance of certain species not only due to their multiplicity of uses but also due to their frequency of interaction with the community. High RFC values signal that these plants are indispensable in daily life, playing consistent roles in nutrition, health, and even economic livelihoods.

Index of Cultural Significance (ICS)

The Index of Cultural Significance (ICS) is a comprehensive ethnobotanical metric that combines three dimensions of a plant's role in society: frequency of use, variety of use, and exclusivity or uniqueness of use. This index goes beyond frequency alone and accounts for how deeply a plant is embedded in cultural traditions, rituals, and daily functions. The ICS values recorded in this study highlight the plants most central to the cultural identity and daily practices of households in Semarang District.

Among the species assessed, the highest ICS score was recorded for *Z. officinale* (ICS = 112), followed by *S. polyanthum* (ICS = 66) and *C. citratus* (ICS = 39) (Table 2). These three species reflect not only high use frequency but also diverse applications and a strong connection to cultural heritage.

Zingiber officinale stands out as a culturally vital plant, used extensively in cooking, traditional medicine, and ceremonial practices. It is a core component in many Javanese herbal drinks (*jamu*), valued for its warming and anti-inflammatory properties. Its role extends beyond the household to communal contexts such as family health traditions and festive food preparation, which justifies its exceptional ICS score. The inclusion of ginger in sacred rituals and its recognized efficacy in healing affirms its symbolic and functional significance.

Syzygium polyanthum is another plant with multifaceted cultural relevance. It is used almost daily in cooking, especially in traditional stews and curries, and has recognized health applications for lowering cholesterol and managing blood pressure. The widespread use of its leaves in domestic kitchens reflects its embeddedness in local dietary culture. Additionally, its cultivation near the house and ease of access further enhance its cultural presence.

Cymbopogon citratus also demonstrates strong cultural ties through its role in both culinary and medicinal traditions. It is commonly used in soups, teas, and aromatic preparations and is known for its calming and anti-microbial properties. Its scent and flavor contribute not only to food preparation but also to a sense of cultural identity associated with traditional home remedies.

Plants with high ICS scores are often those that serve multiple roles—nutritional, medicinal, and symbolic—and are frequently used in both ordinary and special occasions. The ICS thus helps distinguish plants that are not merely popular but are integral to the lived experiences and values of the community.

On the other hand, species with low ICS values may either be underrecognized or serve highly specialized purposes that are not widely known or practiced. These findings can inform conservation and education strategies, emphasizing the protection and promotion of culturally significant plants.

The ICS analysis provides a nuanced understanding of plant importance, highlighting not only what is frequently used but also what is most culturally embedded and symbolically meaningful. It reveals the depth of traditional knowledge systems and helps prioritize species that should be conserved, promoted, or reintroduced into community practices.

Visual Representation of UV, RFC, and ICS Values

To complement the numerical analysis of ethnobotanical indices, visual representations were created to highlight the comparative cultural importance of selected plant species. Figures 11 and 12 illustrate the distribution of *Use Value (UV)*, *Relative Frequency of Citation (RFC)*, and *Index of Cultural Significance (ICS)* for six dominant species frequently cited by respondents across the three study villages: *Z. officinale, S. polyanthum*, *A. barbadensis*, *C. frutescens*, *C. papaya*, and *N. lappaceum*.

As shown in Figure 11 (heatmap), *Z. officinale* stood out with the highest ICS value, signifying its exceptional cultural importance. This plant is widely used not only in daily cooking but also in traditional medicine and ritual practices, such as postpartum care and body warming therapies. Its consistently high UV and RFC values further confirm its functional and symbolic centrality in Javanese households. Similarly, *S. polyanthum*, a native bay leaf used in almost every savory dish, also scored well across all indices, reflecting its indispensable culinary and medicinal role.

Capsicum frutescens recorded the highest RFC, indicating its widespread and near-universal use, especially in spicy food preparation. However, its UV and ICS values were relatively moderate, suggesting that while it is frequently used, its perceived cultural or symbolic significance may be less than that of rhizomatous or ritual-associated plants. *A. barbadensis* (aloe vera) showed a balanced profile, used widely for skin care, burns, and herbal drinks, and often planted for both ornamental and medicinal purposes. *C. papaya* and *N. lappaceum* had lower UV and ICS values, possibly due to their limited medicinal applications or more seasonal availability.

Figure 12 (radar chart) presents these relationships more dynamically by plotting normalized values across the three indices. The chart reveals distinct functional profiles for each species. For example, *Z. officinale* forms a sharp peak in ICS, reflecting high symbolic and practical value, while *C. frutescens* spikes in RFC, emphasizing its prevalence in daily routines. Meanwhile, species like *A. barbadensis* and *S. polyanthum* demonstrate a well-rounded ethnobotanical profile, scoring relatively evenly across all metrics. This balanced pattern suggests multifunctionality and strong retention in household knowledge systems.

The combination of heatmap and radar visualization provides an intuitive understanding of how species are perceived and utilized in daily life. While numerical values alone may not capture cultural nuance, visualizations help reveal the multidimensional roles that certain species play—whether as staple flavoring agents, household remedies, or culturally symbolic plants. These tools also help identify priority species for further conservation or integration into community food and health programs. For instance, species with both high ICS and RFC scores, such as *Z. officinale* and *S. polyanthum*, represent ideal candidates for targeted propagation, policy support, and public health messaging due to their proven social and ecological value.

Overall, these visual summaries enrich the ethnobotanical analysis by bridging quantitative data with intuitive, comparative insights into plant significance across the study villages.

Informant Consensus Factor (ICF)

The Informant Consensus Factor (ICF) is a valuable ethnobotanical index used to evaluate the degree of agreement among informants regarding the use of plant species within specific categories. A high ICF value suggests strong cultural coherence and shared knowledge, whereas a low ICF indicates dispersed or individualized practices and possibly declining traditional relevance.

As shown in Table 4, the spices category exhibited the highest ICF value (0.71), reflecting strong consensus among respondents about the species commonly used for culinary and medicinal purposes. Key plants in this group include *Z. officinale*, *C. longa*, *S. polyanthum*, and *C. citratus*. These species are deeply embedded in daily cooking and traditional herbal preparations (*jamu*), making them culturally prominent and widely recognized across all study villages.

The medicinal category followed with an ICF value of 0.65, suggesting substantial agreement among respondents on the use of plants for health-related purposes. Species such as *A. barbadensis*, and *P. guajava*were frequently mentioned for treating digestive problems, wounds, fever, and general wellness. The strong consensus in this category affirms the continued reliance on plant-based healthcare, especially among older and female informants.

By contrast, fruits (0.52) and vegetables (0.48) showed moderate levels of informant agreement. These lower values likely stem from greater variability in household preferences, seasonal availability, and ecological differences between the villages. While species like *C. papaya* and *P. guajava* were consistently reported, other fruit trees and leafy greens showed more localized or idiosyncratic use, which reduced cross-community uniformity.

The beverages category had a lower ICF value of 0.41, indicating more individualized or experimental use of species such as *C. ternatea*, *C. citratus*, and *M. oleifera* in household herbal drinks. The variation in preparation styles, combinations, and consumption frequency suggests a blend of traditional knowledge and recent innovation, influenced by modern wellness trends.

Notably, the staple foods category had the lowest ICF value at 0.29, highlighting a weak consensus among respondents. This finding reflects a broader shift in consumption patterns and land-use priorities. Traditional staples such as *M. esculenta* (cassava), *I. batatas* (sweet potato), and *C. esculenta* were only sporadically cited. Several factors contribute to this trend: the widespread availability and preference for rice, reduced cultivation space in home gardens, and the labor-intensive nature of staple food production. Moreover, younger generations appear less familiar with traditional preparation techniques, relying instead on market-based or processed foods.

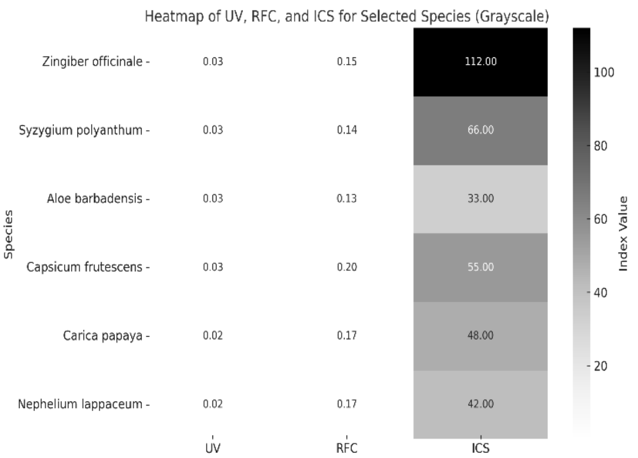

Figure 11. Heatmap of Use Value (UV), Relative Frequency of Citation (RFC), and Index of Cultural Significance (ICS) for six culturally important plant species recorded in home gardens of Semarang District. Higher values indicate greater local relevance or frequency of use

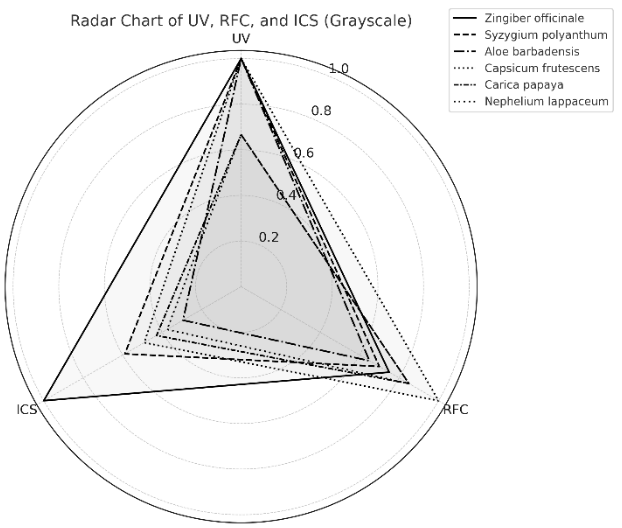

Figure 12. Radar chart displaying normalized UV, RFC, and ICS values for six dominant plant species. The diagram highlights the relative ethnobotanical prominence and functional versatility of each species across multiple cultural dimensions

The low ICF value in this category may thus represent not only fragmented ethnobotanical knowledge but also a gradual cultural and functional displacement of local carbohydrate sources. This is consistent with previous findings in rural Java, where food modernization and urbanization have led to the marginalization of indigenous staples (Cahyaningsih et al. 2021; Santoso et al. 2023).

In summary, ICF values reveal that shared knowledge is highest in categories that remain functionally relevant and culturally central, such as spices and medicinal plants. Meanwhile, staple food plants—once foundational to household resilience—are increasingly neglected. This underscores the need for targeted revitalization efforts, including educational programs, homegarden incentives, and seed-saving initiatives to restore the role of traditional staples in household food systems.

Discussion

Integration of ethnobotanical knowledge into household practices

The integration of ethnobotanical knowledge into daily household practices in Semarang District reveals a deeply rooted cultural system in which plants are more than just resources—they are essential elements of identity, sustenance, and wellbeing. The findings of this study demonstrate that edible and medicinal plants in home gardens are not passively grown or consumed, but are actively selected, maintained, and utilized based on generations of traditional ecological knowledge. This knowledge is embedded in routines such as food preparation, herbal medicine, and garden management, indicating that ethnobotanical practices are both dynamic and adaptive (Albuquerque et al. 2019; Novita et al. 2023).

The demographic profile of respondents—dominated by middle-aged women with senior high school education—plays a crucial role in the continuity of such practices. Women, particularly housewives, serve as the primary custodians of home gardens and traditional plant knowledge, responsible for selecting species, managing cultivation, and transmitting knowledge across generations. Similar observations have been made in other ethnobotanical studies, where women are regarded as key holders of ecological knowledge in domestic spaces (Kujawska and Łuczaj 2015; Duguma 2020). This aligns with the role of women in rural Indonesian communities who manage household health and nutrition through plant-based resources (Hamiyati et al. 2022).

The dominant plant species identified—*Z. officinale, S. polyanthum,* and *A. barbadensis*—are not only valued for their high utility (UV) and cultural significance (ICS), but also function as culturally embedded staples in both culinary and medicinal contexts. Their multifunctionality is evident in how they are incorporated into herbal remedies (*jamu*), traditional cuisine, and seasonal rituals. This confirms findings from studies in other regions of Southeast Asia, where multifunctional plants tend to be the most conserved and frequently used (Hu et al. 2020; Cahyaningsih et al. 2021a).

Table 4. Categories of disease in the study area and the Informant Consensus Factor (ICF)

Classification	Disease details	Species used	ICF
Infectious and certain parasites	Diarrhea, ringworm, worms, malaria, dysentery, leprosy	*Psidium guajava, Eugenia uniflora*	0.67
Circulatory	Hypertension	*Orthosiphon aristatus, Syzygium polyanthum, Annona muricata*	0.00
Digestion	Constipation, stomach ulcers, canker sores, stomach pain, toothache, indigestion, cholesterol	*Piper ornatum, Syzygium polyanthum, Annona muricata*	0.33
Eyes and adnexa	Inflammation of the eyes, eye pain	*Moringa oleifera*	1.00
Genitourinary	Menstrual pain, urination, nephrolithiasis	*Strobilanthes crispa, Carica papaya*	0.67
Respiratory	Asthma, influenza, sore throat	*Zingiber officinale*	1.00
Subcutaneous skin and tissue	Itching, swelling, ulcers, allergies	*Aloe barbadensis*	1.00
Endocrine, nutrients, and metabolism	Diabetes	*Piper ornatum, Cymbopogon citratus, Annona muricata*	0.33
Symptoms and signs involving the circulatory and respiratory systems	Cough, nosebleeds	*Piper ornatum, Zingiber officinale*	0.67
Clinical and laboratory disorders	Fever, runny nose, flatulence, acne, jaundice, headache, pain	*Acorus calamus, Zingiber officinale, Cymbopogon citratus, Curcuma longa*	0.00
Musculoskeletal and connective tissue	Gout arthritis, rheumatism	*Moringa oleifera, Annona muricata, Solanum torvum, Orthosiphon aristatus*	0.00
Symptoms and signs of subcutaneous skin and tissue	Burnt skin	*Aloe barbadensis*	1.00
Mental and behavioral	Appetite	*Curcuma zanthorrhiza*	1.00
Injuries, poisoning, and other consequences of external causes	Wounds, snack poisoning	*Aloe barbadensis, Anredera cordifolia*	0.67

Preparation methods—such as raw consumption, boiling, and cooking—also reflect culturally rooted practices that aim to preserve or enhance the efficacy and flavor of the plants (Andersen et al. 2017). As shown in Figure 9, raw and cooked forms dominate, which corresponds with traditional foodways documented in Java and other parts of Indonesia (Surya et al. 2023). These methods are often guided by empirical understanding of the plants' bioactive compounds, though such knowledge is largely transmitted orally and informally.

The dominance of cultivated plants (89.1%) over wild species (10.9%)—as shown in Figure 10—reflects a system of domesticated sustainability in which home gardens act as curated reservoirs of plant biodiversity (Feni et al. 2022). While wild harvesting still plays a role, particularly for medicinal uses, the strong preference for cultivated species suggests a deliberate effort to manage plant resources efficiently and sustainably, a pattern also reported by Cao et al. (2020) in rural China.

Visualizing plant importance and cultural roles

The inclusion of visual representations of ethnobotanical indices in this study (Figures 11 and 12) provides deeper analytical insight beyond numerical tabulation. The heatmap (Figure 11) reveals that *Z. officinale* stands out for its high ICS, supported by elevated UV and RFC values. This pattern aligns with its role as a culinary-medicinal keystone species in Javanese culture. Similarly, *S. polyanthum* and *A. barbadensis* exhibit strong balance across all three indices, highlighting their well-integrated utility and symbolic roles.

Radar charts (Figure 12) further illustrate the multidimensional relevance of species. While *C. frutescens* spikes in RFC due to its ubiquity in daily food preparation, its moderate ICS suggests more utilitarian than symbolic value. Meanwhile, *C. papaya* and *N. lappaceum* show lower scores, possibly due to seasonal limitations or reduced cultural embedding. This visual evidence supports prior interpretations and helps identify priority species for conservation and knowledge transmission based on both frequency and depth of use.

By presenting index values graphically, the study enables a more intuitive understanding of how plant importance varies along functional and cultural axes. These visual tools are especially valuable for engaging non-academic stakeholders—such as community leaders and policy-makers—in designing responsive and evidence-based strategies for biodiversity protection and ethnobotanical education.

Challenges and opportunities for revitalization

Despite the richness of traditional knowledge, this study also documents emerging challenges. Younger generations show decreasing familiarity with species, as well as reduced understanding of herbal preparations. This generational gap mirrors findings across Southeast Asia (Sujarwo and Caneva 2016; Santoso et al. 2023), and underscores the urgency of intergenerational learning programs and school-based interventions.

Urbanization and shrinking garden spaces—particularly in peri-urban Lerep—also reduce opportunities for maintaining diverse and multifunctional gardens. These pressures lead households to prioritize ornamental or high-yield plants, diminishing the cultivation of culturally significant species. At the same time, however, renewed interest in organic living and wellness post-pandemic creates momentum to reintegrate traditional knowledge into modern contexts (Hamiyati et al. 2022).

Programs such as community herbal gardens, seed banks, and inter-household plant exchanges can play a strategic role in revitalizing plant knowledge and practice. These initiatives should prioritize species with high ethnobotanical indices—as documented in this study—while also incorporating less-known but ecologically resilient wild species. Visual tools such as heatmaps and radar charts can support these efforts by communicating scientific findings in community-friendly formats.

The role of women remains central in this revitalization. As primary agents of household ethnobotany, their participation in knowledge transmission, community training, and decision-making must be foregrounded. Supporting their roles through policy, education, and economic incentives will be crucial for ensuring long-term ethnobotanical sustainability in Semarang and beyond.

Species richness and its socioecological implications

The identification of 64 edible plant species across 52 genera and 34 families in the home gardens of Semarang District demonstrates a remarkable level of species richness. This diversity is particularly significant when understood through the lens of socioecological resilience—highlighting how biodiversity at the household level contributes not only to ecological stability but also to cultural identity, health, and local food security (Albuquerque et al. 2019; Yang et al. 2020).

Among the three research locations, Susukan Village exhibited the highest species richness (45 species), followed by Karangjati (36 species) and Lerep (31 species) (Figure 5). These differences reflect varying degrees of land availability, agroecological conditions, household composition, and local ethnobotanical knowledge. High species richness, as observed in Susukan, often correlates with more extensive yards and a stronger dependence on self-sufficiency, as has been similarly documented in rural Ethiopia and Thailand (Duguma 2020; Hu et al. 2020). Meanwhile, lower species counts in Lerep may be attributed to spatial constraints or a higher emphasis on ornamental rather than functional planting, although ethnobotanical integration still remains strong.

Ecologically, such diversity supports important functions including pest regulation, pollinator attraction, nutrient cycling, and climate buffering within the microenvironment of the home garden. Structurally, the coexistence of herbs, shrubs, trees, and lianas in vertically layered arrangements mimics natural forest systems, enhancing ecosystem services even in anthropogenic landscapes (Cahyaningsih et al. 2021b; Feni et al. 2022). These findings reinforce the notion that home gardens, though often small in area, serve as critical reservoirs of agrobiodiversity and provide essential ecosystem functions at the local level.

Culturally and nutritionally, high species richness ensures greater dietary diversity, reduces dependence on market-based food systems, and enables households to cope with seasonal food shortages. Fruits, spices, vegetables, and medicinal plants are often used interchangeably, and many species serve multiple roles—e.g., *C. papaya* provides both fruit and medicinal latex, while *P. guajava* is valued for both its edible fruit and therapeutic leaves. This multifunctionality is a hallmark of traditional agroecological systems (Ojelel et al. 2019; Cao et al. 2020), where the boundaries between food and medicine are fluid and overlapping.

Importantly, species richness is not merely a measure of ecological value, but also reflects social dynamics such as knowledge sharing, gender roles, and community cohesion. In many cases, the cultivation and exchange of specific plant varieties among neighbors or relatives strengthens social ties and reinforces cultural continuity (Novita et al. 2023). Such informal seed exchange networks are especially relevant in rural Java, where traditional knowledge still guides planting decisions despite increasing market influence.

On the other hand, there is a risk that species richness could decline due to shifting dietary patterns, land conversion, and the undervaluation of traditional species. Studies in other parts of Indonesia have shown that younger generations are less familiar with lesser-known plants, leading to the gradual loss of cultural and biological diversity (Santoso et al. 2023). This underscores the urgency of documenting local plant knowledge and integrating it into formal and informal education systems.

Species richness in home gardens is a vital indicator of both ecological and cultural sustainability. It serves as a buffer against environmental and economic shocks, enhances local nutrition and health, and sustains a living connection to ancestral practices. Supporting this richness through policy, education, and participatory conservation efforts is essential for building resilient and self-reliant rural communities in Central Java and beyond (Li and Siddique 2020; UNDP 2022).

The role of women and household structure in knowledge transmission

The role of women in the transmission of ethnobotanical knowledge is fundamental and deeply embedded within the household structure, especially in rural communities such as those in Semarang District. As the majority of respondents in this study were women—specifically housewives aged 41–60 years—the findings affirm a widely observed pattern in ethnobotany: women are the primary stewards of home gardens and custodians of traditional ecological knowledge (Kujawska and Łuczaj 2015; Hamiyati et al. 2022). Women in the study area play a pivotal role in the cultivation and management of Family Medicinal Plants (TOGA), functioning as primary agents in knowledge exchange and in strengthening social cohesion among community members (Figure 13).

Women's responsibilities in managing food preparation, health care, and domestic spaces naturally position them as the central figures in the cultivation and utilization of edible plants. These responsibilities are not limited to routine tasks but involve complex knowledge systems, including understanding plant cycles, seasonal availability, preparation techniques, and medicinal uses. As observed in this study, women were often able to name specific species, describe their uses in detail, and explain how plants should be prepared depending on the intended function—culinary, medicinal, or ceremonial.

Figure 13. Family Medicinal Plants (TOGA) management in Lerep Village, Semarang District, Central Java, Indonesia

This dynamic of female-led knowledge is reinforced by the social structure of many Javanese households, where multigenerational living arrangements are common. Older women, such as grandmothers or senior housewives, often serve as knowledge brokers, passing information about plant use and cultivation to daughters and grandchildren through daily interaction and practice. Such informal learning is both experiential and oral, relying on repeated participation rather than formal instruction (Feni et al. 2022; Novita et al. 2023). This mode of transmission ensures that ethnobotanical knowledge remains resilient and context-specific, although it is also vulnerable to disruption in the face of modernization.

Studies in other regions of Southeast Asia and Sub-Saharan Africa have echoed similar patterns, where women's plant-related knowledge surpasses that of men in both breadth and depth, especially regarding food, health, and childcare (Duguma 2020; Hu et al. 2020). This reflects a gendered division of knowledge that, rather than being restrictive, allows for the development of rich, localized expertise in plant-based systems. In the context of Semarang District, this gendered role appears to be not only accepted but foundational to household sustainability.

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However, the persistence of this knowledge is increasingly challenged by external pressures such as urbanization, migration of younger family members, and the declining interest of youth in traditional practices. Formal education systems rarely integrate ethnobotanical knowledge, and as younger generations become more detached from agricultural life, the potential for intergenerational knowledge loss increases (Cahyaningsih et al. 2021c; Santoso et al. 2023). Some younger respondents in this study expressed limited familiarity with traditional medicinal uses or local plant names, relying instead on market-purchased food and pharmaceuticals.

To address this, the preservation and revitalization of women-led knowledge systems must be prioritized through community-based programs, integration into school curricula, and recognition in policy frameworks. Programs that promote seed exchange, homegarden training, and documentation of oral histories can strengthen the role of women not only as caregivers but also as agents of biodiversity conservation and cultural continuity (Li and Siddique 2020; UNDP 2022).

Women in Semarang’s rural households are not passive recipients but active agents in maintaining and transmitting ethnobotanical knowledge. Their roles are vital for sustaining the cultural and ecological integrity of home gardens. Supporting this structure through inclusive, gender-aware strategies is essential for long-term resilience in food and health systems.

Multifunctionality and cultural embeddedness of key species

One of the most prominent findings of this study is the multifunctionality of several plant species that serve a variety of roles in the daily lives of the Semarang District community. These roles are not only limited to practical functions such as food and medicine but are also tightly interwoven with cultural identity, rituals, and symbolic meaning. The multifunctionality of plants such as *Z. officinale*, *S. polyanthum*, and *A. barbadensis* (aloe vera) confirms a well-documented pattern in ethnobotanical literature: culturally important plants often fulfill overlapping utilitarian and symbolic roles, making them deeply embedded in local traditions (Sujarwo and Caneva 2016; Albuquerque et al. 2019).

In Semarang District, *Z. officinale* holds the highest Index of Cultural Significance (ICS = 112), reflecting its centrality in both daily and ritual use. It is a staple in traditional Javanese herbal tonics (*jamu*), cooking, and ceremonial offerings. Its known warming and anti-inflammatory properties make it indispensable in household healthcare, while its strong flavor contributes to the sensory identity of local cuisine (Baenas et al. 2019; Surya et al. 2023). The same plant is often planted in easy-to-access locations near kitchens, symbolizing its vital function in daily life.

Syzygium polyanthum also exemplifies cultural embeddedness through its near-universal use in Javanese cooking. Its inclusion in staple dishes such as *rendang* and *opor ayam* elevates it from a mere spice to a culturally significant plant that defines regional flavor profiles. Beyond its culinary use, this species is recognized for its medicinal effects, including lowering blood pressure and improving digestion (Cahyaningsih et al. 2021a). Its high

UV and ICS scores in this study further indicate widespread familiarity, use, and respect for its properties.

Meanwhile, *A. barbadensis* serves as a bridge between traditional and modern applications. While it has long been used to treat skin conditions and internal ailments, it is also increasingly incorporated into contemporary herbal products and cosmetics, reflecting an evolving cultural valuation. Its versatility in raw and processed forms, and its relevance in both folk and commercial domains, exemplifies how multifunctional species can adapt across time and use contexts (Nimma et al. 2017; Sánchez et al. 2020).

These multifunctional species are more likely to be cultivated, shared, and preserved within families. Their embeddedness is not only practical but symbolic—serving as representations of health, nourishment, and continuity with ancestral practices. Their presence in multiple domains (kitchen, medicine cabinet, ceremonial space) underscores the layered meanings they hold within households (Novita et al. 2023).

Comparative studies in other tropical regions have similarly shown that multifunctional plants—particularly those used in both food and healing—are among the most valued and preserved across generations (Kayani et al. 2015; Cao et al. 2020). This multifunctionality is thus a crucial criterion for identifying priority species in biodiversity conservation and cultural revitalization efforts.

The multifunctionality of key species in Semarang's home gardens highlights their pivotal role in maintaining cultural practices, sustaining family health, and securing food needs. These plants form the backbone of a living ethnobotanical system where utility and meaning converge. Efforts to protect and promote these species must therefore go beyond agronomic value, encompassing their roles as cultural and symbolic assets.

Plant habit and garden structure: Reflections of practical ecology

The dominance of herbaceous and shrubby plants in Semarang's home gardens reflects not only ecological pragmatism but also sociocultural adaptation to space, time, and labor constraints. As the data show, most cultivated species fall into the categories of herbs and shrubs, which are easier to plant, harvest, and regenerate, especially in small-scale homegarden settings. This finding aligns with previous studies emphasizing that plant habitus is a decisive factor in household plant selection, particularly in densely inhabited rural and peri-urban areas (Albuquerque et al. 2019; Novita et al. 2023).

Short-lived and fast-growing species such as *Ocimum basilicum* (basil), *C. frutescens* (cayenne pepper), and *C. longa* are common in these gardens due to their relatively quick yield cycles, low maintenance, and continuous household utility. These characteristics make herbaceous plants well-suited for daily needs and dynamic domestic environments, where plant turnover must meet fast-paced consumption patterns. The preference for such forms indicates an agroecological logic that maximizes return while minimizing inputs—a feature consistent with subsistence-based systems globally (Yang et al. 2020).

In contrast, tree species, though less frequent, are carefully integrated into the vertical structure of the garden. Fruit trees like *C. papaya*, *P. guajava*, and *M. indica* are typically planted in corners or along the periphery of the yard to avoid shading smaller crops, reflecting a deliberate spatial strategy that balances canopy cover with understorey production. This vertical stratification mimics forest-like architecture, optimizing space and microclimate conditions (Feni et al. 2022). Such structural complexity not only improves light use efficiency and pest management but also enhances biodiversity at the plot level (Cahyaningsih et al. 2021b).

Additionally, the presence of lianas such as *M. charantia* (bitter gourd) and *A. cordifolia* (binahong) adds another vertical layer, often trained along fences or trellises. These species demonstrate how vertical gardening techniques are employed as adaptive responses to limited land area, allowing households to expand productivity without increasing land use footprint—a trend also seen in other parts of Southeast Asia (Cao et al. 2020).

The overall garden layout observed during field visits supports the idea of a multifunctional and layered system where aesthetics, productivity, and ecological function coexist. Certain plants such as *C. ternatea*, which produce vibrant flowers used for both decoration and drinks, blur the line between ornamental and functional roles. This blurring reflects a local understanding that beauty and utility are not mutually exclusive—a notion reinforced by traditional Javanese philosophies of harmony between nature and household life.

Moreover, the composition of plant habits also mirrors cultural and gendered labor divisions. Herbaceous plants, often grown close to the kitchen or main house, are frequently tended by women, whereas tree planting and maintenance may involve male household members or shared labor during community planting days. This spatial-labor alignment adds another layer of meaning to the physical structure of the garden, embedding social norms into ecological practice (Kujawska and Łuczaj 2015).

The habitus composition and structural arrangement of home gardens in Semarang District reflect a form of practical ecology—a lived, learned system of environmental management shaped by cultural knowledge, labor patterns, and ecological constraints. It illustrates that decisions about what and how to plant are not only agronomic but deeply social, spatial, and ecological. Promoting this integrated model through local policy and educational outreach could enhance agroecological resilience and biodiversity conservation across rural and peri-urban Java.

Domesticated vs. wild plants: Management and resilience

The overwhelming predominance of domesticated species in Semarang's home gardens—89.1% compared to only 10.9% of wild plants (Figure 10)—reflects a conscious strategy of plant management that prioritizes reliability, ease of access, and familiarity. This pattern underscores a system where households intentionally cultivate species with known utility, growth patterns, and cultural relevance, thereby reducing dependency on external or unpredictable sources. Similar findings have been reported in other parts of Indonesia and Southeast Asia, where cultivated species dominate home gardens due to their adaptability to small-scale settings and daily household demands (Cahyaningsih et al. 2021a; Sujarwo and Caneva 2016).

Domesticated species, particularly annual and perennial herbs like *Ocimum basilicum*, *Z. officinale,* and *C. frutescens*, are managed intensively in terms of watering, pruning, and propagation. These plants often occupy the most accessible parts of the garden, near kitchens or water sources, highlighting their functional centrality. Their continued presence in gardens also reflects cultural continuity, as many are inherited knowledge selections passed down through generations. This mirrors what Albuquerque et al. (2019) term "cultural keystone species"—plants so integral to a community's way of life that they shape both landscape and identity.

However, the presence—albeit limited—of wild species in home gardens suggests a different form of ecological resilience. Plants such as *A. cordifolia* (*binahong*) may emerge spontaneously or be transplanted from nearby forests or roadsides. Their survival without constant care highlights their ecological hardiness, while their continued use reflects retained ethnobotanical knowledge. In some cases, these species are considered medicinally potent and are harvested selectively as needed, thus maintaining a link between cultivated gardens and the surrounding natural environment (Kayani et al. 2015; Duguma 2020).

This cultivated-wild dynamic is not simply dichotomous but rather complementary. Many households employ a "semi-wild" strategy in which wild species are tolerated or semi-managed within the garden, blending management with opportunism. This approach enhances functional redundancy—a key trait of resilient systems—where different species can fulfill similar roles, such as treating fever or aiding digestion (Li and Siddique 2020).

Moreover, the limited but strategic inclusion of wild plants may serve as a form of ecological insurance, preserving genetic diversity and local varieties that could otherwise be lost due to market-driven homogenization. Such species may also carry spiritual or symbolic meanings not fully replaced by cultivated alternatives. For instance, *Pandanus* spp. and *C. citratus*, though cultivated, retain strong ritual associations that originated from their wild use in traditional settings (Sánchez et al. 2020).

From a conservation standpoint, the integration of wild plants in home gardens offers an opportunity for in situ conservation, where biodiversity is preserved in the context of daily use rather than isolated in protected areas. This aligns with global calls for participatory conservation approaches that recognize local communities as active agents of biodiversity stewardship (UNDP 2022).

While cultivated species dominate Semarang's home gardens, the continued presence and management of wild plants—however modest—plays a crucial role in maintaining ecological diversity, cultural memory, and household adaptability. Strengthening both domains through documentation, seed exchange programs, and education will be vital in sustaining this hybrid ethnobotanical system amidst changing socioecological landscapes.

Traditional knowledge as a pillar of household health security

Traditional knowledge plays a foundational role in shaping household health strategies in rural communities, and this is clearly reflected in the ethnobotanical practices observed in Semarang District. The use of homegarden plants for medicinal purposes—whether for treating common ailments such as colds, digestive issues, or wounds—illustrates the importance of inherited, experience-based knowledge systems in maintaining family wellbeing. As shown in this study, 12.5% of the recorded species were used primarily as medicinal plants, and many others served dual roles as food and medicine, emphasizing the blurred line between nourishment and healing in traditional contexts (Sujarwo and Caneva 2016; Andersen et al. 2017).

The most commonly cited medicinal species, including *Z. officinale*, *A. barbadensis*, and *P. guajava*, were widely known across respondents and typically used in accessible forms such as decoctions, infusions, and topical applications. These preparation methods, which rely on boiling, pounding, or using the plant raw (Figure 9), reflect long-standing traditions that are passed down orally—especially by women within the household. As previous studies have shown, such practices often exhibit a high degree of internal consistency, built upon generational trial and observation (Kujawska and Łuczaj 2015; Duguma 2020).

The central role of plants in household health care is especially important in contexts where access to formal health services may be limited, expensive, or culturally unfamiliar. In this way, traditional plant knowledge serves as a first line of defense—providing affordable, familiar, and trusted remedies within the domestic sphere. Similar patterns have been reported across Southeast Asia, where ethnomedicine continues to complement modern healthcare, especially among older generations and in lower-income households (Hu et al. 2020; Hamiyati et al. 2022).

Moreover, traditional medicine in Java is not only utilitarian but deeply embedded in cosmological and spiritual frameworks. Plants are used not just to heal the body, but to restore balance, protect from misfortune, or purify the household. For instance, *C. citratus* is often burned as an aromatic to cleanse indoor spaces, while *Pandanus* spp. is used in both ritual offerings and food as a symbol of protection and harmony. These symbolic uses indicate that plant-based health practices operate at the intersection of physical and metaphysical wellbeing (Sánchez et al. 2020; Cahyaningsih et al. 2021c).

However, this rich body of knowledge is at risk. As younger generations become increasingly detached from agricultural practices and more reliant on pharmaceutical products, the transmission of traditional medicinal knowledge is weakening. In this study, some younger participants expressed uncertainty about the preparation and dosage of herbal remedies, relying more on packaged herbal drinks or over-the-counter medications. This mirrors broader trends in Indonesia and other countries where traditional health systems face marginalization in favor of biomedical approaches (UNDP 2022; Santoso et al. 2023).

To address this erosion, it is critical to document and revitalize traditional knowledge as part of public health strategies. Integrating ethnobotanical education into school curricula, promoting intergenerational learning spaces, and supporting home-based herbal gardens can help safeguard this knowledge. Such approaches not only preserve cultural identity but also enhance community resilience by providing sustainable and locally adapted healthcare options (Albuquerque et al. 2019; Li and Siddique 2020).

Traditional plant knowledge remains a pillar of household health security in Semarang's villages. It offers a culturally relevant, economically accessible, and ecologically sustainable approach to everyday healthcare. Recognizing and supporting this knowledge system is essential for building resilient, inclusive, and self-reliant rural health infrastructures.

Challenges and opportunities for conservation and knowledge revitalization

While the ethnobotanical richness documented in Semarang District's home gardens reflects a vibrant and functional knowledge system, it is increasingly threatened by social, economic, and environmental changes. A major challenge is the erosion of traditional knowledge, particularly among younger generations, who show declining interest in plant-based practices and greater dependence on commercial food and health products. This generational shift, commonly observed in rural Southeast Asia, leads to the gradual disappearance of local terminologies, preparation techniques, and even plant varieties (Sujarwo and Caneva 2016; Santoso et al. 2023).

Field observations during this study revealed that many less-utilized species, and certain local landraces of *Pandanus*, are no longer commonly known or used by younger household members. This suggests an underutilization of local biodiversity, not due to ecological constraints, but because of weakening cultural transmission. As Li and Siddique (2020) argue, without active intergenerational transfer, knowledge systems can become "intangible heritage at risk," with functional loss often preceding ecological loss.

Another challenge is land-use change. Urbanization, reduction in yard size, and the shift toward ornamental landscaping have contributed to declining species richness in some areas, particularly in peri-urban villages such as Lerep. Limited space leads to prioritization of fast-growing or economically profitable species, reducing the diversity and multifunctionality traditionally associated with home gardens (Cahyaningsih et al. 2021b; UNDP 2022). Market pressures also contribute to the replacement of indigenous species with hybrid or imported varieties, further undermining local agro-biodiversity.

Despite these challenges, several opportunities exist for conservation and revitalization. First, the documented data on species with high UV, RFC, and ICS scores can inform community-led prioritization of key plants for protection and propagation. Plants like *Z. officinale*, *S. polyanthum*, and *C. citratus* serve as entry points for education and conservation programs, given their cultural familiarity and continued relevance (Albuquerque et al. 2019).

Second, the momentum of interest in herbal medicine, organic gardening, and wellness—particularly post-pandemic—offers a timely opportunity to reintroduce traditional plant knowledge into public discourse. Community herbal gardens, "green schools," and home-based training programs have shown success in other Indonesian regions and could be adapted to the Semarang context (Hamiyati et al. 2022; Novita et al. 2023).

Documentation efforts—such as the current study—also contribute to conservation by providing a baseline for species inventory, usage patterns, and cultural significance. Such data can support local governments and NGOs in designing culturally appropriate biodiversity programs, including seed exchange networks, native species festivals, and oral history archives. Moreover, engaging women and elders as knowledge keepers and facilitators can ensure authenticity and sustainability of revitalization initiatives (Kujawska and Łuczaj 2015; Duguma 2020).

Finally, integrating traditional knowledge into formal education and local policy can institutionalize its value. Ethnobotanical curricula, school gardens, and participatory documentation projects involving youth have been effective in other cultural contexts for strengthening biocultural heritage (Yang et al. 2020). Local policy support—through village regulations or incentives for maintaining biodiversity-rich gardens—can complement grassroots efforts and offer long-term protection to cultural plant landscapes. While traditional plant knowledge in Semarang's home gardens faces significant challenges, the foundation for its revitalization is strong. By bridging generations, integrating policy and practice, and aligning conservation with local values, communities can sustain and even strengthen their ethnobotanical heritage for the future.

In conclusion, homegardens in Semarang District serve as vital spaces where biodiversity, cultural tradition, and household needs intersect. The diversity of edible plant species, dominated by herbs and shrubs, reflects practical and ecological considerations, while the high cultural value of multifunctional species like *Z. officinale* and *S. polyanthum* underscores their embeddedness in daily life. Women play a central role in managing and transmitting ethnobotanical knowledge, which remains essential for food security and household health. However, generational knowledge erosion and land-use change pose significant threats. Despite these challenges, opportunities exist to revitalize traditional plant knowledge through education, community initiatives, and inclusive conservation strategies that affirm its role in sustaining resilient and culturally rooted homegarden systems.

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