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Proceeding:

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Ethnobotanical study of homegarden by local communities in the urban area of Surakarta City, Central Java, Indonesia

LINTANG SYAFA AYUNINGRUM¹, MARISCA SETYANINGRUM¹, MARISKA ROSIDA AGUSTIN¹,
MITA AURELIA SABRINA¹, KIRANA NURUL ARIFIANI¹, IRFAN ABU NAZAR¹, DARLINA MD NAIM²,
AHMAD DWI SETYAWAN^{1,3,✉}

¹Department of Environmental Science, Faculty of Mathematics and Natural Sciences, Universitas Sebelas Maret. Jl. Ir. Sutami 36A, Surakarta 57126, Central Java, Indonesia. Tel./fax.: +62-271-663375, ✉email: volatileoils@gmail.com

²School of Biological Sciences, Universiti Sains Malaysia. 11800 Pulau Pinang, Malaysia

³Biodiversity Research Group, Universitas Sebelas Maret. Jl. Ir. Sutami 36A, Surakarta 57126, Central Java, Indonesia

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Abstract. *Ayuningrum LS, Setyaningrum M, Agustin MR, Sabrina MA, Arifiani KN, Nazar IA, Md Naim D, Setyawan AD. 2024. Ethnobotanical study of homegarden by local communities in the urban area of Surakarta City, Central Java, Indonesia. Asian J Ethnobiol 7: 79-88.* Communities in Surakarta City, Central Java Province, Indonesia, utilize many plants from their homegardens daily. Urban homegardens have the potential to provide biological, social, and economic environmental services. However, documentation and further information on local knowledge of food crops and plant diversity in homegardens is still limited and needs to be presented. This study aims to document and reveal local knowledge of the diversity of homegarden plants for daily life in Mojosongo, Kestalan, and Nusukan Villages, Surakarta City, and homegarden patterns in these villages. Data collection was conducted in December 2023 through surveys and direct interviews using the simple random sampling method, with 72 respondents interviewed, with details of 6 men and 66 women. The majority of respondents have a high school/equivalent educational background. The age range of respondents was dominated by 56-65 years. Plant inventory amounted to 148 species from 55 families, consisting of 73 species of food plants, 19 species of medicinal plants, 18 species of shade, 66 species of ornamental plants, and 2 species of mystical plants. The most common growth form found is the type of tree (54 species), and the family found is Zingiberaceae (11 species), followed by Araceae (8 species) and Solanaceae (7 species). Therefore, the study's results show that homegarden plants used by the community are divided into five categories of use: food, medicine, shading, ornamental, and mystical. Local people use many food plants daily, and a homegarden can be an alternative source of diverse and nutritious food plants for households.

Keywords: Food plant, homegarden, local knowledge, ornamental plant, urban area

INTRODUCTION

The interaction between the local population and their surroundings is known as ethnobotany, especially on plants and the study of plant utilization as food, shelter, medicine, clothing, hunting, and traditional rituals (Atmojo 2013). The efficacy of ethnobotanical plants covers various areas of human life, including health, food, religious ceremonies, and various daily needs. In the medical sector, many ethnobotanical plants are used as traditional medicines, from ancient times, when our ancestors used medicinal plants as raw materials for traditional potions, to the present day when contemporary society uses them (Destryana and Ismawati 2019). The very helpful first step to knowing a plant has medicinal properties is from the community's traditional knowledge for generations (Solang 2020). In the food sector, some ethnobotanical plants are also used as a source of nutrition or food. For example, plants that produce seeds, fruits, or leaves can be processed into food. Food needs can be fulfilled on a small scale, such as in rural areas, by utilizing plants in the community environment (Firdawati et al. 2021). In addition, some plants are used in religious ceremonies or local traditions for rituals, offerings, or spiritual medicine. In addition,

ethnobotanical plants can also play a role in industry and crafts. Some plants produce fiber, wood, or other materials that can be used to make tools, textiles, and traditional crafts (A'tourrohman 2020).

Homegarden studies are crucial for evaluating the significance of plant livelihoods and the interaction between humans and the natural systems that sustain and surround them in ethnobotanical research (Ahoyo et al. 2017). Small plots of cultivated ground immediately surrounding a house or farmhouse are called homegardens (Cuanalo and Mukul 2008). A homegarden is a ready-to-use traditional garden encircled by residential areas, has different plant species planted in it, is tended to by family members, and yields domestic crops (Shrestha et al. 2004). These backyard gardens have the potential to significantly increase fruit and vegetable production as well as household food self-sufficiency. Homegardens' productivity and output could be a good substitute for producing food and essential nutrients (Ferdous et al. 2016). Homegardens offer numerous benefits, including enhanced food security, increased food availability, better nutrition from various foods, higher income and better rural employment, and environmental benefits from recycling water and waste nutrients (Cabalda et al. 2011; Weinberger

2013). Homegardens, sometimes called household gardens, target women because they are typically responsible for food preparation and family health (Depenbusch et al. 2021). The culture of an ethnic group is one of the numerous variables that affect the diversity of plants grown in homegardens (Galhena et al. 2013). High-plant variety homegardens serve as in situ conservation sites, particularly for native species (Shrestha et al. 2004). According to Das and Das (2005), homegardens can aid in preserving wild flora, such as a diverse range of natural plants.

Maintaining community yard plants is expected to become food security and a source of increasing community and regional incomes. One of the interesting areas to study is Surakarta City, which has the concept of plant maintenance, especially on a household scale. The people of Surakarta City are identical, with a fairly dense settlement with a small yard area. However, the community still uses the narrow area to grow plants to meet their daily needs or even just for home decoration. The community's homegarden plants are planted in the front and back yards and a special area using a hydroponic system. They use their yard for ornamental plants, food, and horticulture. Several villages in Surakarta City have a farmer's group organization for both men (farmers group) and women (women farmers group). Women Farmers Group (KWT, *Kelompok Wanita Tani*) can increase women's knowledge, skills, and participation in the village (Syarif 2018). Then, it can contribute to maintaining knowledge about utilizing food, ornamental, mystical, and traditional medicinal plants. Participation in KWT also improves the family economy through farming, indirectly supporting fulfilling people's daily needs through natural resources (Istiqomah 2022). Urban communities' knowledge about homegarden plants, especially medicinal plants, is important to preserve so that they are sustainable. This study aims to document and reveal local knowledge of the diversity of homegarden plants for daily life in Mojosoongo, Kestalan, and Nusukan Villages, Surakarta, Central Java, Indonesia, and homegarden patterns in these villages.

MATERIALS AND METHODS

Study area

This study was conducted in three urban villages in Surakarta City, Central Java, Indonesia, i.e.: Kestalan, Mojosoongo, and Nusukan, in December 2023 (Figure 1). Kestalan Village is located at $7^{\circ}33'35''\text{S}$ and $110^{\circ}49'23''\text{E}$ with an area of 20.8 ha with an altitude of 150 to 450 m asl (meters above sea level). The second location is Mojosoongo Village, located at $7^{\circ}32'36''\text{S}$ and $110^{\circ}50'30''\text{E}$, with an altitude of 80-130 m asl and an area of 532.927 ha. The third location is Nusukan Village at $7^{\circ}32'56''\text{S}$ and $110^{\circ}49'15''\text{E}$ with an area of 206.25 ha and an altitude of around 92 m asl. The three research villages have non-government organizations that play a role in improving and developing the community's ability to develop the village agricultural sector, namely planting crops with economic value, such as fruits and vegetables that are harvested and consumed by themselves or sold.

Data collection and analysis

Data was collected using a field survey method and open-ended interviews with a simple random sampling method (Silalahi and Nisyawati 2018). The type of homegarden that is the object of research is all home yards with space or courtyards both at the front and back. Homegarden has access to sufficient water sources and contributes to plant cultivation. Plants that are cultivated are plants both in the ground and in pots, namely plants for consumption, fruits, vegetables, for ornamental, shading, medicinal, and mystical needs. Residential categories are not limited to land. Therefore, 72 informants were obtained with the same number of respondents in each village, and the data was recorded during the interview and the written method. As a result, local names of plant information were identified using websites such as planetnet.org and gbif.org and then were analyzed. During the interviews with informants, the data on the plant uses in the yard for various purposes and how they are managed was documented (Mekonen et al. 2015). The results on plant list data and supporting information are presented in tables and graphs to combine information for easy understanding and data analysis.

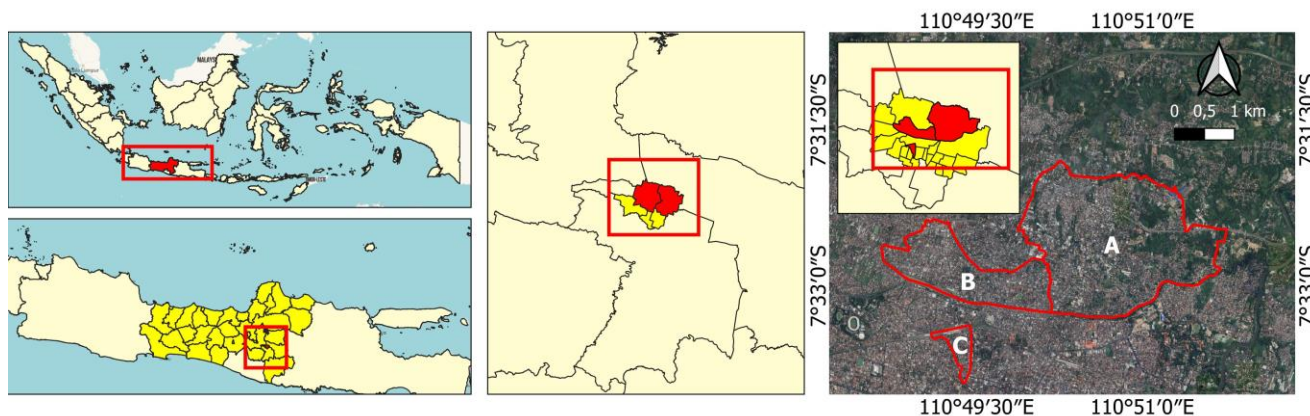


Figure 1. The map of the study area in the urban area in A. Mojosoongo, B. Nusukan, and C. Kestalan Villages, Surakarta City, Central Java, Indonesia

RESULTS AND DISCUSSION

To gather information for this research, 72 interviewees were obtained, consisting of 66 women and 6 men. Their educational backgrounds ranged from non-education to college, although most held senior high school degrees with 27 informants. The age span covered 17 to 75 years, with the predominant age group being 56 to 65, and most of the informants were housewives. The demographic data of the informants (Table 1) shows that the knowledge within local communities regarding the utilization of homegarden plants in the Villages of Mojosongo, Kestalan, and Nusukan is consistently preserved across various age groups. Despite being rooted in daily practices and ingrained habits, the information about plant usage is notably sustained from the elderly to the younger generation.

Plant diversity

Mojosongo, Kestalan, and Nusukan Villages have unique homegarden plant diversity characteristics (Table 3). Mojosongo and Nusukan Villages stand out for their rich variety of homegarden plants. This happens because of the communities' cultural foundations, specifically on agricultural practices such as cultivating and planting; most homes also showcase traditional Javanese style, often featuring spacious front yards. Mojosongo, in particular, has earned the designation of "*Kampung Sayur*" highlighting the community's commitment to vegetable cultivation to foster economic empowerment. In contrast, Kestalan Village leans towards a more modern architectural aesthetic, primarily characterized by shophouses. Notably, houses with well-developed yards and abundant plant life are a rarity in Kestalan. Where ornamental plants are commonly used for yard adornment, the Kestalan Village community generally cultivates fewer plants in their surroundings.

Multipurpose use plant

In this research, the plant types collected from the homegarden consisting of 148 species and 55 families which are classified into five categories of uses. The local community in the urban area of Surakarta District utilizes homegarden plants for various purposes (Table 2 and Figure 2). The largest family found was Zingiberaceae, with 11 species. The growth form most commonly found is tree (54 species), followed by herbaceous (52 species), shrub (26 species), and climber (16 species). The tree-type growth form dominates the growth form in food, shading, and mystical uses. The herbaceous growth form dominates the growth form in ornamental and medicinal uses. The most widely used by the community are food plants (41.0%), followed by medicinal (10.7%), shading (10.1%), ornamental (37.1%), and mystical plants (1.1%). The study revealed that some plants have more than one purpose. For example, *Moringa oleifera* can be used for medicinal and food crops. *Nephelium lappaceum* and *Mangifera indica* are also used as food and shading plants.

Table 1. The demographic structure of informants

Parameter	Specification	Frequency
Gender	Male	6
	Female	66
Age	15-25	2
	26-35	8
	36-45	13
	46-55	18
	56-65	22
	>65	9
Education	No Education	2
	Elementary School	15
	Junior High School	20
	Senior High School	27
	University	8

Table 2. Number of species and families used for homegarden purposes by communities of Mojosongo, Kestalan, and Nusukan Villages, Surakarta, Central Java, Indonesia

Purposes	Number of species	Number of families	Percentage (%)
Food plant	73	37	49%
Medicinal plant	19	9	13%
Shading	18	10	12%
Ornamental	66	35	45%
Mystical	2	2	1%

Table 3. Table of differences in plant diversity in research location

Distinctive category	Mojosongo	Nusukan	Kestalan
Location Type	Urban and some areas still have a rural area type.	Almost all areas are included in the urban area category	Almost all areas are included in the urban area category
Types of plants (based on use) that are most commonly found	Food, Medicinal, Mystical	Food, Medicinal, Ornamental	Ornamental, Shading

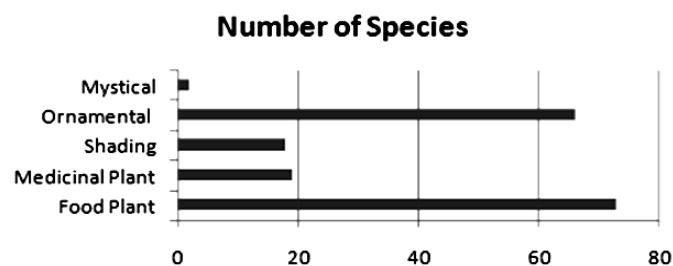


Figure 2. Number of species and families used for homegarden purposes by communities of Mojosongo, Kestalan, and Nusukan Villages, Surakarta, Central Java, Indonesia

Table 4. Diversity of ethnobotany plants used for various purposes

Family	Scientific name	Local name	Growth form	Planting location	Species functions				
					F	O	S	M	MY
Acanthaceae	<i>Graptophyllum pictum</i> (L.) Griff.	<i>Daun ungu</i>	Shrub	Front yard	-	✓	-	-	-
Acanthaceae	<i>Pseuderanthemum carruthersii</i> var. <i>atropurpureum</i> (W.Bull) Fosberg	<i>Melati jepang merah</i>	Shrub	Back yard	-	✓	-	-	-
Amaranteceae	<i>Amaranthus spinosus</i> L.	<i>Bayam</i>	Herbaceous	Front yard	✓	-	-	-	-
Amaryllidaceae	<i>Allium fistulosum</i> L.	<i>Bawang daun</i>	Herbaceous	Front yard	✓	-	-	-	-
Amaryllidaceae	<i>Allium tuberosum</i> Rottler ex Spreng.	<i>Kuca</i>	Herbaceous	Front yard	✓	-	-	-	-
Amaryllidaceae	<i>Crinum asiaticum</i> L.	<i>Bakung putih</i>	Herbaceous	Front yard	-	✓	-	-	-
Anacardiaceae	<i>Mangifera laljiwa</i> Kosterm.	<i>Mangga talijiwo</i>	Tree	Front yard	✓	-	-	-	-
Anacardiaceae	<i>Mangifera indica</i> L.	<i>Mangga</i>	Tree	Front yard	✓	-	✓	-	-
Annonaceae	<i>Annona muricata</i> L.	<i>Sirsak</i>	Tree	Front yard	✓	-	✓	-	-
Annonaceae	<i>Annona reticulata</i> L.	<i>Mulwa</i>	Tree	Back yard	✓	-	-	-	-
Annonaceae	<i>Annona squamosa</i> L.	<i>Srikaya</i>	Tree	Front yard	✓	-	✓	-	-
Apiaceae	<i>Apium graveolens</i> L.	<i>Seledri</i>	Herbaceous	Front yard	✓	-	-	-	-
Apocynaceae	<i>Plumeria rubra</i> L.	<i>Kamboja merah</i>	Tree	Front yard	-	✓	-	-	-
Apocynaceae	<i>Allamanda cathartica</i> L.	<i>Alamanda</i>	Herbaceous	Back yard	-	✓	-	-	-
Apocynaceae	<i>Catharanthus roseus</i> (L.) G.Don	<i>Tapak dara</i>	Shrub	Front yard	-	✓	-	-	-
Araceae	<i>Aglaonema</i> sp.	<i>Sri rejeki</i>	Herbaceous	Front yard	-	✓	-	-	-
Araceae	<i>Anthurium plowmanii</i> Croat	<i>Gelombang cinta</i>	Herbaceous	Front yard	-	✓	-	-	-
Araceae	<i>Caladium bicolor</i> (Aiton) Vent.	<i>Lompong</i>	Herbaceous	Front yard	-	✓	-	-	-
Araceae	<i>Caladium</i> sp.	<i>Keladi</i>	Herbaceous	Back yard	-	✓	-	-	-
Araceae	<i>Colocasia esculenta</i> (L.) Schott	<i>Talas</i>	Herbaceous	Front yard	-	✓	-	-	-
Araceae	<i>Epipremnum aureum</i> (Linden & André) G.S.Bunting	<i>Sirih gading</i>	Climber	Front yard	-	✓	-	-	-
Araceae	<i>Monstera</i> sp.	<i>Janda bolong</i>	Herbaceous	Front yard	-	✓	-	-	-
Araceae	<i>Spathiphyllum wallisii</i> Regel	<i>Peace lily</i>	Herbaceous	Front yard	-	✓	-	-	-
Araliaceae	<i>Polyscias scutellaria</i> (Burm.fil.) Fosberg	<i>Mangkonan</i>	Shrub	Front yard	-	✓	-	-	-
Araliaceae	<i>Schefflera arboricola</i> (Hayata) Merr.	<i>Wali songo</i>	Shrub	Front yard	-	✓	-	-	-
Arecaceae	<i>Cocos nucifera</i> L.	<i>Kelapa</i>	Tree	Front yard	✓	-	✓	-	-
Arecaceae	<i>Salacca zalacca</i> (Gaertn.) Voss	<i>Salak</i>	Tree	Front yard	✓	-	-	-	-
Arecaceae	<i>Dypsis lutescens</i> (H.Wendl.) Beentje & J.Dransf.	<i>Palem kuning</i>	Tree	Front yard	-	✓	-	-	-
Asparagaceae	<i>Agave americana</i> L.	<i>Lidah buaya amerika</i>	Herbaceous	Front yard	-	✓	-	✓	-
Asparagaceae	<i>Cordyline fruticosa</i> (L.) A.Chev.	<i>Andong</i>	Shrub	Front yard	-	✓	-	-	-
Asparagaceae	<i>Dracaena angolensis</i> (Welw. ex Carrière) Byng & Christenh.	<i>Dracaena angolensis</i>	Herbaceous	Front yard	-	✓	-	-	-
Asparagaceae	<i>Dracaena marginata</i> Lem.	<i>Manggar</i>	Herbaceous	Front yard	-	✓	-	-	-
Asparagaceae	<i>Dracaena trifasciata</i> (Prain) Mabb.	<i>Lidah mertua</i>	Herbaceous	Front yard	-	✓	-	-	-
Asphodelaceae	<i>Aloe vera</i> (L.) Burm.f.	<i>Lidah buaya</i>	Herbaceous	Front yard	-	✓	-	✓	-
Asteraceae	<i>Lactuca sativa</i> L.	<i>Selada</i>	Herbaceous	Hydroponic farm	✓	-	-	-	-
Asteraceae	<i>Galinsoga parviflora</i> Cav.	<i>Loseh</i>	Herbaceous	Front yard	-	✓	-	-	-
Asteraceae	<i>Helianthus annuus</i> L.	<i>Matahari</i>	Herbaceous	Front yard	-	✓	-	-	-
Asteraceae	<i>Senecio radicans</i> (L.fil.) Sch.Bip.	<i>Curio radicans</i>	Climber	Front yard	-	✓	-	-	-
Basellaceae	<i>Anredera cordifolia</i> (Ten.) Steenis	<i>Binahong</i>	Climber	Front yard	-	-	-	✓	-
Brassicaceae	<i>Brassica oleracea</i> var. <i>botrytis</i> L.	<i>Kembang kol</i>	Herbaceous	Front yard	✓	-	-	-	-
Brassicaceae	<i>Brassica rapa</i> L.	<i>Pokcoy</i>	Herbaceous	Hydroponic farm	✓	-	-	-	-
Brassicaceae	<i>Brassica rapa</i> subsp. <i>pekinensis</i> (Lour.) Hanelt	<i>Sawi putih</i>	Herbaceous	Front yard	✓	-	-	-	-
Cactaceae	<i>Selenicereus undatus</i> (Haw.) D.R.Hunt	<i>Buah naga</i>	Shrub	Front yard	✓	-	-	-	-
Cactaceae	<i>Epiphyllum anguliger</i> (Lem.) G.Don	<i>Wijaya kusuma</i>	Shrub	Front yard	-	✓	-	-	-
Cactaceae	<i>Pereskia bleo</i> (Kunth) DC.	<i>Jarum tujuh bilah</i>	Shrub	Front yard	-	✓	-	-	-
Caricaceae	<i>Carica papaya</i> L.	<i>Pepaya</i>	Tree	Front yard	✓	-	-	-	-
Combretaceae	<i>Combretum indicum</i> (L.) De Filippis	<i>Bunga ceguk</i>	Climber	Back yard	-	✓	-	-	-
Convolvulaceae	<i>Ipomoea aquatica</i> Forssk.	<i>Kangkung</i>	Herbaceous	Hydroponic farm	✓	-	-	-	-
Convolvulaceae	<i>Ipomoea batatas</i> (L.) Lam.	<i>Ketela rambat/ubi jalar</i>	Climber	Front yard	✓	-	-	-	-
Crassulaceae	<i>Kalanchoe pinnata</i> (Lamk.) Pers.	<i>Cocor bebek</i>	Herbaceous	Front yard	-	✓	-	-	-
Cucurbitaceae	<i>Cucumis melo</i> L.	<i>Melon</i>	Climber	Front yard	✓	-	-	-	-

Cucurbitaceae	<i>Cucumis sativus</i> L.	Timun	Climber	Front yard	✓	-	-	-	-
Cucurbitaceae	<i>Momordica charantia</i> L.	Pare	Shrub	Front yard	✓	-	-	-	-
Cycadaceae	<i>Cycas rumphii</i> Miq.	Pakis haji (sikas)	Tree	Front yard	-	✓	-	-	-
Euphorbiaceae	<i>Manihot esculenta</i> Crantz	Singkong	Shrub	Front yard	✓	-	-	-	-
Euphorbiaceae	<i>Jatropha multifida</i> L.	Jarak tintir	Shrub	Front yard	-	✓	-	-	-
Euphorbiaceae	<i>Jatropha podagrica</i> Hook.	Jarak bali	Shrub	Front yard	-	✓	-	-	-
Fabaceae	<i>Leucaena leucocephala</i> (Lam.) de Wit	Petai cina	Herbaceous	Front yard	✓	-	-	-	-
Fabaceae	<i>Pisum sativum</i> L.	Kacang polong	Climber	Front yard	✓	-	-	-	-
Fabaceae	<i>Tamarindus indica</i> L.	Asam jawa	Tree	Front yard	✓	-	✓	-	-
Fabaceae	<i>Vigna unguiculata</i> subsp. <i>sesquipedalis</i> (L.) Verdc.	Kacang panjang	Climber	Front yard	✓	-	-	-	-
Fabaceae	<i>Clitoria ternatea</i> L.	Telang	Climber	Front yard	-	-	-	✓	-
Fabaceae	<i>Vigna radiata</i> (L.) R.Wilczek	Karet kebo	Tree	Front yard	-	✓	-	✓	-
Gnetaceae	<i>Gnetum gnemon</i> L.	Mlinjo	Tree	Front yard	✓	-	✓	-	-
Lamiaceae	<i>Ocimum sanctum</i> L.	Kemangi	Shrub	Front yard	✓	-	-	-	-
Lamiaceae	<i>Coleus scutellarioides</i> (L) Benth.	Miana	Herbaceous	Front yard	-	✓	-	-	-
Lamiaceae	<i>Lavandula angustifolia</i> Mill.	Lavender	Herbaceous	Front yard	-	✓	-	-	-
Lamiaceae	<i>Mentha xipiperita</i> L.	Mint	Herbaceous	Front yard	-	✓	-	-	-
Lamiaceae	<i>Orthosiphon aristatus</i> (Blume) Miq.	Kumis kucing	Herbaceous	Front yard	-	✓	-	-	-
Lamiaceae	<i>Perilla frutescens</i> var. <i>crispa</i> (Thunb.) H.Deane	Daun shiso	Herbaceous	Front yard	-	✓	-	-	-
Lauraceae	<i>Persea americana</i> Mill.	Alpukat	Tree	Back yard	✓	-	-	-	-
Lythraceae	<i>Punica granatum</i> L.	Delima	Tree	Back yard	✓	-	-	-	-
Lythraceae	<i>Lagerstroemia</i> sp.	Bungur	Tree	Front yard	-	✓	-	-	-
Malvaceae	<i>Durio zibethinus</i> Murray	Durian	Tree	Front yard	✓	-	-	-	-
Malvaceae	<i>Abelmoschus esculentus</i> (L.) Moench	Okra	Herbaceous	Front yard	-	✓	-	-	-
Malvaceae	<i>Hibiscus rosa-sinensis</i> L.	Bunga sepatu	Shrub	Front yard	-	✓	-	-	-
Malvaceae	<i>Hibiscus tiliaceus</i> L.	Waru	Tree	Front yard	-	✓	-	-	-
Moraceae	<i>Artocarpus altilis</i>	Jambu sukun	Tree	Front yard	✓	-	-	-	-
Moraceae	<i>Artocarpus heterophyllus</i>	Nangka madu	Tree	Front yard	✓	-	✓	-	-
Moraceae	<i>Morus alba</i> L.	Murbei	Tree	Front yard	✓	-	-	-	-
Moraceae	<i>Ficus microcarpa</i> var. <i>latifolia</i> (Miq.) Corner	Beringin dolar	Tree	Front yard	-	✓	-	-	-
Moraceae	<i>Ficus benjamina</i> L.	Beringin	Tree	Front yard	-	-	✓	-	-
Moringaceae	<i>Moringa oleifera</i> Lam.	Kelor	Tree	Front yard	✓	-	-	✓	-
Muntingiaceae	<i>Muntingia calabura</i> L.	Kersen	Tree	Front yard	✓	-	-	-	-
Musaceae	<i>Musa xparadisiaca</i> L.	Pisang	Tree	Front yard	✓	-	-	-	-
Myrtaceae	<i>Psidium guajava</i> L.	Jambu biji	Tree	Front yard	✓	-	✓	-	-
Myrtaceae	<i>Syzygium aqueum</i> (Burm.fil.) Alston	Jambu air	Tree	Front yard	✓	-	✓	-	-
Myrtaceae	<i>Syzygium polyanthum</i> (Wight) Walp.	Daun salam	Tree	Front yard	✓	-	-	-	-
Myrtaceae	<i>Eugenia uniflora</i> L.	Dewa ndaru	Tree	Back yard	-	-	-	-	✓
Myrtaceae	<i>Syzygium oleinum</i> Wall.	Pucuk merah	Tree	Front yard	-	✓	✓	-	-
Nyctaginaceae	<i>Bougainvillea</i> sp.	Bougenville	Tree	Front yard	-	✓	-	-	-
Ochnaceae	<i>Ochna serrulata</i> (Hochst.) Walp.	Wahyu tumurun	Tree	Back yard	-	✓	-	-	-
Oleaceae	<i>Jasminum sambac</i> (L.) Aiton	Melati	Shrub	Front yard	-	✓	✓	-	-
Orchidaceae	<i>Rhynchostylis gigantea</i> (Lindl.) Ridl.	Anggrek	Climber	Front yard	-	✓	-	-	-
Orchidaceae	<i>Spathoglottis plicata</i> Blume	Anggrek tanah ungu	Climber	Back yard	-	✓	-	-	-
Oxalidaceae	<i>Averrhoa bilimbi</i> L.	Belimbing wuluh	Tree	Front yard	✓	-	-	-	-
Oxalidaceae	<i>Averrhoa carambola</i> L.	Belimbing	Tree	Back yard	✓	-	✓	-	-
Pandanaceae	<i>Pandanus amaryllifolius</i> Roxb. ex Lindl.	Pandan wangi	Shrub	Front yard	✓	✓	-	-	-
Phyllanthaceae	<i>Phyllanthus acidus</i> (L.) Skeels	Cermai	Tree	Front yard	✓	-	-	-	-
Phyllanthaceae	<i>Sauropus androgynus</i> (L.) Merr.	Katuk	Tree	Front yard	✓	-	-	✓	-
Phyllanthaceae	<i>Phyllanthus buxifolius</i> (Blume) Müll.Arg.	Seligi	Tree	Front yard	-	✓	-	-	-
Piperaceae	<i>Piper nigrum</i> L.	Merica	Climber	Front yard	✓	-	-	-	-
Piperaceae	<i>Piper betle</i> L.	Sirih hijau	Climber	Back yard	-	-	-	✓	-
Piperaceae	<i>Piper ornatum</i> N.E.Br.	Sirih merah	Climber	Front yard	-	-	-	✓	-
Piperaceae	<i>Peperomia ferreyrae</i> Yunck.	Happy bean	Shrub	Front yard	-	✓	-	-	-
Poaceae	<i>Cymbopogon citratus</i> (DC.) Stapf	Serai	Herbaceous	Front yard	✓	-	-	✓	-
Poaceae	<i>Saccharum officinarum</i> L.	Tebu	Herbaceous	Front yard	✓	-	-	-	-
Poaceae	<i>Zea mays</i> L.	Jagung hitam	Tree	Front yard	✓	-	-	-	-
Poaceae	<i>Bambusa multiplex</i> (Lour.) Raeusch. ex Schult.f.	Bambu cina	Tree	Front yard	-	✓	-	-	-

Poaceae	<i>Bambusa vulgaris</i> Schrad. ex. J.C.Wendl.	<i>Bambu kuning</i>	Tree	Front yard	-	✓	-	-	-
Portulacaceae	<i>Portulaca grandiflora</i> Hook.	<i>Bunga krokot</i>	Herbaceous	Front yard	-	✓	-	-	-
Pteridaceae	<i>Adiantum capillus-veneris</i> L.	<i>Suplir</i>	Herbaceous	Back yard	-	✓	-	-	-
Rhamnaceae	<i>Ziziphus mauritiana</i> Lam.	<i>Bidara</i>	Tree	Back yard	-	-	-	-	✓
Rosaceae	<i>Fragaria vesca</i> L.	<i>Stroberi</i>	Herbaceous	Front yard	✓	-	-	-	-
Rosaceae	<i>Rosa</i> sp.	<i>Mawar</i>	Shrub	Front yard	-	✓	-	-	-
Rubiaceae	<i>Gardenia jasminoides</i> J.Ellis	<i>Ceplok piring</i>	Shrub	Front yard	-	✓	-	-	-
Rubiaceae	<i>Ixora acuminata</i> Roxb.	<i>Asoka merah</i>	Shrub	Front yard	-	✓	-	-	-
Rutaceae	<i>Citrus ×aurantiifolia</i> (Christm.) Swingle	<i>Jeruk nipis</i>	Tree	Front yard	✓	-	-	-	-
Rutaceae	<i>Citrus ×limon</i> (L.) Osbeck	<i>Lemon</i>	Tree	Front yard	✓	-	-	-	-
Rutaceae	<i>Citrus ×sinensis</i> (L.) Osbeck	<i>Jeruk manis</i>	Tree	Front yard	✓	-	-	-	-
Rutaceae	<i>Citrus hystrix</i> DC.	<i>Jeruk purut</i>	Tree	Front yard	✓	-	-	-	-
Rutaceae	<i>Citrus maxima</i> (Burm.) Merr.	<i>Jeruk bali</i>	Tree	Front yard	✓	-	-	-	-
Rutaceae	<i>Murraya paniculata</i> (L.) Jack.	<i>Kemuning</i>	Tree	Front yard	-	✓	-	-	-
Sapindaceae	<i>Dimocarpus longan</i> Lour.	<i>Kelengkeng</i>	Tree	Back yard	✓	-	✓	-	-
Sapindaceae	<i>Nephelium lappaceum</i> L.	<i>Rambutan</i>	Tree	Front yard	✓	-	✓	-	-
Sapindaceae	<i>Pometia pinnata</i> J.R.Forst. & G.Forst.	<i>Matoa</i>	Tree	Front yard	✓	-	✓	-	-
Sapotaceae	<i>Manilkara kauki</i> (L.) Dubard	<i>Sawo kecil</i>	Tree	Back yard	✓	-	✓	-	-
Sapotaceae	<i>Manilkara zapota</i> (L.) P.Royen	<i>Sawo manila</i>	Tree	Front yard	✓	-	✓	-	-
Solanaceae	<i>Capsicum annum</i> L.	<i>Cabai merah besar</i>	Shrub	Front yard	✓	-	-	-	-
Solanaceae	<i>Capsicum frutescens</i> L.	<i>Cabai rawit</i>	Shrub	Front yard	✓	-	-	-	-
Solanaceae	<i>Physalis angulata</i> L.	<i>Ciplukan</i>	Herbaceous	Front yard	✓	-	-	-	-
Solanaceae	<i>Solanum lycopersicum</i> L.	<i>Tomat</i>	Shrub	Front yard	✓	-	-	-	-
Solanaceae	<i>Solanum melongena</i> L.	<i>Terong</i>	Shrub	Front yard	✓	-	-	-	-
Solanaceae	<i>Limncharis flava</i> (L.) Buchenau	<i>Genjer</i>	Herbaceous	Front yard	-	✓	-	-	-
Solanaceae	<i>Solanum nigrum</i> L.	<i>Tapak kebo</i>	Shrub	Front yard	-	✓	-	-	-
Umbelliferae	<i>Centella asiatica</i> (L.) Urb.	<i>Pegagan</i>	Herbaceous	Front yard	-	✓	-	-	-
Vitaceae	<i>Vitis vinifera</i> L.	<i>Anggur</i>	Climber	Front yard	✓	-	-	-	-
Zingiberaceae	<i>Alpinia galanga</i> (L.) Willd.	<i>Laos</i>	Herbaceous	Back yard	✓	-	-	✓	-
Zingiberaceae	<i>Amomum cardamomum</i> L.	<i>Kapulaga</i>	Herbaceous	Back yard	✓	-	-	✓	-
Zingiberaceae	<i>Boesenbergia rotunda</i> (L.) Mansf.	<i>Temu kunci</i>	Herbaceous	Back yard	✓	-	-	✓	-
Zingiberaceae	<i>Etilingera elatior</i> (Jack) R.M.Sm.	<i>Kecombrang</i>	Herbaceous	Back yard	✓	-	-	-	-
Zingiberaceae	<i>Curcuma longa</i> L.	<i>Kunyit</i>	Herbaceous	Front yard	✓	-	-	✓	-
Zingiberaceae	<i>Curcuma mangga</i> Valeton & Zijp	<i>Kunir putih</i>	Herbaceous	Front yard	-	-	-	✓	-
Zingiberaceae	<i>Curcuma xanthorrhiza</i> Roxb.	<i>Temulawak</i>	Herbaceous	Front yard	-	-	-	✓	-
Zingiberaceae	<i>Kaempferia galanga</i> L.	<i>Kencur</i>	Herbaceous	Back yard	-	-	-	✓	-
Zingiberaceae	<i>Zingiber officinale</i> Roscoe	<i>Jahe</i>	Herbaceous	Back yard	✓	-	-	✓	-
Zingiberaceae	<i>Costus</i> sp.	<i>Sirih cina</i>	Herbaceous	Front yard	-	✓	-	-	-
Zingiberaceae	<i>Zingiber zerumbet</i> (L.) Roscoe ex Sm.	<i>Lempuyang</i>	Herbaceous	Front yard	-	✓	-	✓	-

Note: F: Food, M: Medical, MY: Mystical, O: Ornamental, S: Shading. Back yard includes plants on the side and back of the house.



Figure 3. Examples of food plants in Mojoosongo, Nusukan, and Kestalan Villages, Surakarta, Central Java, Indonesia. A. *Morus alba* L. B. *Manilkara zapota* (L.) P. Royen

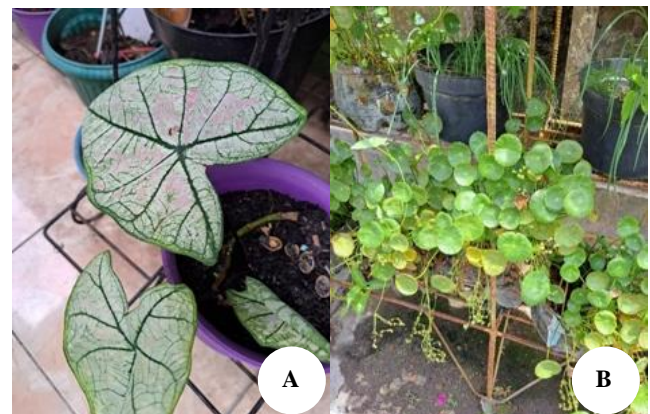


Figure 4. Examples of ornamental plants in Mojoosongo, Nusukan, and Kestalan Villages, Surakarta, Central Java, Indonesia. A. *Caladium* sp. B. *Centella asiatica* (L.) Urb.

Plants used for food

The people of Mojosongo, Nusukan, and Kestalan Villages utilize 73 species of food plants, consisting of 37 families (Table 4), with the highest utilization compared to other uses, namely with a percentage of 41%. Most edible plants the community uses are planted in front of the house, making it easier to maintain and utilize. Food plants utilized by most of the community are categorized vegetables and fruits that can be eaten directly, either raw or processed first by cooking. Food plants are mostly grown in garden farms and some respondents also grow vegetables hydroponically. However, interviews show that villagers' knowledge regarding edible plant utilization is limited to plants commonly planted in front of the house and consumed daily; less information is obtained about wild plants they used. Some respondents deliberately cultivated a plant for consumption because it is rare and difficult to obtain, as shown in Figure 3.

Solanaceae families, such as chili peppers, tomatoes, and eggplants, are the most widely utilized food crops in Mojosongo, Kestalan, and Nusukan Villages, Surakarta City. Members of the Solanaceae family consist of *Capsicum annuum*, *C. frutescens*, *Physalis angulata*, *Solanum lycopersicum*, *S. melongena*, and *S. nigrum*. All Solanaceae species are harvested for cooking as vegetables and also as seasonings. The village area is an urbanized area with limited planting areas, so people choose to grow food crops that are easy to grow in front of their houses and do not cover much space; these crops are also found and used throughout Java Island, Indonesia. The next most widely planted species by the people of Mojosongo, Nusukan, and Kestalan Villages is *C. frutescens*. Rural communities widely cultivated this plant because it is easy and does not require special care (Barik et al. 2020). In addition, Indonesian people, especially Javanese people, like to eat spicy food, so this plant can be consumed daily to add dishes flavors. *Syzygium aqueum* is one of the easier-to-maintain plants. The *S. aqueum* plants can grow practically anywhere in Indonesia (Sari and Wahyuni 2020). The next food crop widely grown by the people in the site areas is *Dimocarpus longan*; this plant is also a seasonal crop, and the fruit tastes sweet and juicy. This plant can bear fruit in large quantities, so many people plant it. Besides that, it is expensive compared to other fruits, especially when not in harvest seasons.

Other vegetable families that dominate after Solanaceae are Brassicaceae, Amaryllidaceae, and Convolvulaceae. Vegetable plant species found include *Amaranthus spinosus*, *Apium graveolens*, *Lactuca sativa*, *Momordica charantia*, *Manihot esculenta*, *Vigna unguiculata* subsp. *sesquipedalis*, *Gnetum gnemon*, *Ocimum sanctum*, *M. oleifera*, *Sauropus androgynus*, and *Ertlingera elatior*. Several species are planted in front and back yards and with water, such as *L. sativa*, *Brassica rapa*, and *Ipomoea aquatica*. People who struggle with limited agricultural land may be able to use the hydroponic system as an alternative to modern plant cultivation. The community uses hydroponic processing because the implementation is relatively simple, and the costs are not as high as other traditional planting methods. The community can operate

the system with energy efficiency, and if operated intensively, the plants will grow faster and provide higher results (Suryaningprang et al. 2021). The largest family of fruit plants (consumed) planted by the people of Mojosongo, Nusukan, and Kestalan villages is Rutaceae, followed by Sapindaceae, Moraceae, Annonaceae, Oxalidaceae, Myrtaceae, Sapotaceae, Anacardiaceae, Arecaceae, and Cucurbitaceae. Fruit plant species include *Selenicereus undatus*, *Carica papaya*, *Tamarindus indica*, *Fragaria vesca*, *Phyllanthus acidus*, *Vitis vinifera*, *Muntingia calabura*, *Musa ×paradisica*, *Persea americana*, *Punica granatum*, and *Durio zibethinus*.

Plants used for ornamental

There are 66 ornamental plants, consisting of 35 families, that the people of Mojosongo, Nusukan, and Kestalan Villages planted. The most widely used plants as ornaments or ornamental the people of Mojosongo, Nusukan, and Kestalan Villages planted, *Anthurium plowmanii*, *Caladium bicolor*, *Caladium* sp., *Colocasia esculenta*, *Epipremnum aureum*, *Monstera* sp., and *Spathiphyllum wallisii* (Figure 4). Those plants are widely used to decorate the house because they are beautiful and can beautify the front yard. In addition, some plants, such as *Monstera* sp., can be used as air purifiers; hence, it is not only for decoration but also has very useful benefits. *Aloe vera* is the most widely planted ornamental plant by the people of Mojosongo, Nusukan, and Kestalan Villages because this plant has many benefits besides decoration. The *A. vera* can also be used as a medicinal plant to make hair loss smoother and denser (Salsabila et al. 2022). Besides that, *A. vera* can also be consumed if properly processed (Purwanti et al. 2022).

Besides *A. vera*, another ornamental plant that is widely planted is *Dracaena trifasciata*. This plant is quite famous among ornamental plant collectors, so many people plant it in their front house. Apart from the aesthetics of this plant, *D. trifasciata* also has an aroma that provides a relaxing effect and relieves stress (Boboc and Cantor 2012). Some ornamental plants were only found in a few places because few people grow them around their homes. Some ornamental plants found only in one respondent's house are *Graptophyllum pictum*, *Pseuderanthemum carruthersii* var. *atropurpureum*, *Crinum asiaticum*, *Catharantus roseus*, *C. esculenta*, *C. bicolor*, *Caladium* sp., *S. wallisii*, *Schefflera arboricola*, *Senecio radicans*, *Helianthus annuus*, and *Galinsoga parviflora*.

Plants used for shading

There are 18 shading plant species, consisting of 11 families, that the people of Mojosongo, Nusukan, and Kestalan Villages planted. Many people use plants that produce fruit as shading plants, such as *M. indica*, *Annona muricata*, *Annona squamosa*, *Cocos nucifera*, *T. indica*, *D. longan*, and *N. lappaceum*. Plants are used as shade because they have several benefits for the surrounding environment (Akbari 2002). Shade plants can produce sufficient oxygen levels and absorb carbon dioxide in the air (Kusminingrum 2008). In addition, shade plants can also function as filters for air pollution and noise absorbers

(Givoni 1991), which can also fight global warming and air pollution. Shade plants are generally large trees with strong roots to maintain the soil structure strength and increase water content. Shade plants that are widely planted by the people of Mojosongo, Nusukan, and Kestalan Villages are *M. indica* and *S. oleinum*; it can be used as a shade and beautify the front of the house because of its reddish leaf tips. Another plant used as a shade is *Ficus benjamina*, which is widely used in the suburbs because it has strong roots, grows large, and has a long life.

Plants used for medicinal stuffs

The people of Mojosongo, Nusukan, and Kestalan Villages utilize 19 species of medicinal plants, comprising 9 families. Plants planted in front of the house, in addition to shade or decoration, can also be used for treatment. People usually deliberately cultivated these plants to treat certain diseases. Plants used for treatment are dominated by plants from the Zingiberaceae family, namely *Zingiber officinale*, *Curcuma longa*, *C. xanthorrhiza*, *Kaempferia galangal*, and *C. mangga*. They are perennials that frequently have sympodial (forked) fleshy rhizomes and grow in moist areas of the tropics and subtropics, including some seasonably dry regions (Larsen et al. 1998). Zingiberaceae contains several significant genera with medicinal applications, including *Alpinia*, *Amomum*, *Curcuma*, *Elettaria*, *Kaempferia*, and *Zingiber* (Kumar et al. 2013). The most widely planted medicinal plants by the Mojosongo, Nusukan, and Kestalan villagers are two plants, namely *K. galangal* and *Z. officinale*. The *K. galanga* is useful for lowering blood pressure, relieving pain, reducing stress, increasing appetite, and preventing cancer (Sumarlina et al. 2022).

The next widely planted plant is *Z. officinale*. This plant can maintain body immunity (Mohammadi et al. 2020), and its numerous advantages make it a useful traditional medicine for treating and preventing acute and chronic illnesses. It can also be used as a spice to enhance culinary preparations (Andriani et al. 2021). This plant is widely processed into drinks to warm the body. Other medicinal plants found in small quantities include *C. xanthorrhiza* and *C. mangga*. This plant is mostly planted to treat certain diseases, so few people grow it or know its health benefits. The three village populations got the traditional medicine they ate from a variety of sources, mostly members of their own families —mothers, grandparents, and ancestors— as well as electronic media, which included print and online publications. Respondents stated that while using medicinal plants, people never experience side effects from consuming medicinal plants because they don't consume excessively.

Plants used for mystical

In Indonesia, many people still believe in mystical powers (Soemarwoto and Conway 1992). Some people deliberately plant certain plants for mystical purposes or certain beliefs. Two species of plants were found, which were used for mystical needs by the community. The mystical plants cultivated were *Ziziphus mauritiana* and *Eugenia uniflora*, and the community now hardly ever used

the *Z. mauritiana* organs. The leaves were sometimes used for bathing the corpse because they produced a foam similar to soap when kneaded with water or as a component of a traditional wedding and spiritual ceremony (Rahayu et al. 2018). Young branches of *Z. mauritiana*, which ranged from 5 to 10 meters in height, spread out and frequently dangled. With one or two upright stipular spines on young branches and fewer on mature branches, the branches slope upward; the leaf is simple, ovate, oblong, alternate, and petiolate. Above, the leaf is glossy green and hairless; underneath, it has dense, soft, white hairs, and three prominent veins form a base that runs abaxially. Apex subrounded, margin crenulate, base asymmetric, and base subrounded. Therefore, *Z. mauritiana* has many health benefits due to its mystical. Moreover, numerous studies have investigated the pharmacological potential of different plant parts, including the fruits, leaves, and stems, as hepato-protective, immune-modulatory, antimicrobial, antioxidant, and anti-diarrheal (Prakash et al. 2021). In Javanese terminology, the *E. uniflora* plant, called the dewandaru plant, implies it can be interpreted as "bearer of divine revelation". The dewa ndaru tree in Kawi Mountain is sacred; the local people believe *E. uniflora* can bring good luck and use it as an amulet. *E. uniflora* is also believed to foreshadow events that will occur (Renjana 2020).

A homegarden is the land surrounding a settlement and maintained by a family. Homegardens are social centers and cultural sites in many places worldwide (Chen et al. 2019), and the culture of an ethnic group is one of the many factors that influence homegarden plant diversities. Owners' lives and yards are closely linked (Galluzzi et al. 2010), and households get much food from their yards (Galhena et al. 2013). Homegardens perform significant social tasks and can be considered a representation of the community's social status; hence, homegarden shows the family's social and economic status. Homegarden can help people fulfill social needs and manage the environment. Therefore, making observations in homegardens can be an effective method to study people's knowledge and culture. Culturally important plant species are essential for household income, therapy, decoration, and other non-food benefits (Yinebeb et al. 2022). The culture and habits of people in growing plants in homegardens are important in biodiversity conservation efforts. They can improve household food security and availability and efforts to obtain quality community nutrition through homegardens (Weinberger 2013). Homegarden production and productivity may be a viable alternative to provide food and nutritional security for poor households. Residents' culture and knowledge of their homegarden influence biodiversity conservation and food security (Ferdous et al. 2016).

A homegarden can contribute significantly to the nation's production of fruits and vegetables and promote household food self-sufficiency. Homegarden interventions usually focus on women, mostly responsible for household food preparation and family health (Depenbusch et al. 2021). Homegardens, if developed into a business, have the potential to contribute to food security and also create

employment opportunities that support the community's economy. The homegarden concept tends to contribute to low household income suitably. Ferdous et al. (2016) reported that in a number of Asian nations, including Bangladesh, Sri Lanka, India, and the Philippines, homegarden enterprises have the potential to boost community income and provide jobs, according to the Food and Agriculture Organization of the United Nations. In the three villages, vegetable buying and selling activities went well. Several KWT members grow vegetables at home and sell vegetables to the local community.

Homegarden has various ecological functions: contributing oxygen and reducing carbon dioxide in the air; habitat for animals, especially birds, and insects, such as pollinators for various plants; wind barrier and protection from lightning and soil erosion. Homegardeners can contribute to preserving land-derived ecosystems by growing their carbon sequestration, lowering greenhouse gas emissions into the atmosphere, and conserving carbon biomass. As a result, those trees serve as a global mitigation of climate change, assisting in reducing its adverse effects (Raihan et al. 2021). This aligns with research conducted by Septiyani et al. (2010), which found that yard vegetation can reduce the concentration of dust particles in hemorrhoidal air. The more shading the yard vegetation owned by the community, the lower the dust particle concentrations in the ambient air. This shows that the existence of a community-owned yard can improve the quality of the environment which will support the quality of public health. The dense vegetation in the yard causes the yard to become a habitat for animals, and due to the extraordinary plant species diversity, the homegarden is a rich genetic resource. A homegarden can serve as a platform for the conservation of wild plants. The variety of these plants can provide valuable information that can be used to conserve local ethnobotanical knowledge (Benz et al. 1994). Once many wild or semi-wild plants are discovered, these plants can be cultivated for cultivation. Multi-story structures with a high plant species diversity are essential for soil and water conservation, and plant canopy stratification protects the soil from erosion and pests (Santos et al. 2022). Homegardens can trigger an effective waste recycling system; the residents' livestock waste or plants' dry leaves, which are then composted, can be used as fertilizer and plant caring (Karyono 2000). Efforts to maintain and preserve homegarden plants need to be made so that the benefits of homegarden are still obtained for human life and other organisms. Several efforts to preserve ethnobotanical plants, especially medicinal plants, have been carried out in the three villages. These preservation activities are mainly supported by the KWT organization. Efforts to preserve homegarden plants owned by the community are also supported by community service activities carried out by students through local and regional university programs. University community service activities usually involve socialization to community groups such as Family Welfare Movement (PKK) or other community institutions. The hope is that participants can learn or obtain information on how to preserve plants and pass on their knowledge to other

communities. Therefore, community knowledge can be maintained and preserved for future generations through socialization activities at these universities.

In conclusion, the people of Mojosongo, Kestalan, and Nusukan Villages use plants for various purposes, such as food, medicinal, shading, mystical, and ornamental plants. The three villages have farmers' groups, which are crucial to increasing the knowledge and skills of the village community regarding the food sector, hence improving the village economy through planted garden incomes. Therefore, the most dominant plants are used for food, while the least utilized is mystic. Village communities use plants for this purpose by cultivating in their yards or certain areas. The leaves and fruit are the most widely used plant parts as food and medicinal plants from 148 plant species of 55 families were identified. The community plant's knowledge and species diversity are still relatively high from the old to the young. Still, this plant's knowledge may be further degraded if there is no teaching about the traditional use in their villages.

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Ethnomedicinal and cytotoxicity study of plants used by Dumagat Tribe in Philippines

MARK LLOYD M. DOMINGO, MATTHEW GABALES, DOMINIQUE ANN A. GUERRA,
JACINTA SOPHIA REIGN M. LINDO, SAMUEL C. BRILLO*

Department of Biology, College of Science, Pamantasan ng Lungsod ng Maynila, General Luna, corner Muralla St, Intramuros, Manila, 1002 Metro Manila, Philippines. Tel.: +63-2-8643-2500, *email: scbrillo@plm.edu.ph, sambrillo24@gmail.com

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Abstract. Domingo MLM, Gabales M, Guerra DAA, Lindo JSRM, Brillo SC. 2024. Ethnomedicinal and cytotoxicity study of plants used by Dumagat Tribe in Philippines. *Asian J Ethnobiol* 7: 90-104. Many indigenous tribes lack access to modern medicine and rely on ethnomedicinal plants to treat various medical conditions. This study documented the ethnomedicinal knowledge and practices of the Dumagats in Barangays San Lorenzo, Norzagaray, and Kabayunan, Doña Remedios Trinidad, Bulacan, Philippines. The study identified 22 ethnomedicinal plants used to treat everyday ailments, with leaves being the most frequently utilized plant part, typically decocted and taken orally. Eighteen out of 22 (68.18%) of the plants were identified to be native to the Philippines: *Alstonia scholaris*, *Homalomena philippinensis*, *Blumea balsamifera*, *Combretum indicum*, *Dillenia philippinensis*, *Pterocarpus indicus*, *Flagellaria indica*, *Cyrtandra incisa*, *Leea philippinensis*, *Lagerstroemia speciosa*, *Saccharum spontaneum*, *Embelia philippinensis*, *Antidesma bunius*, and *Buddleja asiatica* highlight the predominance of native plants in the area and its utilization by the tribe. The most frequently used plants were *Artemisia vulgaris*, *B. balsamifera*, *S. spontaneum*, and *D. philippinensis*, with a use value 0.57. The results shed light on the pharmacological characteristics of plant extracts from *A. vulgaris*, *C. amboinicus*, and *B. balsamifera* using brine shrimp lethality and trypan blue assays. Examination of concentration and time-dependent effects revealed cytotoxic properties. Higher concentrations (1 mg/mL) significantly reduced cell viability, while lower concentrations (100 and 10 micrograms/mL) showed varied responses; prolonged exposure exacerbated cytotoxic effects. These findings underscored the importance of documenting ethnomedicinal practices and assessing the cytotoxicity of medicinal plants to understand their potential health impacts, providing practical insights for researchers, botanists, and healthcare professionals interested in ethnomedicine and pharmacology.

Keywords: Assay, cytotoxicity, Dumagats, ethnomedicinal, plants

Abbreviations: BSLA: Brine Shrimp Lethality Assay, LC₅₀: Lethal Concentration 50, TBA: Trypan Blue Assay

INTRODUCTION

Plants serve as the primary source for discovering new pharmacologically active substances in the pharmaceutical industry, leading to the development of many medicines. This benefits both conventional medicine and the global healthcare system by providing raw materials for drug development, supporting traditional medicine, and contributing to biodiversity and ecosystem stability. Additionally, plants offer sustainable alternatives to synthetic drugs and enhance healthcare access, especially in developing regions, improving global health outcomes. Roberson (2008) stated that between 50,000 and 80,000 flowering plants are used for medicinal purposes worldwide. The Philippines boasts diverse plant species and numerous ethnic groups with distinct cultural traditions (Dapar et al. 2020). Given the Philippines' wide range of medicinal plant species, researchers and medical experts can offer the nation and its people more affordable and accessible healthcare, particularly in impoverished and remote areas without modern medical facilities.

De Vera (2007) conducted a country case study on the Philippines, revealing the presence of 110 significant indigenous tribes and 112 ethnolinguistic groups. The

indigenous people continue to rely on upland areas for their traditional agricultural practices. Over generations, traditional cultures effectively shared knowledge about using plants for curing ailments. Despite the archipelago's various indigenous tribal populations and their traditional medicine practices, there is a lack of comprehensive research on ethnomedicine, particularly regarding the cytotoxicity of plants used in the Philippines. Ethnomedicine focuses on cultural interpretations of health, disease, and illness and aims to address the healthcare process and healing practices (Krippner and Staples 2003; Mahapatra et al. 2019). The deeper integration of younger generations into society is leading to a gradual loss of traditional knowledge. Preserving ethnomedicinal practices and knowledge in the Philippines faces challenges due to transmitting knowledge through oral traditions, which may require more extensive documentation.

Adriano (2020) described the Dumagats as an indigenous group living in Barangays San Lorenzo, Norzagaray, and Kabayunan, Doña Remedios Trinidad, Bulacan, Philippines near the Angat watershed and the Sierra Mountains. A dedicated missionary, Martin Francisco played a critical role in the Dumagats' establishment. The Kabuwelan phrase "*hubad sa gubat*"

(naked in the forest) is the source of the word "*dumagat*," which refers to the small community where the Dumagats reside. Adriano (2020) also mentioned the Agta, Alta, and Remontado Tribes, three of the Dumagat Tribes. Access to clean water is a pressing concern for the Dumagats, leading to amoeba-borne diseases and other health problems.

The risks faced by ethnomedicinal knowledge and practices in the Philippines motivated the researchers to conduct a cytotoxicity assay and document ethnomedicinal plants. These risks include the lack of information on traditional medicine, which can lead to indigenous people being unaware of the potentially harmful and fatal cytotoxic activity of certain plants. Furthermore, there is limited information available on the Dumagats and their medical practices, prompting researchers to conduct a study with the Dumagat community in Barangays San Lorenzo, Norzagaray, and Kabayunan, Doña Remedios Trinidad, Bulacan.

The study aimed to explore the cytotoxicity of specific ethnomedicinal plants in Norzagaray and Doña Remedios Trinidad, Bulacan. It utilized local ethnomedicinal knowledge and practices in the barangays of San Lorenzo and Kabayunan. The study also focused on the importance and diversity of traditional medical applications by identifying and documenting the locally used medicinal plants. The study's findings, with their potential to inspire and guide future research, provide valuable insights for future research.

MATERIALS AND METHODS

Research design

This study employed non-experimental and experimental quantitative research methods, focusing on practical applications. Survey research, a common tool in health services research, describes Dumagats' practices, including the plant parts they use, their preparation and application methods, and the ailments they claim to cure.

Experimental methods, such as cytotoxicity assays like the BSLA and TBA, further enhance the practicality of the study.

Research locale

The Dumagat Tribe of Barangays San Lorenzo, Norzagaray, and Kabayunan, Doña Remedios Trinidad, Bulacan, Philippines participated in this study (Figure 1). Kabayunan is located by maps at approximately 14.9440, 121.2688, in the municipality of Doña Remedios Trinidad, while San Lorenzo is located at approximately 14.8664, 121.2398, in the municipality of Norzagaray (Figure 2). Due to the presence of Dumagats in these barangays in Norzagaray and Doña Remedios Trinidad, Bulacan, it was chosen as the study's site.

Samples and sampling procedures

We conducted this study from January 2023 to June 2024. Researchers used nonprobability and purposive sampling. Considering the number of participants and the community, the researchers have determined that purposive sampling is the most appropriate method for the study. According to Allen (1971), one way to determine how to select informants is to establish criteria for identifying a trustworthy informant. We construct a list of qualifications based on these criteria. The researchers provided the list of qualifications to resource people (community leaders, local government officials, or residents) who can assist in finding informants. This research aims to highlight the benefits of the research to the community, thereby reducing time and preventing conflicts during data collection (Allen 1971; Bernard et al. 1986). We asked individual resource persons to identify the eight most pertinent informants. The goal is to identify the most highly referenced individual who will serve as an informant (Sanders 1960). We have adopted the purposeful sampling method because it best suits ethnomedicinal research, which involves studying cultural traits unknown to all participants.



Figure 1. The general community of Dumagat Tribes in Norzagaray and Doña Remedios of Bulacan, Philippines

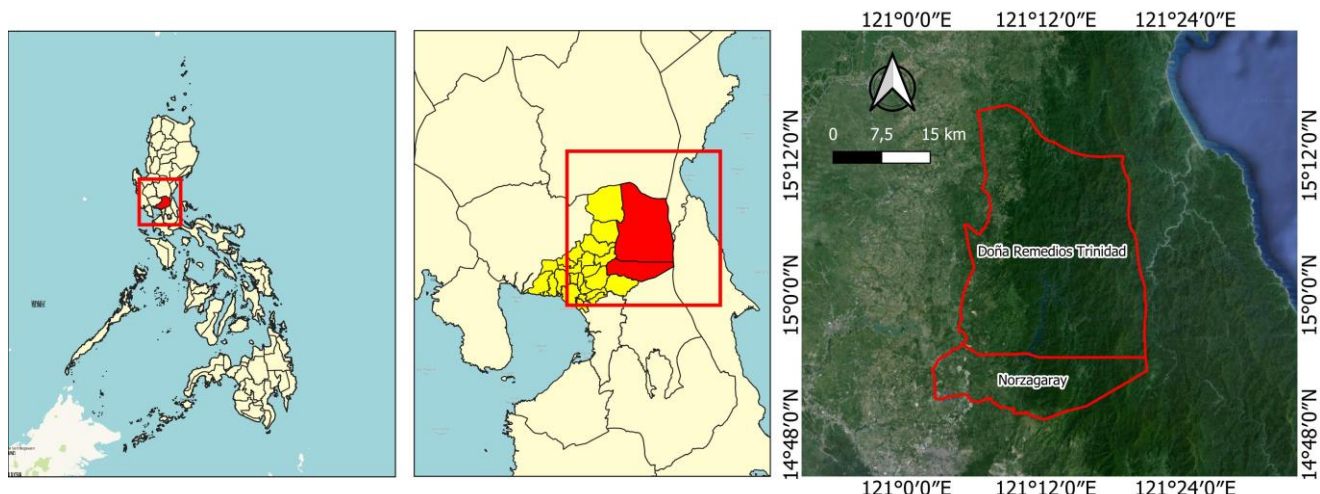


Figure 2. Study area in Norzagaray and Doña Remedios of Bulacan, Philippines

Inclusion and exclusion criteria

The informants in this study are 18-80 years old, male and female, and part of the Dumagat Tribe. These individuals are native and have at least 5 years of experience using or applying plants to cure ailments to themselves or others in the study area, resulting in a favorable reputation. Regarding barangays, only the two—Barangays San Lorenzo, Norzagaray, and Kabayunan—and Doña Remedios Trinidad in Bulacan were selected to be part of the study due to the interest and accessibility of researchers to the population. Plant inclusion criteria are based on selecting plants within the research locale that are either spontaneous or cultivated; the informants mention any plant parts they use to treat ailments. We exclude informants who are non-Dumagats, have less than 5 years of experience, or are non-herbalists. We also exclude Norzagaray's remaining barangays from the study.

Methods of collecting data and research instrumentation

Before conducting the study, the local government of Norzagaray, Bulacan, received an informed consent form. We then conducted semi-structured interviews and focus group discussions to gather ethnomedicinal knowledge. A semi-structured questionnaire guided the interview with the informants. In addition, we conducted the semi-structured interview in Tagalog, given that the Dumagats have acquired the ability to speak and communicate in this language due to the internal migration of other ethnolinguistic groups into their territory.

Plant collection

We collected the plant specimens mentioned by the informants. The researchers further identified the plant specimens using various book references, including *A Pictorial Cyclopaedia of Philippine Ornamental Plants* by Madulid (1995), *Co's Digital Flora of the Philippines* (updated 2024, Pelser et al. 2011), and Stuart's (2024) *List of Philippine Herbal and Medicinal Plants*. Plant specimens

were identified and verified at the University of the Philippines—Diliman.

Plant preservation

The plant specimens were preserved using Queensland Herbarium's (2013) *Collection and Preservation of Plant Specimens*. We washed the specimens with denatured alcohol to prevent molding. We individually placed the specimens between layers of newspapers and pressed corrugated boards between wooden pressers. We preserved the plants using a plywood press and checked their daily status. Once the plant had thoroughly dried, we mounted it on a bristol board and covered it with a plastic cover. We sent the herbarium to the Jose Vera Santos Memorial Herbarium at the University of the Philippines—Diliman for storage and future reference for identification.

Plant extraction

A kilogram of each fresh plant part from the three selected species was collected to prepare crude extracts for the brine shrimp lethality assay. The fresh plant parts were washed with tap water to remove unwanted particles and oven-dried at 44.5°C for 4 hours. The dried plant samples were cut into small pieces and pulverized using a blender (600 W, model NB-101B, Nutribullet 600 series). The obtained powder from each plant species was weighed using an analytical balance. The maceration procedure from Ang et al. (2019) was slightly modified by soaking powdered dry plant leaf samples in sufficient amounts of 95% ethanol for 24 hours at ambient room temperature. The samples were then filtered twice using Whatman filter paper, and the collected filtrates were rotary-evaporated at 40°C to remove the solvent (ethanol). Before experimental use, the dried crude ethanol extracts were kept at 4°C (Selvamohan et al. 2012). The serial dilution procedure from Sarah et al. (2017) was also slightly modified. A stock solution was prepared by dissolving 10 mg of the powder in 1 mL of water, followed by serial dilution to obtain concentrations of 1 mg/mL, 100 µg/mL, and 10 µg/mL.

Clean, properly labeled test tubes were used for this preparation.

Brine Shrimp Lethality Assay

The brine shrimp lethality assay, adapted from Sarah et al. (2017), assessed the cytotoxicity of plant extracts. Researchers prepared artificial seawater by mixing 27 g of table salt with 3 L of water in a rectangular tank and aerated it with an air pump. Then, 15 g of brine shrimp eggs were added and incubated under a light source (60-100-watt bulb) for 20-24 hours to hatch nauplii. After another 24 hours, the nauplii were separated from the empty eggs by turning off the air pump and light. Ten nauplii were transferred to test tubes using a Pasteur pipette and exposed to varying concentrations of plant extracts. The number of survivors was recorded every four hours for 24 hours. Positive and negative controls, using potassium dichromate and no extracts, respectively, ensured result accuracy.

Trypan Blue Assay

A yeast broth was prepared by dissolving 11.5 grams of S-04 *Saccharomyces cerevisiae* in 240 mL of warm water, and 1 mL of this slurry was diluted with 10 mL of distilled water. Following Kamiloglu et al. (2020), 1 mL of plant extracts at concentrations of 1 mg/mL, 100 µg/mL, and 10 µg/mL was mixed with 1 mL of diluted yeast slurry. The mixture was observed at 15, 30, and 45 minutes, then combined with 2 mL of 0.4% trypan blue stain and left at room temperature for 3 minutes. After incubation, a mixture drop was placed on a microscope slide to count viable (unstained) and nonviable (stained) cells.

Statistical analysis

The researchers used Use Value (UV) to estimate the relative significance of the plant species used by the Dumagats. According to Zenderland et al. (2019), use value is a commonly employed indicator for ranking the comparative value of plant species. We widely use it to identify notable species of interest because it incorporates the frequency of a particular species' mention and the number of uses described per species.

$$UV = \frac{U_i}{N}$$

Where:

UV: Use Value

U_i : The number of plant usage reports in the research region

N: The overall number of respondents

The Brine Shrimp Lethality Assay evaluated the lethality of plant extracts against *Artemia salina*. The following equation was used to determine the percentage of mortality:

$$\%mortality = \frac{\text{Number of dead nauplii}}{\text{Number of live nauplii taken}} \times 100$$

Data were analyzed using one-way ANOVA in SPSS to identify significant differences in mortality rates at various extract concentrations after 24 hours, with a p-value below 0.05 considered significant. The LC_{50} , the concentration at which 50% of brine shrimp died, was determined using 24-hour mortality data and probit analysis. LC_{50} is a reliable measure, less affected by extreme values, reflecting the median lethal dose. Extracts with LC_{50} values less than 1 mg/mL were considered toxic, while those above 1 mg/mL were non-toxic. Toxicity levels were classified using Clarkson's et al. (2004) criteria: non-toxic (>1.00 mg/mL), mildly hazardous (0.50-1.00 mg/mL), moderately toxic (0.10-0.50 mg/mL), and very toxic (<0.10 mg/mL).

For the trypan blue test, the proportion of live cells (percent viable cells) was computed with the following formula provided by Strober (1997):

$$\text{viable cell (\%)} = \frac{\text{Total number of viable cells per ml of aliquot}}{\text{Total number of cells per ml of aliquot}} \times 100$$

The percent viability computed for the triplicates at different concentrations under three-time exposures (15, 30, and 45 minutes) was analyzed using a one-way ANOVA to determine if there was a significant difference in the concentration values for each plant extract.

RESULTS AND DISCUSSION

Plants used by the Dumagat Tribe and modes of preparation

Following the interviews made with the informants, presented in Table 1, the 22 medicinal plants belonging to 21 taxonomic families were documented in Sitio Manalo, Barangay San Lorenzo, Norzagaray, Bulacan, and Sitio Iyak, Barangay Kabayunan, Doña Remedios Trinidad, Bulacan. Figure 3 shows that the Asteraceae family represents these plants with two plants, while the other families each record one plant. Dumagats treat 34 ailments with ethnomedicinal plants, according to the study. Colds, coughs, fever, UTI, pneumonia, and mouth sores were the most common diseases treated using medicinal plants in the two Barangays. Cough was the most common ailment documented, with 11 plants, followed by fever with five plants, mouth sores, colds, pneumonia, and UTI with two plants, and the rest of the ailments with one plant. Table 1 shows that Dumagats use specific plants to treat three or more ailments. The Dumagats used some of these plants, such as *Artemisia vulgaris*, commonly known as mugwort and known locally as *damong maria*, to treat cough, hyperacidity, and loss of appetite. *Blumea balsamifera* (*sambong*) also served as a remedy for folk illnesses like numbness, stomach pain, or “*pasma*.” *Pasma* is a Filipino folk illness believed to be caused by the sudden exposure of hot or sweaty body parts to cold, leading to symptoms like tremors, muscle spasms, or numbness (Jocano 1973). Meanwhile, *Dillenia philippinensis* (*katmon*) fruit was a remedy for flu-like symptoms. *Alstonia scholaris* (*dita*) fruit was specifically used as a malaria treatment. *Combretum indicum* (*taryantan*) can treat ailments like

coughs, colds, pneumonia, and sprains. This was the most effective medicinal plant, treating four different ailments. The sap of this plant can treat other ailments, such as mouth sores in children and adults, while *talahib*, *lagundi*, *tawa-tawa*, or *tanaw-dagat* can treat coughs and fevers (Lam et al. 2018).

According to Canceran et al. (2021), the leaves of *A. vulgaris* (*damong maria*) were used to treat stomach pain, one of the causes of hyperacidity. Researchers in Bangalore, India, have scientifically studied this traditional remedy, demonstrating its potential to reduce hyperacidity (Zubair et al. 2020). In albino rats, the same pharmacological study revealed the anti-inflammatory effects of flavonoids in *A. vulgaris* leaves. In Aurora, Quezon, people also use *B. balsamifera* (*sambong*) to treat *parasma* (a local term referring to musculoskeletal spasms) and body pain by consuming its leaves orally (Canceran et al. 2021). People apply the plant, which contains compounds with anti-inflammatory and antioxidant properties, directly through heat to relieve muscle pain or strain (Kantasrila et al. 2020). Additionally, Boy et al. (2019) noted that *B. balsamifera* is among the medicinal plants approved by the Department of Health, Cubans with a persistent cough or tuberculosis received a decoction from the leaves. Researchers discovered that *C. amboinicus* (*oregano*) effectively combats *Mycobacterium tuberculosis* (Arumugam et al. 2016).

Regarding ethnomedicinal knowledge, it's important to note that all informants have used medicinal plants for over five years and inherited knowledge of their preparation and application from their parents, siblings, and ancestors. This inheritance is a sign of the informants' deep respect for

their ancestors and cultural heritage, a connection that the audience can surely relate to. The informants mainly found the herbal plants they used in the surrounding environment. In addition, plants are widely available throughout the year and are easy to reach. Seasonal variations usually do not affect the plants mentioned by informants, indicating their availability throughout the year (Balinado and Chan 2017). Apart from the ethnomedicinal knowledge mentioned previously, informants also documented the use of herbal plants, the diseases they believe can be treated, how they are made, and how they are applied. Table 1 summarizes data regarding these traditional healthcare practices.

The Dumagats utilized various plant parts, such as the stem, trunk, sap, roots, fruit, heart of palm, bark, and leaves. In Figures 5, 6, and 7, plant species can fall into one or more categories if such plant part is used in such application or category. As shown in Figure 4, leaves are the most used plant part by Dumagats, accounting for 41% of the ethnomedicinal practices. This is also the case with the Dumagats of Casiguran, Aurora, where leaves are the most utilized plant for ethnomedicinal practices (Canceran et al. 2021). Bark accounted for 17% of Dumagats' ethnomedicinal practices, followed by fruit at 10%. The palm's trunk, roots, sap, and heart came next with 7% each, while the stem was the least used plant part, with 4% out of all the parts. According to the study by Gnanaraj et al. (2016), the leaves of *Flagellaria indica* (*baling-uai*) are believed by some to have additional medicinal benefits, including treating cough and vomiting. Furthermore, people consume the roots of *F. indica* to treat vomiting, influenza, and coughs (Haris et al. 2022).

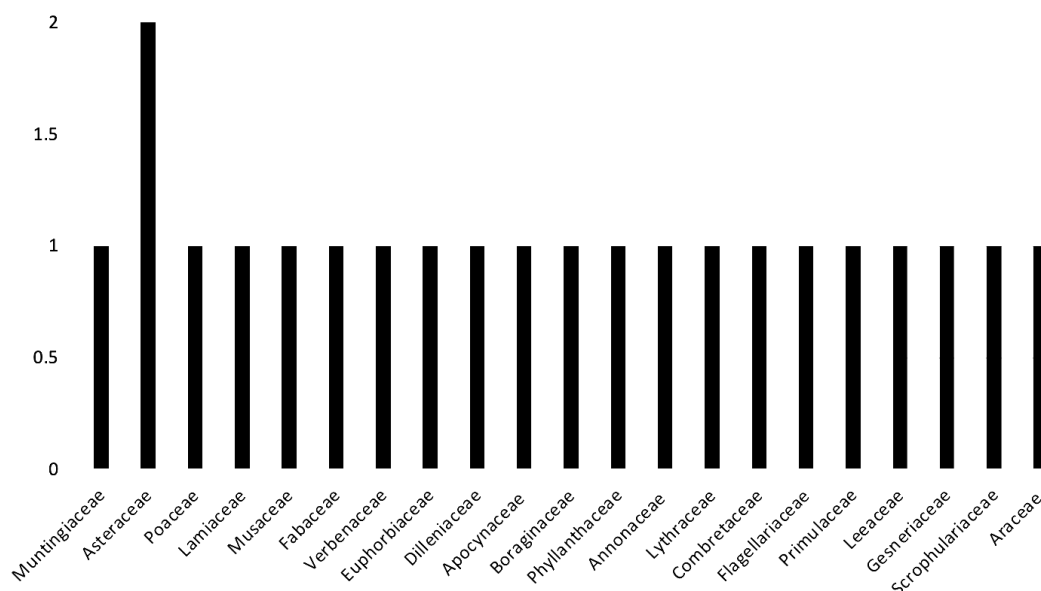


Figure 3. Family of ethnobotanical plants used by Dumagats of two selected barangays in Philippines

Table 1. List of ethnomedicinal plants used by Dumagats of two selected barangays in Philippines

Family ¹	Scientific name ¹	Local name	Common name	Plant part used ²	Mode of preparation ²	Mode of application ²	Ailment ²	Conservation Status ^{3,4}	Distribution record ³
Annonaceae	<i>Annona muricata</i> L.	<i>Guyabano</i>	Soursop	Leaves	Decoction	Taken orally	Diabetes, pneumonia	Not Evaluated	Central America, Caribbean
Apocynaceae	<i>Alstonia scholaris</i> (L.) Dita		Blackboard tree	Fruit	Decoction	Taken orally	Malaria	Not Evaluated	Australia, Borneo, China, India, Laos, Luzon, Mindanao, Visayas
Araceae	<i>Homalomena philippinensis</i> Engl.	<i>Tagupos</i>	Payau, emerald gem	Leaves	Directly heated	Taken orally	Cough	Not Evaluated	Luzon, Mindanao, Taiwan
Asteraceae	<i>Artemisia vulgaris</i> L.	<i>Damong maria</i>	Mugwort	Leaves	Directly heated	Taken orally	Cough, hyperacidity, Loss of appetite	Not Evaluated	Negros, Panay (Pantropic)
	<i>Blumea balsamifera</i> (L.) DC.	<i>Sambong</i>	Ngai camphor, sembung	Leaves	Directly heated	Direct application	Folk illness, numbness, stomach pain	Least Concern	Australia, Borneo, China, India, Java, Luzon, Mindanao, Visayas
Boraginaceae	<i>Cordia dichotoma</i> G. Forst.	<i>Anonang</i>	Indian cherry	Bark	Decoction	Taken orally	Fever, relapse	Not Evaluated	Borneo, Java, Luzon, Mindanao, New Guinea, Singapore, Sumatra, Visayas
Combretaceae	<i>Combretum indicum</i> (L.) DeFilipps	<i>Taryantan</i>	Rangoon creeper	Bark	Decoction	Taken orally	Cough, colds, Pneumonia, sprain	Not Evaluated	Bangladesh, China, India, Laos, Luzon, Mindanao, Myanmar, Visayas
Dilleniaceae	<i>Dillenia philippinensis</i> Rolfe	<i>Katmon</i>	Philippine dillenia, philippine katmon, elephant apple	Fruit	Directly heated, Decoction	Direct application	Cough, colds, fever	Not Evaluated	Luzon, Mindanao, Visayas
Euphorbiaceae	<i>Euphorbia hirta</i> L.	<i>Tawa-tawa</i>	Asthma weed, asthma plant, hairy spurge	Roots	Decoction	Taken orally	Cough, fever	Not Evaluated	America, Luzon, Visayas
Fabaceae	<i>Pterocarpus indicus</i> Willd.	<i>Narra</i>	Angsana	Trunk, Sap	Sap extraction	Direct application	Mouth sore	Vulnerable	Cambodia, Luzon, Malesia, Mindanao, Myanmar, Thailand, Visayas
Flagellariaceae	<i>Flagellaria indica</i> L.	<i>Baling-uai</i>	Whip vine	Heart of palm	Directly heated	Taken orally	Cough	Not Evaluated	Africa, Borneo, Cambodia, China, India, Luzon, Mindanao, Visayas
Gesneriaceae	<i>Cyrtandra incisa</i> C.B. Clarke in DC	<i>Katampas</i>	Katampas	Roots, Leaves	Decoction	Direct application	Indigestion	Not Evaluated	Luzon
Lamiaceae	<i>Coleus amboinicus</i> Lour.	<i>Oregano</i>	Indian borage, cuban oregano, mexican mint, spanish thyme	Leaves	Steamed, pounding	Direct application	Cough	Not Evaluated	Luzon

Leeaceae	<i>Leea philippinensis</i> Merr.	<i>Makasdo</i>	West indian holly	Leaves	Directly heated	Taken orally	Cough	Not Evaluated	Luzon, Mindanao, Taiwan, Visayas
Lythraceae	<i>Lagerstroemia speciosa</i> (L.) Pers.	<i>Banaba</i>	Queen crepe myrtle, rose of india	Fruit, leaves, bark	Decoction	Taken orally	Urinary tract infection	Not Evaluated	Borneo, Cambodia, China, India, Laos, Luzon, Mindanao, Visayas
Muntingiaceae	<i>Muntingia calabura</i> L.	<i>Aratiles</i>	Jamaica cherry	Bark	Decoction	Taken orally	Dysentery	Not Evaluated	Luzon, Mindanao, Visayas
Musaceae	<i>Musa</i> sp.	<i>Saging matsing</i>	Banana	trunk	Directly heated	Direct application	Mouth sore	Not Evaluated	Borneo, China, India, Java, Laos, Luzon, Mindanao, Visayas
Poaceae	<i>Saccharum spontaneum</i> L.	<i>Talahib</i>	Wild sugarcane	Leaves, stem	Directly heated, pounding	Taken orally, direct application	Cough, fever	Not Evaluated	Africa, Australia, Luzon, Mindanao, Visayas
Primulaceae	<i>Embelia philippinensis</i> A. DC.	<i>Lando</i>	Dikai	Leaves	Directly heated	Direct application	Fever	Not Evaluated	Luzon, Mindanao, Visayas
Phyllanthaceae	<i>Antidesma bunius</i> (L.) Bignay	<i>Bignay</i>	Chinese laurel	Bark	Decoction	Taken orally	Urinary tract infection	Not Evaluated	Borneo, China, India, Java, Laos, Luzon, Mindanao, Visayas
Scrophulariaceae	<i>Buddleja asiatica</i> Lour.	<i>Tanaw dagat</i>	Dog tail, malasambung, butterfly bush	Leaves	Directly heated	Taken orally	Cough, fever	Not Evaluated	China, India, Luzon, Malesia, Mindanao, Pakistan, Taiwan, Visayas
Verbenaceae	<i>Vitex negundo</i> L.	<i>Lagundi</i>	Chaste tree	Leaves	Decoction	Taken orally	Cough, fever	Not Evaluated	China, India, Java, Luzon, Mindanao,

Note: ¹Jose Vera Santos Memorial Herbarium verified data at the University of the Philippines, Diliman, ²Data were derived from the ethnobotanical survey of informants, ³(Pelser et al. 2011), ⁴(IUCN 2024)

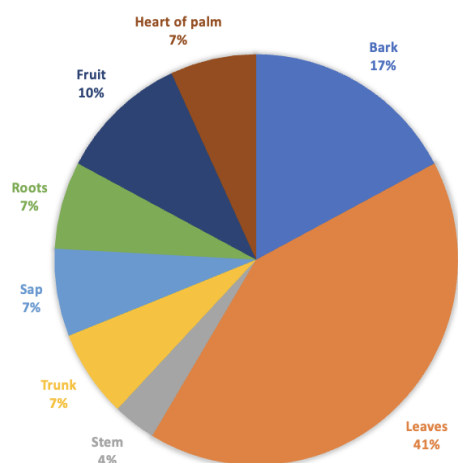


Figure 4. Percentage analysis of plant parts used for ailments treated

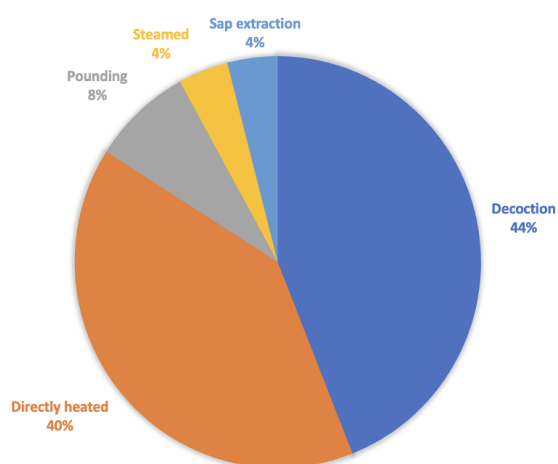


Figure 5. Percentage analysis of methods of preparation by Dumagats in Philippines

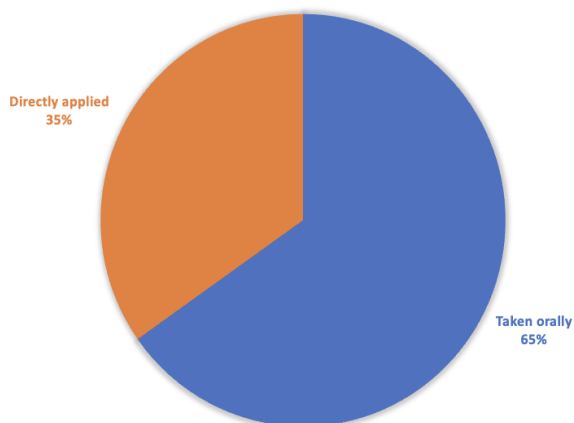


Figure 6. Percentage analysis of methods of application by Dumagats in Philippines

In Figure 5, the preferred preparation method for Dumagats is decoction (44%), followed by direct heating (40%). This is consistent with other Dumagats in Casiguran, Aurora (Canceran et al. 2021). Ethnomedicinal plants in Sitio Manalo and Sitio Iyak are commonly boiled. *V. negundo* (*lagundi*) and *L. speciosa* (*banaba*) are boiled for 30 minutes. The hearts of *F. indica* (*baling-uai*) and *S. spontaneum* (*talahib*) are heated until sap appears. *D. philippinensis* (*katmon*) fruit is either decocted or directly heated. Pounding is used to obtain plant extracts, notably for *S. spontaneum* and *C. amboinicus* (*oregano*). Steaming and cutting are the least used methods. *P. indicus* (*narra*) is prepared by cutting the trunk for sap. *C. amboinicus* is also steamed over rice. The Dumagats obtain a sap extract of *Pterocarpus indicus* (*narra*) to treat mouth sores (Canceran et al. 2021). Furthermore, Dharmaraj et al. (2022) views *P. indicus* as a potential source of natural anti-inflammatory substances that could aid in treating inflammation.

Administration methods can be internal or external; of 22 reported medicinal plant species, 65% are taken orally, whereas the remaining 35% are applied directly to the skin, as seen in Figure 6. The most preferred way of administering the plant is through an oral route. Since cough is the most common ailment, people typically consume the plants orally. Hussaqin et al. (2014) and Hassan et al. (2024) found that *Saccharum spontaneum* (*talahib*) leaves have the potential to treat respiratory problems, and the stems have demonstrated efficacy in addressing general debility. *Annona muricata* (*guyabano*) is one of the medicinal plants studied in Tarlac that has an antihyperglycemic effect (Mina and Mina 2017). The same study used the leaves of *A. muricata* for a tea decoction. Different plant parts of *Muntingia calabura* (*aratiles*) are used as antiseptics, diuretics, and laxatives. Chaudhari et al. (2020) also uses this to treat conditions like diarrhea, dysentery, and asthma.

The use of medicinal plants is a testament to the individualized nature of healthcare. These plants are usually applied directly to affected body areas, and there are no standard measurements for administering herbal remedies. Instead, dosages are tailored to each patient, considering their age, condition, and level of relief. For instance, young people may receive less than adults. This personalized approach respects the unique needs of each patient. *Musa* sp. is a prime example of this, as it can potentially treat anti-inflammatory ailments using several plant parts, including the leaf, sap, and trunk (Yadav 2021).

Based on the consolidated data in Table 2, the following plants had the highest UV in the two barangays: *A. vulgaris* (UV = 0.57), *S. spontaneum* (0.57), *B. balsamifera* (0.57), and *D. philippinensis* (0.57). This demonstrates these plants' extensive use, high value, and perceived effectiveness in the reported barangays. Plant species sensitive to high UV levels face intense harvest pressure and require extra conservation measures. Most medicinal plants used in the research area are confirmed to be cultivated, ensuring they do not threaten to pose a threat to their wild counterparts (Albuquerque et al. 2006).

Table 2. Number of Use Reports (UR) and its calculated Use Value (UV) of reported ethnomedicinal plants

Family	Scientific name	Local name	Use reports ¹	Use value ¹
Asteraceae	<i>Artemisia vulgaris</i> L.	<i>Damong maria</i>	4	0.57
	<i>Blumea balsamifera</i> (L.) DC.	<i>Sambong</i>		
Dilleniaceae	<i>Dillenia philippinensis</i> Rolfe	<i>Katmon</i>		
Poaceae	<i>Saccharum spontaneum</i> L.	<i>Talahib</i>		
Fabaceae	<i>Pterocarpus indicus</i> Willd.	<i>Narra</i>	2	0.28
Flagellariaceae	<i>Flagellaria indica</i> L.	<i>Baling-uai</i>		
Lamiaceae	<i>Coleus amboinicus</i> Lour.	<i>Oregano</i>		
Muntingiaceae	<i>Muntingia calabura</i> L.	<i>Aratiles</i>		
Musaceae	<i>Musa</i> sp.	<i>Saging matsing</i>		
Verbenaceae	<i>Vitex negundo</i> L.	<i>Lagundi</i>		
Annonaceae	<i>Annona muricata</i> L.	<i>Guyabano</i>	1	0.14
Apocynaceae	<i>Alstonia scholaris</i> (L.) R.Br.	<i>Dita</i>		
Araceae	<i>Homalomena philippinensis</i> Engl.	<i>Tagupos</i>		
Boraginaceae	<i>Cordia dichotoma</i> G. Forst.	<i>Anonang</i>		
Combretaceae	<i>Combretum indicum</i> (L.) DeFilipps	<i>Taryantan</i>		
Euphorbiaceae	<i>Euphorbia hirta</i> L.	<i>Tawa-tawa</i>		
Gesneriaceae	<i>Cyrtandra incisa</i> C.B. Clarke in DC	<i>Katampas</i>		
Leeaceae	<i>Leea philippinensis</i> Merr.	<i>Makasdo</i>		
Lythraceae	<i>Lagerstroemia speciosa</i> (L.) Pers.	<i>Banaba</i>		
Phyllanthaceae	<i>Antidesma bunius</i> (L.)	<i>Bignay</i>		
Primulaceae	<i>Embelia philippinensis</i> A. DC.	<i>Lando</i>		
Scrophulariaceae	<i>Buddleja asiatica</i> Lour.	<i>Tanaw dagat</i>		

Note: ¹(Zenderland et al. 2019)

Table 3. LC₅₀ was obtained using Brine Shrimp Lethality Assay in 6, 12, 18, and 24 hours post-treatment of the plant extracts and controls

Treatment	Time			
	6 hours	12 hours	18 hours	24 hours
Potassium dichromate	0.000	0.000	0.000	0.000
<i>A. vulgaris</i>	0.953	0.859	0.732	0.706
<i>C. amboinicus</i>	0.832	0.685	0.591	0.338
<i>B. balsamifera</i>	1.000	1.000	0.826	0.706
No concentration	1.000	1.000	0.900	0.800

Brine Shrimp Lethality Assay

The present study assesses the cytotoxicity of selected ethnomedicinal plants used by the Dumagats. The results reveal cytotoxicity in plant extracts and other compounds based on their ability to cause death in lab-cultured brine shrimp larvae (nauplii), supporting the use of chosen ethnomedicinal plants in traditional medicine.

Table 3 displays the LC₅₀ values obtained through experimentation with brine shrimp as test subjects. The results of the current study were comparable to Waghulde et al. (2019), who found that the extent of lethality is directly proportional to the extract's concentration. The constant LC₅₀ values of 1 mg/mL at 6 hours and 12 hours, 0.900 mg/mL at 18 hours, and 0.800 mg/mL at 24 hours indicate that the brine shrimp in the control group (no concentration) did not experience any adverse effects within the given time frames. Among the substances tested, potassium dichromate demonstrates a remarkably high level of toxicity, as evidenced by an LC₅₀ value of 0.00000 mg/mL at 6 hours of exposure. Additionally, the data indicates a time-dependent increase in toxicity for *A.*

vulgaris, as indicated by the decreasing LC₅₀ values over longer exposure periods. Specifically, a concentration of 0.953 mg/mL was lethal to 50% of the brine shrimp within 6 hours, while concentrations of 0.859 mg/mL, 0.732 mg/mL, and 0.706 mg/mL caused similar mortality rates within 12, 18, and 24 hours, respectively.

Inducing *C. amboinicus* resulted in an LC₅₀ value of 0.832 mg/mL at 6 hours, indicating that about half of the brine shrimp population died at that concentration. At 12 hours, the value dropped to 0.685 mg/mL, suggesting a lower concentration was required to maintain the same mortality rate. The concentration dropped to 0.591 mg/mL after 18 hours and 0.338 mg/mL after 24 hours. The results for *B. balsamifera* showed that it was toxic to brine shrimp for about 6 to 12 hours, with an LC₅₀ value of 1 mg/mL at both times. This means that the same concentration was needed to get a 50% death rate. However, at 18 hours, the LC₅₀ value decreased to 0.826 mg/mL, indicating that a lower concentration of *B. balsamifera* was required to achieve the same effect. Furthermore, at 24 hours, the LC₅₀ value decreased further to 0.706 mg/mL, suggesting that the brine shrimp's sensitivity to *B. balsamifera* exposure increased over time.

Findings from the brine shrimp lethality assay show that the survival rates of the negative control group (no concentration) stayed at the expected level. This is because there was no substance or experimental treatment in that group. This provides a baseline for comparison when evaluating the potential toxicity or effects of substances tested in the experimental group. On the other hand, results for the positive control suggest that even minute concentrations of potassium dichromate can lead to a considerable reduction in the brine shrimp population within a specified timeframe.

Findings also suggest prolonged exposure to *A. vulgaris* results in a higher toxicity level for the brine shrimp population. As for *C. amboinicus* and *B. balsamifera*, the LC₅₀ values demonstrated that the brine shrimp's sensitivity to both plant extract exposures increased as the duration of exposure increased. Wagholde et al. (2019) also found that the shrimp started to die after prolonged exposure to higher concentrations of treatment extracts.

We used Clarkson's et al. (2004) criteria to infer the toxicity of extracts tested in the brine shrimp lethality assay. Clarkson et al. (2004) categorized the extract as non-toxic at concentrations greater than 1.00 mg/mL, mildly hazardous around 0.50 and 1.00 mg/mL, moderately toxic within 0.10 and 0.50 mg/mL, or very toxic below 0.10 mg/mL. Therefore, based on the results after 24 hours, potassium dichromate is considered very toxic, *A. vulgaris* is mildly hazardous, *C. amboinicus* is moderately toxic, and *B. balsamifera* is also mildly hazardous. As expected, no concentration is non-toxic.

Artemisia vulgaris (damong maria)

As stated in the study by Chan and Lin (2010), *A. vulgaris* contains thujones, which can be the reason for its toxicity. Aronson (2016) found in another study that *A. vulgaris* contains the toxic lactone santonin, once used as an anthelmintic drug to kill or stun parasitic worms but now replaced by less toxic compounds. According to Scott (2005), lactones can act as sedatives and antispasmodics; however, some lactones exhibit neurotoxic effects and can also cause skin sensitizing or irritation. On the other hand, santonin is a sesquiterpene lactone most frequently found in the Asteraceae plant and isolated from santonin-containing *Artemisia* species (Wedge et al. 2000). Based on the same study by Aronson (2016), depending on the origin of the plant, major components can be 1,8-cineole, camphor, linalool, and thujone.

According to Hoch et al. (2023), 1,8-cineole (Eucalyptol) clinical applications include treating rhinosinusitis, chronic obstructive pulmonary disease, asthma, and bronchitis. Meanwhile, medicinal practitioners use camphor as an antipruritic, mild analgesic, and counterirritant. However, camphor can cause generalized seizures because it acts as a CNS stimulant. It also acts as a local mucosal irritant and can cause hepatic failure in severe intoxications (Adkins 2024). In the psychopharmacological evaluation of mice, Elisabethsky (2002) revealed anticonvulsant properties (dose-dependent, marked sedative effects at the CNS). Romm et al. (2010) found that internal consumption of thujone, as practiced by the Dumagats, can be neurotoxic, convulsant, and hallucinogenic. Long-term and excessive use of thujone-rich products can cause restlessness, vomiting, vertigo, tremors, renal damage, and convulsions.

In 2016, Judzentiene and Garjonyte (2016) investigated the different parts of *A. vulgaris* essential oils and their toxicity. They found that the main parts were davanones (13.8-45.5%, six oils), germacrene D (9.1-30.5%, four oils), 1,8-cineole (16.4%, one oil), camphor (18.9%, one oil), trans-thujone (8.9 and 10.9%, two oils), and cis-chrysanthenyl acetate (10.4%, one oil). Judzentiene and

Garjonyte (2016) were the first to describe *A. vulgaris* davanone chemotype and obtain LC₅₀ values using the brine shrimp assay. The results, after 24 hours of exposure, revealed that the oils containing appreciable amounts of germacrene D, 1,8-cineole, camphor, and davanone were notably toxic, of which two of the components (1,8-cineole and camphor) were also previously mentioned.

Blumea balsamifera (sambong)

Masyudi et al. (2022) used ethanol and ethyl acetate to test sambong extracts for phytochemicals. They found that steroids, flavonoids, phenolics, and phenolics were present. Pang et al. (2014) have isolated 100 volatile and non-volatile constituents from *B. balsamifera*. Its volatile constituents, which were the primary active ingredients, contain most of these components. These volatile constituents encompass a range of compounds, including terpenoids, fatty acids, phenols, alcohols, aldehydes, ethers, ketones, pyridines, furans, and alkanes. On the other hand, flavonoids, such as flavonoid, flavanone, and chalcone components, constitute the primary non-volatile elements in *B. balsamifera*. Sesquiterpene lactones (SLs), found in many Asteraceae plants, are among the compounds discovered (Pang et al. 2014). The same study identified three sesquiterpene lactones: blumealactone A, blumealactone B, and blumealactone C. Fujimoto et al. (1988) extracted these compounds from dried *B. balsamifera* leaves using 90% ethanol. Moreover, terpenoids are a common class of compounds in *B. balsamifera*, and their cytoskeleton types include monoterpenoids, sesquiterpenes, diterpenes, and triterpenes, among others (Wang et al. 2023). Sesquiterpene lactones, particularly, have garnered interest due to their cytotoxic properties and potential as agents against tumors. Clarkson's et al. (2004) toxicity index suggests the mildly harmful result may be due to the sesquiterpene lactones in *B. balsamifera*'s ethanolic extract.

Coleus amboinicus (oregano)

Arumugam et al. (2016) assert that *oregano*'s natural phytochemical components with their nutritional and medicinal properties, are important to the pharmaceutical industry. The literature review identified 76 volatile and 30 non-volatile compounds, including monoterpenoids, diterpenoids, triterpenoids, sesquiterpenoids, phenolics, flavonoids, esters, alcohols, and aldehydes. *P. amboinicus* is rich in oxygenated monoterpenes, monoterpene hydrocarbons, sesquiterpene hydrocarbons, and oxygenated sesquiterpenes. Like *A. vulgaris* and *B. balsamifera*, it contains flavonoids and sesquiterpenes contributing to its cytotoxicity. It is particularly rich in phenolic monoterpenes such as thymol and carvacrol, which have various pharmacological properties. However, scientific validation of traditional uses is needed to authenticate novel bioactive compounds from *C. amboinicus*. While cytotoxicity assays like BSLA and TBA provide initial toxicity data, further testing in more complex biological systems, including animal models and human clinical trials, is necessary to determine its human toxicity.

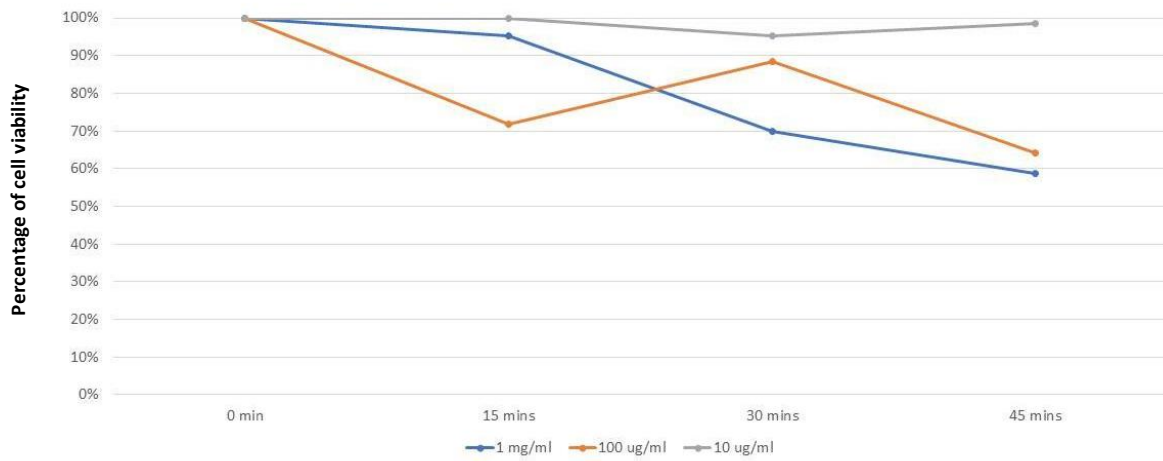


Figure 7. *Artemisia vulgaris* cell viability for different concentrations (1 mg/mL, 100 µg/mL, 10 µg/mL) under different exposure times (15, 30, and 45 minutes)

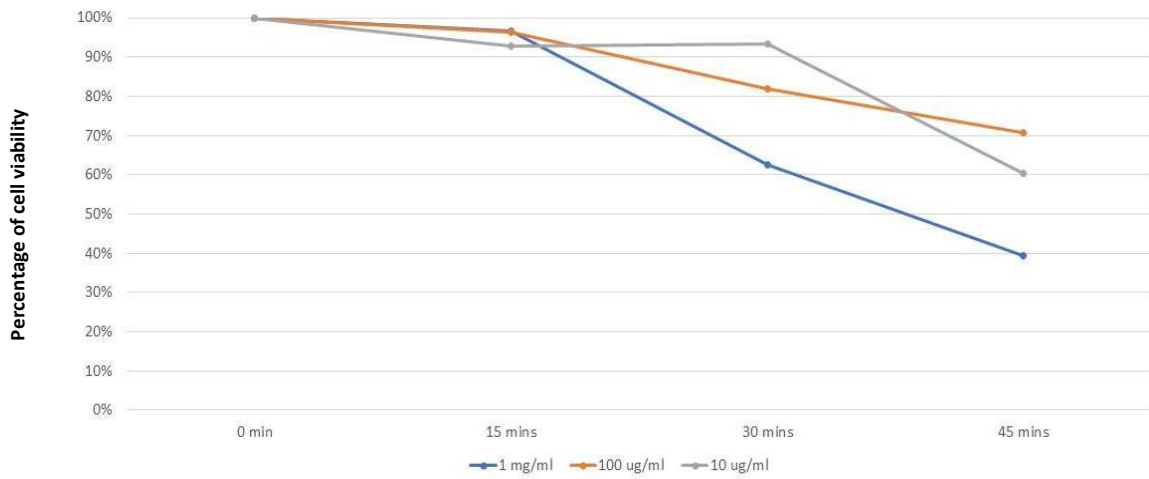


Figure 8. *Coleus amboinicus* cell viability for different concentrations (1 mg/mL, 100 µg/mL, 10 µg/mL) under different exposure times (15, 30, and 45 minutes)

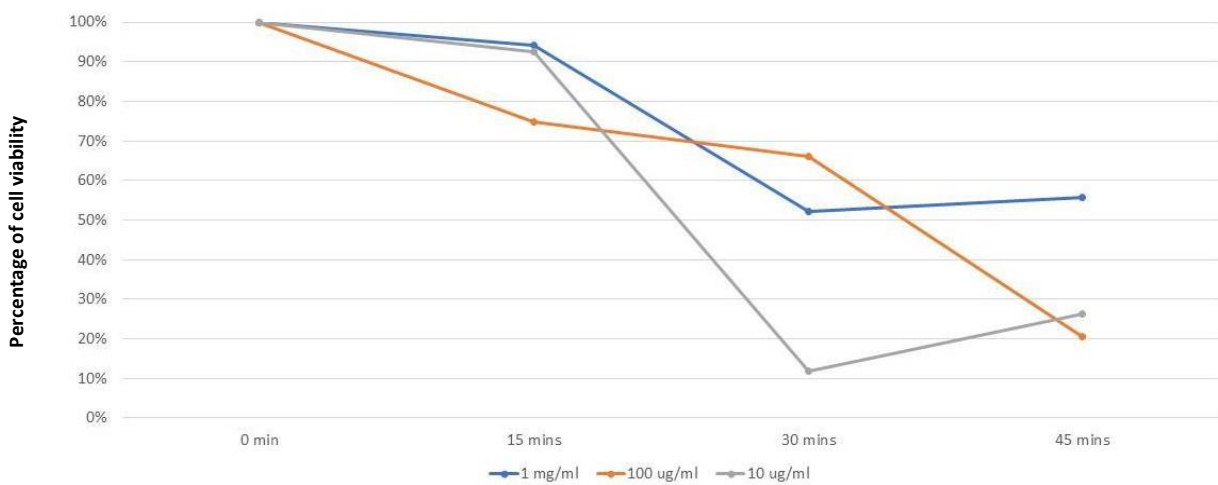


Figure 9. *Blumea balsamifera* cell viability for different concentrations (1 mg/mL, 100 µg/mL, 10 µg/mL) under different exposure times (15, 30, and 45 minutes)

Trypan Blue Assay

The assessment of the cytotoxic effects of *A. vulgaris* on cell viability at various concentrations and exposure durations unveiled several significant patterns as seen in Figure 7. During the 15-minute exposure period, the cell viability at the highest concentration of 1 mg/mL was 95.29%, indicating a consistently high level of viability. Nevertheless, when the concentration was set at 100 µg/mL, the viability of the cells decreased to 71.75%, suggesting a notable decrease. Notably, the lowest 10 µg/mL concentration could sustain full cell viability at 100%. These findings indicate that even brief exposure to moderate concentrations can negatively impact cell viability. However, cells appear more resilient when exposed to higher doses for shorter periods, showing minimal loss of viability.

There was a clear decrease in cell viability as the exposure time reached 30 minutes. With an elevated concentration of 1 mg/mL, the viability of cells decreased to 69.86%, indicating a rise in cytotoxicity after prolonged exposure. The cell viability was higher (88.35%) for the medium concentration (100 µg/mL) than for the 15-minute exposure. There are a couple of possibilities for this observation. It could indicate that cells adapt or suggest that the experimental conditions are being altered. At a concentration of 10 µg/mL, there was a minor decline in viability to 95.29%. This suggests that lower concentrations have a relatively minimal long-term impact.

During the 45-minute exposure period, the cytotoxic effects became more evident. Cell viability decreased to 58.68% at 1 mg/mL concentration and reduced to 64.29% at 100µg/mL. The results demonstrate a noticeable decrease in cell viability as the concentration and exposure time increase. Nevertheless, the 10 µg/mL concentration consistently exhibited a high cell viability of 98.5%, indicating that lower concentrations of *A. vulgaris* are considerably less harmful to cells even with prolonged exposure.

In 2009, a study by Emami et al. (2009) examined the anticancer effects of five different species of *Artemisia* on Hep2 and HepG2 cell lines. It was discovered that *A. vulgaris* can eliminate these cell lines due to the presence of sesquiterpene lactones, terpenoids, and flavonoids. A recent study by Jakovljević et al. (2020) discovered that *A. vulgaris* has cytotoxic effects attributed to its flavonoids and phenolic compounds. It was evident from the results that higher concentrations of 50, 100, and 250 µg/mL led to an increased presence of micronuclei in peripheral blood lymphocytes. Combining these compounds with mitomycin C resulted in cytotoxic effects while not significantly impacting the viability of human periodontal ligament stem cells. Essential oils, specifically the essential oil derived from the leaves, have been found to induce apoptosis in different cancer cell types while sparing normal cells. According to Saleh et al. (2014), this indicates that they may have the potential to serve as a novel class of anticancer medications.

As presented in Figure 8, the cells' viability has remained impressively high throughout the 15-minute exposure period for *C. amboinicus*, the cells' viability has

remained impressively high, regardless of the concentrations. At the highest concentration of 1 mg/mL, the cell viability was 96.7%, whereas at 100 µg/mL, it was slightly lower at 96.25%. At a concentration of 10 µg/mL, there was a slight decrease in cell viability to 92.84%. The findings suggest that short-term exposure to *C. amboinicus* does not significantly impact cell viability even when exposed to higher concentrations; short-term exposure to *C. amboinicus* does not significantly impact cell viability. This implies that there is a relatively low immediate cytotoxic effect.

With an increase in exposure time to 30 minutes, a noticeable decline in cell viability became evident, especially at higher concentrations. At the highest concentration of 1 mg/mL, there was a notable decrease in cell viability to 62.5%, suggesting considerable cytotoxicity after prolonged exposure. The viability of the intermediate concentration (100 µg/mL) was reduced to 81.93%, although it remained higher than the highest concentration. Notably, the lowest concentration of 10 µg/mL exhibited a remarkable cell viability of 93.24%, comparable to the results observed during short-term exposure. It can be inferred that lower concentrations of *C. amboinicus* have a relatively minimal impact over a reasonably long duration.

During the 45-minute exposure period, the cytotoxic effects became even more evident. When the concentration was at 1 mg/mL, the cell viability dropped significantly to 39.37%, indicating a notable rise in cytotoxicity after prolonged exposure. The viability of the intermediate concentration (100 µg/mL) was significantly reduced to 70.74%. The cell viability decreased significantly even at the lowest concentration (10 µg/mL), reaching 60.33%. This suggests prolonged exposure to *C. amboinicus* at any concentration reduces cell viability, with a more pronounced effect observed at higher concentrations.

A study conducted by Hasibuan and Rosidah in 2017 found that increasing the concentration of extracts reduced cell viability. The presence of phenolic compounds, specifically carvacrol and thymol, in *C. amboinicus* is the reason for this. The compounds mentioned in the study have been found to impact cancer cells significantly. They promote apoptosis, disrupt cell membranes, and enhance cytotoxicity and ROS levels, increasing oxidative stress in cancer cells (Pinheiro et al. 2015). *C. amboinicus* also contains flavonoids and sesquiterpenes, contributing to its cytotoxic effects on cells (Arumugam et al. 2016).

ANOVA					
Viability	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	11069.914	2	5534.957	6.280	0.003
Within Groups	68744.653	78	881.342		
Total	79814.567	80			

Figure 10. ANOVA results for cell viability with three plant extracts

Figure 9 shows during the 15-minute exposure period, the cell viability remained consistently high for most concentrations. At the highest 1 mg/mL concentration, the cell viability was 94.14%, suggesting minimal immediate cytotoxic effects. The 100µg/mL concentration exhibited a significant decrease to 74.74%, whereas the lowest concentration of 10µg/mL demonstrated a high cell viability of 92.5%. These findings indicate that brief exposure to *B. balsamifera*, especially at lower concentrations, has a lesser impact on cells.

Nevertheless, a longer exposure time resulted in a significant reduction in cell viability. After 30 minutes, 1 mg/mL concentration caused a significant decrease in cell viability, which dropped to 52.15%. The concentration of 100µg/mL displayed a moderate decrease to 65.98%, whereas the lowest concentration of 10 µg/mL demonstrated a significant reduction in cell viability to 11.86%. It can be observed that the cytotoxic effects of *B. balsamifera* become more noticeable with prolonged exposure, particularly at lower concentrations. This could imply a threshold effect, where lower concentrations are more lethal over extended periods.

The 45-minute exposure period it provided additional evidence of the cytotoxic effects of *B. balsamifera*. The 1 mg/mL concentration exhibited a modest increase in cell viability, reaching 55.8%. This observation may suggest the presence of a cellular adaptation mechanism or experimental variability. The concentration of 100 µg/mL demonstrated a notable reduction in cell viability to 20.65%, while the lowest concentration of 10 µg/mL yielded a viability of 26.21%. The results of this study emphasize the significant cytotoxic effect that occurs with prolonged exposure, especially at intermediate and low concentrations. This finding suggests a complex relationship between the dose and response.

The cytotoxic effects of *B. balsamifera* are mainly attributed to its non-volatile constituents, specifically flavonoids. A study by Pang et al. (2014) and Tan et al. (2013) discovered combining ultrasound and 30% ethanol can effectively extract flavonoids such as blumeatin, velutin, and quercetin, resulting in a concentrated solution. Scientists recognized the medicinal properties of these flavonoids, including their capacity to induce cytotoxicity. In addition, the plant contains other non-volatile compounds, such as sterols and sesquiterpene lactones, which can potentially be used as antitumor agents (Fujimoto et al. 1988).

Figure 10 shows data on the viability percentages of three different plants: *A. vulgaris* (*damong maria*), *C. amboinicus* (*oregano*), and *B. balsamifera* (*sambong*). Viability, expressed as a percentage, reflects the health and vitality of these plants under certain conditions. The results indicate no statistically significant difference in viability between the plant groups ($F = 6.280$, $p = 0.003$). However, intriguing trends emerge upon closer examination of the mean viability percentages. *Damong maria* demonstrates the highest mean viability at 80.17%, followed by *oregano* at 73.87% and *sambong* at 52.83%. Though the overall difference is not significant, it's noteworthy that *sambong* exhibits substantially lower viability compared to the other

two plants. The post-hoc tests, which provide additional insights, revealed that *sambong's* viability was significantly lower than that of *damong maria* (mean difference = -27.34, $p = 0.003$) and *oregano* (mean difference = -21.04, $p = 0.029$) at a 0.05 significance level. Moreover, examining the data for each plant individually provides additional context. For *damong maria*, a trend shows a decrease in viability with increasing concentration, with the highest average viability seen at 10 µg/mL (94.71%) and the lowest at 1 mg/mL (69.69%). Similarly, *oregano* showed a slight decrease in viability at higher concentrations, whereas *sambong* showed variability over a wide range of concentrations without a clear trend.

In conclusion, this study highlighted the critical role of traditional healing practices in Indigenous communities' healthcare systems and advocated for ongoing research and collaboration to preserve these practices. The study looked at the pharmacological properties of plant extracts from *A. vulgaris*, *C. amboinicus*, and *B. balsamifera*. It showed that the cytotoxic effects changed depending on the concentration and time. Findings indicated significant cytotoxicity at higher concentrations and variable responses at lower concentrations, highlighting the importance of precise dosage optimization and exposure duration. The study further recommended the need for advanced assays to elucidate the mechanisms of cytotoxicity and suggested similar studies in other indigenous tribes to document and preserve their medicinal knowledge. This approach supported the sustainability of traditional practices and assisted in discovering new therapeutic agents, emphasizing integrating traditional knowledge with modern scientific methods in drug discovery.

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Ethno-botanical study on medicinal plant species utilized by Marma community of Wagga Union in Rangamati Hill District, Bangladesh

TUSHER KUMER RAY¹, SHOURAV DUTTA^{2*}, SANJOY DAS¹, KANCHAN CHAKMA³

¹Bangladesh Forest Research Institute, Sholashahar, Chattogram-4000, Bangladesh

²Department of Forestry and Environmental Science, Faculty of Agricultural and Biological Sciences, Rangamati Science and Technology University, Rangamati-4500, Bangladesh. Tel.: +8801319052645, *email: shourav.forestry@gmail.com

³Department of Biochemistry and Molecular Biology, University of Chittagong, Chattogram-4331, Bangladesh

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Abstract. Ray TK, Dutta S, Das S, Chakma K. 2024. *Ethno-botanical study on medicinal plant species utilized by Marma community of Wagga Union in Rangamati Hill District, Bangladesh. Asian J Ethnobiol 7: 105-114.* The utilization of medicinal plant species to cure various health-related ailments is a common practice among the ethnic communities of Bangladesh. This study, conducted in Wagga Union of Kaptai upazila, Rangamati hill district, Bangladesh, aimed to document indigenous traditional knowledge (ITK) regarding using ethnomedicinal plants to cure various diseases. The extensive field data collection and various established ethnobotanical survey methods revealed significant findings. The results recorded a total of 53 medicinal plant species belonging to 53 genera and 38 families from the study area, generally used to treat 51 diseases. The family most widely used in the context of the number of medicinal plant species is Asteraceae (9%), followed by Apocynaceae (7%), Amaranthaceae (6%), and Rubiaceae (6%). The research results revealed that leaves are the most widely used plant part (40%) utilized by the local Marma community to make herbal medicine, followed by the whole plant (17%) and roots (14%). The results showed that ethnomedicinal plants were most widely utilized to treat fever (13.21%) and jaundice (11.32%). This study emphasizes the significance of documenting the indigenous traditional knowledge (ITK) of sustainable natural resource management in biodiversity-rich forest areas, fostering a sense of responsibility and commitment.

Keywords: Bangladesh, ethnomedicine, indigenous traditional knowledge, Marma community, medicinal plants

INTRODUCTION

Plants have been utilized for medicinal purposes long before prehistoric times (Ghani 2003). Medicinal plant species, generally used for traditional medicinal systems (e.g., Ayurveda, Unani, Folk medicine, etc.) along with numerous allopathic medicinal practices, play a significant role in the primary healthcare systems for the majority of rural people (Hamayun et al. 2003; Paul et al. 2019). The World Health Organization (WHO) estimated that more than 80% of people in the developing world rely on traditional medicine, and most medicines are directly derived from various plant species (Senthilkumar et al. 2013). Simultaneously, the acceptance and use of plant-based medicines are increasing globally (Tugume et al. 2016). The indigenous people of different countries living in nature have first-hand knowledge of plant benefits, including medicinal values. The indigenous communities gradually utilized plant species not only to treat various ailments but also as preventive measures against different ailments (Rahmatullah et al. 2011).

Additionally, several important modern pharmaceuticals have been derived from different plant parts used by indigenous communities, including antibiotics, anti-malarial drugs, cardio-tonic, sympathomimetic, and parasympathomimetic (Balick and Cox 1996). Historically, forest inhabitants and ethnic communities of developing countries like Bangladesh use medicinal plant species as herbal remedies from the ancient periods, and the

utilization of various medicinal plant species in rural Bangladesh is considered a traditional heritage (Rahmatullah et al. 2011; Paul et al. 2019). Ethnic people still depend on local medicinal plant species for the treatment of different diseases, and they have their own traditional medicinal practitioners, locally known as *Baidhya*, who process the parts of medicinal plant species for therapeutic as well as preventive purposes (Mohiuddin et al. 2012; Sarker et al. 2013). The knowledge of such healthcare uses has been going on for centuries from ancestors to offspring of the ethnic communities in verbal form by traditional herbal healers and elderly persons in their communities (Paul et al. 2019).

Several researchers (Kadir et al. 2012; Uddin 2014) reported that numerous ethnic communities (about 12) reside in the Chittagong Hill Tracts (CHTs) of Bangladesh. However, currently, the indigenous healthcare knowledge of the Marma community of Wagga Union, Kaptai Upazila, Bangladesh, is at great risk due to the existence of various external threats like allopaths, homeopaths, etc. Furthermore, ethno-medicinal knowledge and medicinal plant resources are depleting at an alarming rate nowadays due to the availability of modern medical facilities and other socio-economic factors. Recent research findings by Uddin et al. (2013), Faruque et al. (2019), and Islam et al. (2020) indicated, that social issues, urbanization, and modernization, the impact of advanced medication, the unwillingness of the younger generation toward traditional treatment systems, etc., are key reasons for the extinction

of the indigenous knowledge on medicinal plant utilization. Suppose the present trend of eroding status prevails; in that case, the valuable knowledge possessed by the indigenous Marma people on available medicinal plants will be lost forever without being properly recorded and documented (Uddin 2014; Paul et al. 2019). Few works have been found on ethnomedicinal plant species of Chittagong Hill Tracts, conducted by several researchers (Alam 1992; Rahman 1997; et al. 1998; Chakma et al. 2003; Uddin et al. 2004; Yusuf et al. 2002, 2005, 2006). Nevertheless, no inventory on focusing medicinal plant species of the Wagga Union of Kaptai Upazila, Rangamati Hill District, and their medicinal role in Marma Ethnics has been found.

Hence, an attempt has been made to comprehensively document the usage of medicinal plant species for the treatment of various diseases, as practiced by the indigenous practitioners of Marma community residing in Wagga Union of Kaptai Upazila, Rangamati Hill District, Bangladesh. The study was conducted to elucidate the distribution and abundance of medicinal plant species belonging to different families across the study area and conserve the endangered Marma-based ethno-medicines. The specific objective of this study was to determine the utilization pattern of medicinal plants and preparation approaches of herbal medicines by traditional herbal healers for curing numerous diseases across the study area. Simultaneously, the study dispensed several policy recommendations to conserve and sustain the ITK of the study area.

MATERIALS AND METHODS

Study area

The present investigation was carried out for about one year, from June 2021 to June 2022, at Wagga Union in Kaptai Upazila, Rangamati Hill District of Bangladesh. The Kaptai Upazila consists of 5 unions (i.e., Chandraghona, Chitmaram, Kaptai, Raikhali, and Wagga); 10 Mauzas; and 144 villages with an estimated population

of more than 66,000 people (BBS 2001). The region has a tropical climate with heavy rainfall intensified in the monsoon period (Feroz et al. 2014). Wagga Union is geographically located in the biodiversity-rich zone of Kaptai Upazila (Figure 1). The general features of the Wagga Union are expressed in Table 1.

Experimental design of the study

The experimental design of this study includes a reconnaissance survey (pre-fieldwork), the development of the questionnaire, the selection of the respondents (traditional herbal healers/herbalists) from the Marma community of the Wagga Union, extensive fieldwork, data collection, and compilation, and finally, data analysis and scientific representation of the key findings.

Reconnaissance survey

Kukimara Marma para at Wagga Union of Kaptai Upazila, Rangamati Hill District, was selected for the investigation due to its geophysical location, accessibility, availability, and abundance of the desired communities. Before the main research, a reconnaissance survey/pre-fieldwork (field observation) was conducted in the study area to attain a general idea regarding the physiographic and overall conditions of the study site, with particular attention to ethnic majorities, species composition, the occurrence of medicinal species, and activities of herbal practitioners. Such observation provided a basis to carry out the in-depth principal investigation.

Sampling design

A total of 8 field trips were conducted from June 2021 to June 2022 to determine the utilization pattern of different medicinal plant species among the residents of Wagga Union, Kaptai Upazila, Bangladesh. Considering their proximity and availability, traditional herbal healers were selected from the study area. The community and respondents were selected randomly using a random number table proposed by Nath et al. (2013).

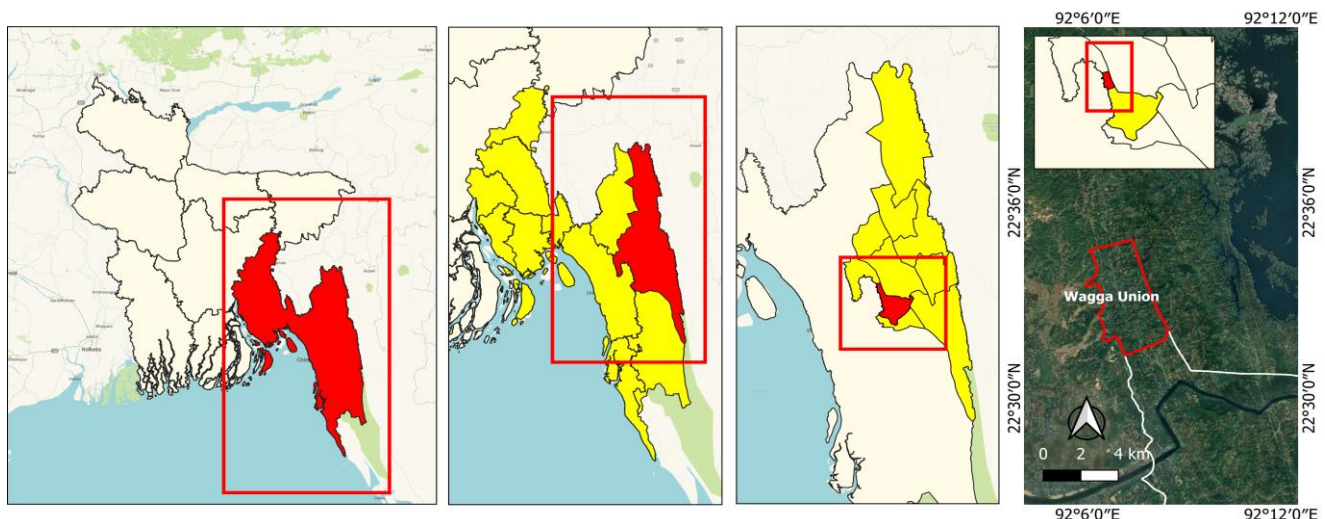


Figure 1. Study area at Wagga Union in Kaptai Upazila, Rangamati Hill District of Bangladesh

Table 1. General features of the Wagga Union of Kaptai Upazila, Rangamati Hill District, Bangladesh

Parameters	Data	Sources
Geographic features		Chowdhury et al. (2020); BBS (2001); ULR (2021)
Area (acre)	12,160	
Latitude	22°21' and 22°35' North	
Longitude	92°05' and 92°18' East	
Average annual rainfall (mm)	2,653	
Soil type	Clay and sandy silt	
Demographic features		
Population	9,170	
Male (%)	52.4	
Female (%)	47.6	
Major ethnicity	Marma, Chakma, Thanchangya	
Minor ethnicity	Tripura, Murang, Khayang, Pankhoa	
Literacy rate (%)	43.93	
Income sources	Agriculture (41%), service (37%), commerce (12%), transport (2%), remittance and others (8%)	

Data collection through interviews and Focus Group Discussions (FGDs)

Ethnomedicinal information about the study area was collected by applying different established ethnobotanical survey methods. A total of 25 herbal healers (locally called *baidya*) were selected randomly and then interviewed with a pretested semi-structured questionnaire to collect information on herbal treatments. The *baidyas* that been directly involved with the herbal treatment processes for a long time were selected for this survey. The interview schedule was designed to attain all relevant information regarding medicinal plant resources and their utilization in the study area. Information was collected on the mentioned local names of plants, uses, methods of uses, formulations, diseases for which the formulations were utilized, and dosages. Information was also collected on the season of plant collection, which plant parts were used, application of the processed medicines, etc.

Data validation

Collected information was validated through five Focus Group Discussions (FGDs). Specifically, FGD was used in the clarification of information gathered. Each FGD consists of 7-8 (minimum) persons, including herbal healers, local community leaders (headmen), local villagers, resource collectors, members of the administrative unit, and resource-dependent persons. An interpreter who translated the Marma language (locally known as *Marama/Mraima*) into Bengali was involved in data collection and sharing. The authors identified the common plant samples in the field, and the unidentified species were preserved in the herbarium sheet and finally identified with the help of plant taxonomists. Voucher specimens were deposited in the herbarium of Bangladesh Forest Research Institute (BFRI), Chattogram, Bangladesh. Simultaneously, several types of literature, published articles, publications, institutional data, etc. checked out and reviewed as secondary data during the study.

Data analysis and representation of the findings

All the collected qualitative and quantitative data were gathered and sorted cautiously using spreadsheet software (Microsoft Excel, version MS 2010). Then, the sorted data was compiled and analyzed to obtain the desired findings. The final results of this study are expressed scientifically through tables, graphs, and pictures.

RESULTS AND DISCUSSION

Distribution of medicinal plant species recorded from the study area

The study enumerated a total of 53 medicinal plant species belonging to 53 genera from the study area, which are used in treating different ailments by the studied Marma community; the plants were distributed into 38 families. All the recorded medicinal plant species were categorized based on their habit form and classified under genus and family. Herb constitutes the major plant category (21 species) among the 53 medicinal plant species and occupies (39.7%) of all the recorded plants, followed by shrub (26.4%), tree (24.5%), and climber (9.4%). The distribution of medicinal plant species under four major vegetation types (habit forms) is shown in Figure 2.

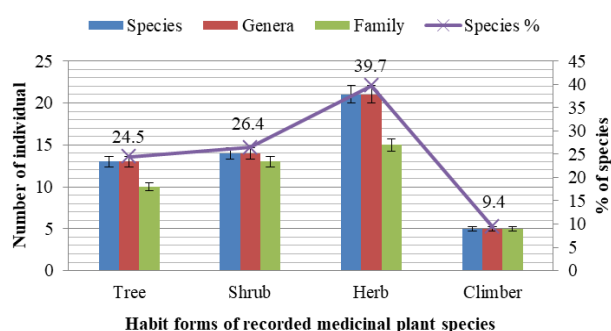
**Figure 2.** Distribution of various medicinal plant species recorded from the study area

Table 2. Marma ethnic communities across the study area utilize medicinal plant species to treat different health-related ailments

Scientific name	Family	Vernacular/ Bengali name	Marma name	Habit	Plant parts used	Ailment
<i>Achyranthes aspera</i> L.	Amaranthaceae	<i>Apang</i>	<i>Nairahang creung</i>	Herb	Root	Abdominal pain
<i>Aerva sanguinolenta</i> (L.) Blume.	Amaranthaceae	<i>Bishallyakarani</i>	<i>She shan da</i>	Herb	Whole plant	Stomach pain
<i>Allophylus cobbe</i> (L.) Raeusch.	Sapindaceae	<i>Rakhalphul</i>	<i>Maygransi</i>	Shrub	Leaf	Joint pain, gout, paralysis
<i>Alpinia conchigera</i> Griff.	Zingiberaceae	<i>Konchi elachi, khetranga</i>	<i>Pada gru</i>	Herb	Rhizome	Gastric problem
<i>Alstonia scholaris</i> (L.) R. Br.	Apocynaceae	<i>Chhatim, chhatian</i>	<i>Chuinui pang, chai lang</i>	Tree	Bark	Joint pain, chronic diarrhea, dysentery, fever, earache
<i>Amaranthus spinosus</i> L.	Amaranthaceae	<i>Kantanotey, kantadenga</i>	<i>Mong gue pang</i>	Herb	Whole plant	Burning urination
<i>Anogeissus acuminata</i> Roxb. ex DC.	Combretaceae	<i>Chakwa, kanta koroï, itchri, hitchri</i>	<i>Samankhuum</i>	Tree	Leaf	Diarrhea, dysentery, anemia, toothache
<i>Blumea lacera</i> (Burm.f.) DC.	Asteraceae	<i>Kuksunga</i>	<i>Pongma</i>	Herb	Leaf, root	Toothache
<i>Bryophyllum pinnatum</i> (Lam.) Oken	Crassulaceae	<i>Patharkuchi</i>	<i>Wakhia pangboo</i>	Herb	Leaf	Asthma, gallstone, cough
<i>Buddleja asiatica</i> Lour	Buddlejaceae	<i>Budbhota, neemda, badbhota</i>	<i>Lulangbow</i>	Shrub	Leaf	Skin diseases
<i>Byttneria pilosa</i> Roxb.	Sterculiaceae	<i>Harbangha lota</i>	<i>Choloibri</i>	Climber	Leaf	Boils
<i>Clerodendrum viscosum</i> Vent.	Verbenaceae	<i>Ghetu, bhat</i>	<i>Khung prik chai</i>	Shrub	Whole plant	Boils
<i>Crinum latifolium</i> L.	Liliaceae	<i>Sukhdarshan</i>	<i>Kegaincrac scoain</i>	Herb	Tuber	Stomach pain
<i>Cuscuta reflexa</i> Roxb.	Cuscutaceae	<i>Swarnalata, algusi, halde algusi lata</i>	<i>Jirgo nuya</i>	Herb	Whole plant	Jaundice, intestinal worms
<i>Desmodium triquetrum</i> (L.) DC.	Fabaceae	<i>Kodalía</i>	<i>Kingmring</i>	Shrub	Whole plant	Fistula, piles
<i>Emblíca officínalis</i> Gaertn.	Euphorbiaceae	<i>Amloki</i>	<i>Chachabang</i>	Tree	Whole plant	Digestive problems, skin disease
<i>Equisetum diffusum</i> D. Don	Equisetaceae	<i>Kurkure jhar, ashalah</i>	<i>Rossa crassa</i>	Herb	Stem	Muscle stiffness
<i>Ficus hispida</i> L. f.	Moraceae	<i>Dumur</i>	<i>Khanaung</i>	Tree	Leaf	Gastric problem
<i>Flueggea virosa</i> (Roxb. ex Willd.) Baill.	Phyllanthaceae	<i>Khaukra, shikori</i>	<i>Craw yong</i>	Shrub	Whole plant	Smallpox
<i>Gynura pseudochina</i> (L.) DC.	Asteraceae	<i>Nurachina</i>	<i>Mring seba</i>	Herb	Leaf	Snake bite
<i>Heliotropium indicum</i> L.	Boraginaceae	<i>Hatishur</i>	<i>Saimagri</i>	Herb	Leaf	Injured muscle
<i>Hibiscus surattensis</i> L.	Malvaceae	<i>Ram bhindi</i>	<i>Pungru mra</i>	Shrub	Leaf	Itching, tumor
<i>Hymenodictyon orixense</i> (Roxb.) Mabb.	Rubiaceae	<i>Kali-kadam, bhui-kadam</i>	<i>Khujai, chuung paing craw</i>	Tree	Leaf, bark	Snakebite, jaundice
<i>Ichnocarpus frutescens</i> (L.) R. Br.	Apocynaceae	<i>Shamalata</i>	<i>Tabu chi</i>	Climber	Leaf	Hemorrhage
<i>Imperata cylindrica</i> (L.) Beauv.	Poaceae	<i>Uluhor</i>	<i>Chida chon</i>	Herb	Root	Burning urination
<i>Jasminum scandens</i> Vahl	Oleaceae	<i>Ban-juí</i>	<i>Nacheraung</i>	Shrub	Whole plant	Paralysis, sexual disease, insect bites
<i>Justicia adhatoda</i> L.	Acanthaceae	<i>Basak</i>	<i>Shin mang gree</i>	Shrub	Leaf	Cough, asthma, fever
<i>Leucas zeylanica</i> (L.) R. Br.	Lamiaceae	<i>Shetadrone</i>	<i>Pai sung cha</i>	Herb	Leaf, root	Joint pain, fever, insomnia, gout, paralysis
<i>Litsea glutinosa</i> (Lour.) C. B. Rob.	Lauraceae	<i>Kukurchita, meda</i>	<i>Chak show</i>	Tree	Bark	Fracture healing
<i>Maesa indica</i> (Roxb.) A. DC.	Myrsinaceae	<i>Ramjoni</i>	<i>Thah mong shu</i>	Shrub	Whole plant	Fever, headache, dizziness
<i>Maranta arundinacea</i> L.	Marantaceae	<i>Arrarut</i>	<i>Siksa dery</i>	Herb	Rhizome	Cold, cough
<i>Melastoma malabathricum</i> L.	Melastomataceae	<i>Bon tej pata</i>	<i>Quaindium</i>	Shrub	Root	Satanophobia
<i>Melia azedarach</i> L.	Meliaceae	<i>Goranim, kawanim, mahanim, bokain</i>	<i>Agoroi</i>	Tree	Leaf, root	Diarrhea
<i>Mikania cordata</i> (Burm. f.) Robinson	Asteraceae	<i>Assam lata, refuzi lata, toofani lata, taru lata</i>	<i>Rifuzi nuiyee moi dui nuiyee</i>	Herb	Young, fresh leaf	Hemorrhage

<i>Mimosa pudica</i> L.	Mimosaceae	<i>Lajjaboti, sarminda</i>	<i>Thrapayeng, khrapaing</i>	Shrub	Whole plant	Abscess, lymphedema
<i>Molineria capitulata</i> (Lour.) Herb.	Hypoxidaceae	<i>Dhoti sara, satipata</i>	<i>Awlee</i>	Herb	Stem	Stop bleeding, fracture healing
<i>Moringa oleifera</i> Lam.	Moringaceae	<i>Sajna, sajina</i>	<i>Daing tho rai</i>	Tree	Leaf, bark	High blood pressure, rheumatic pain, cough, headache
<i>Neolamarckia cadamba</i> (Roxb.) Bosser	Rubiaceae	<i>Kadam, bul-kadam</i>	<i>Mou bang, rang khi</i>	Tree	Leaf	Liver disease
<i>Nyctanthes arbor-tristis</i> L.	Oleaceae	<i>Sheuli</i>	<i>Chhia raja</i>	Herb	Leaf	Tonsils
<i>Oroxylum indicum</i> (L.) Kurz	Bignoniaceae	<i>Khona, thona</i>	<i>Croncha</i>	Tree	Bark	Jaundice
<i>Paederia foetida</i> L.	Rubiaceae	<i>Gondho badali</i>	<i>Nuyebok</i>	Climber	Whole plant	Rheumatic pain, stomach pain
<i>Pandanus foetidus</i> Roxb.	Pandanaceae	<i>Keyakata</i>	<i>Thasu sua</i>	Herb	Stem	Hydrocele
<i>Piper longum</i> L.	Piperaceae	<i>Pepul</i>	<i>Shin mang thui</i>	Shrub	Leaf	Breast pain
<i>Plumeria rubra</i> L.	Apocynaceae	<i>Kat golap, chalta golap, golak champa</i>	<i>Anggra bang</i>	Tree	Bark	Anemia, facial paralysis, jaundice, piles, asthma
<i>Premna esculenta</i> Roxb.	Verbenaceae	<i>Lalana, lalong</i>	<i>Kamarah</i>	Shrub	Leaf, bark	Fever, headache, abdominal pain, high blood pressure, respiratory problems
<i>Rauvolfia serpentina</i> (L.) Benth ex Kurz	Apocynaceae	<i>Sarpagandha</i>	<i>Bongmaraja</i>	Shrub	Leaf, root, bark	Constipation
<i>Scoparia dulcis</i> L.	Scrophulariaceae	<i>Bandhoney</i>	<i>Tang-ganja</i>	Herb	Leaf	Toothache
<i>Sonchus wightianus</i> DC.	Asteraceae	<i>Ban palang</i>	<i>Pema, tougmula</i>	Herb	Root	Constipation, gastric problems
<i>Stephania japonica</i> (Thunb.) Miers	Menispermaceae	<i>Akandi manik</i>	<i>Tung nah way</i>	Climber	Whole plant	Constipation
<i>Stereospermum colais</i> (Buch.-Ham. ex Dillwyn) Mabb.	Bignoniaceae	<i>Dharmara, pahari awal, atkapali</i>	<i>Saing sek pang</i>	Tree	Bark	Intestinal worms
<i>Syzygium cumini</i> (L.) Skeels	Myrtaceae	<i>Jam, kala jam</i>	<i>Sochi tobri</i>	Tree	Bark	Jaundice, dysentery
<i>Thunbergia grandiflora</i> Roxb.	Acanthaceae	<i>Neel lota</i>	<i>Laksui nuye</i>	Climber	Stem	Eye allergy
<i>Vernonia cinerea</i> (L.) Less.	Asteraceae	<i>Kukshim</i>	<i>Rakhain</i>	Herb	Root	Fever

The abundance of medicinal plant species among different families

The study revealed the abundance of recorded plant species from different families varied enormously. About 44% of plant species were represented by 8 dominant families, whereas 30 families represented the rest of the 56% of species. Among the dominant plant families, Asteraceae contained the highest number of species (9%), followed by Apocynaceae (7%), Amaranthaceae (6%), Rubiaceae (6%), Bignoniaceae (4%), Acanthaceae (4%), Verbenaceae (4%), and Oleaceae (4%) (Figure 3).

Medicinal ailments and uses of the recorded plant species

The value of recorded plant species was assessed based on several criteria, e.g., the frequency of utilization, the number of ailments treated, and the parts of the plant used. The healers' reliance on specific plants for treating multiple ailments highlighted their perceived efficacy and importance within the community. During the study, interviews and focus group discussions revealed variations in using certain plants. While most herbal healers agreed on the use of specific plants for common ailments, there were instances of contradictory uses. For instance, some herbal healers used a particular plant to treat fever, while others used the same plant for gastrointestinal issues. These contradictions indicate the dynamic and diverse nature of traditional knowledge within the Marma community of the study area. All the recorded plant species were listed along with their scientific name, local name, Marma name, family, habit, used parts, and illness treated. Table 2 represents each species' scientific and local name, family name, part(s) used, and diseases treated.

This study documented the use value of different medicinal plant species utilized by the Marma community. Most of the plants recorded during the study had multiple uses. The medicinal plant species used to cure different ailments by the Marma community were herbs 38% (20 species), followed by shrubs 26% (14 species), trees 25% (13 species), and climbers 11% (6 species) (Figure 4).

Utilization of plant parts for folk medicine preparation

The study revealed that Marma community of the study area uses various plant parts, e.g., leaf, stem, root, rhizome,

bark, fruit, flower, and tuber, to treat multiple diseases. Among the plant parts, leaves constituted the major plant part-used category (40%) for treating ailments, followed by whole plant (17%), root (14%), and bark (13%). Other plant parts, i.e., stem (8%), rhizome (5%), flower (1%), fruit (1%), and tuber (1%), were also used for the preparation of medicines (Figure 5).

Preparation of the herbal medicines by the traditional herbal healers in the study area

In the study area, it was observed that local herbal healers (*baiddyas*) process plant parts and prepare herbal medicines by applying different methods. One of the most common methods of herbal medicine preparation in the study area is manufacturing liquid juice (using extract or sap of any medicinal plant part). Other observed herbal medicine preparation techniques are paste preparation, powder manufacturing, decoction (boiling plant parts), mixtures (soaking plant parts in water) production, shower, etc. Local herbal healers (*baiddyas*) of the study area gradually prepare various herbal medicines by blending the ingredients (as pastes, juices, or decoctions) of plant parts with a variety of substances (e.g., honey, spices, milk, oils, chemicals, and/or other pharmacological agents).

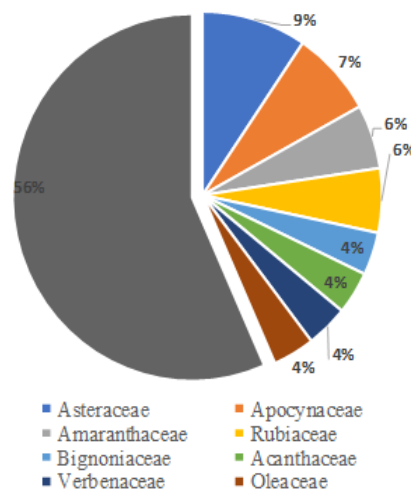


Figure 3. Abundance of medicinal plant species belonging to different families

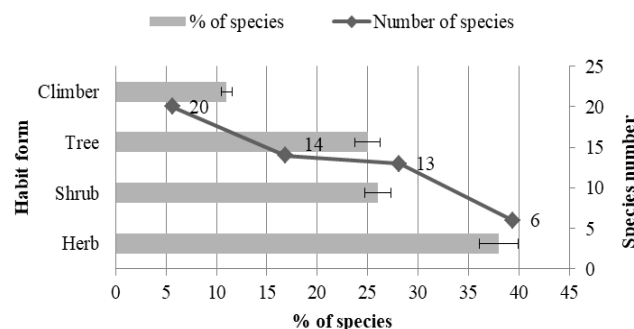


Figure 4. Percentage of recorded medicinal plant species belonging to various vegetation types used by the Marma community across the study area

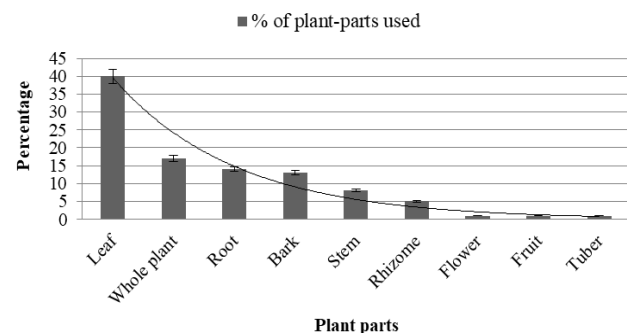


Figure 5. Distribution (%) of plant parts used in folk medicine preparation

Leaf juices are the major ingredients used to treat numerous diseases by the Marma herbal healers in the study area. Leaf juices of *Melia azedarach* are used for treating diarrhea by herbal healers. Leaves of *Justicia adhatoda* are highly used for treating cough, asthma, and fever. Traditional herbalists processed the leaves of *Heliotropium indicum* to cure the injured muscle. Leaf juices of two rare plant species, i.e., *Gynura pseudochina* and *Hymenodictyon orixense*, are utilized to treat snakebite by the Marma herbal healers. Moreover, leaf juices of *Alstonia scholaris* used directly on skin lesions in cases of wounds, dermatitis, and earache. Leaf juices and pastes of *Moringa oleifera* are applied to treat high blood pressure, rheumatic pain, cough, and severe headache. Meanwhile, traditional herbal healers apply leaf juice in the case of painful diseases or the paste of the leaves and massage directly at the human organ of pain.

This study indicated that about 13.21% plants were used to treat fever followed by jaundice (11.32%), cough (9.43%), skin ailments (9.43%), stomach problem (9.43%), toothache (9.43%), asthma (7.55%), burning urination (7.55%), diarrhea (7.55%), dysentery (7.55%), headache (7.55%), different types of pains (7.55%) and paralysis (7.55%). Gastric problems, boils, constipation, insect bites, satanophobia, anemia, hemorrhage, sexual diseases, and rheumatism are the other major complaints treated by local herbal healers (*baiddyas*). However, the *baiddyas* use about seven plant species to treat fever problems, indicating that this disorder is very common among the Marma community of Wagga Union, Kaptai Upazila, Bangladesh. Frequencies of various medicinal plant species used for curing numerous diseases are presented in Figure 6.

Discussion

The Marma community is one of the major ethnic communities residing at the Kaptai Upazila of Rangamati Hill District, Chittagong Hill Tracts (CHTs) in the southeast portion of Bangladesh. The Marma community of

Wagga Union of Kaptai Upazila utilizes diverse medicinal plant species to cure numerous daily ailments. This study was of interest to comprehensively document their traditional medicinal practices due to the long history and affluent tradition of their medicinal practices in this region. The study revealed that the richness of medicinal plant species and their utilization by the Marma community in the Wagga Union of Kaptai Upazila were comparatively higher than the medicinal plant composition of Bilaichari Union of Rangamati Hill District utilized by the local Pankho Community. Sarker et al. (2013) reported the utilization pattern of about 41 medicinal plant species belonging to 26 families for the preparation of herbal medicines by the herbal healers of Pankho community of Bilaichari Union in Rangamati Hill District, Bangladesh.

Key findings of this study revealed that Marma community utilizes 53 medicinal plant species belonging to 38 families, which is quite lower than that of Paul et al. (2019). An extensive study conducted by Paul et al. (2019) on medicinal plant utilization identified 125 plant species belonging to 46 families utilized by the Chakma Ethnic Communities in Rangamati and Khagrachari Hill Districts of Bangladesh.

This study identified and documented 53 medicinal plant species belonging to 38 families from the study area, which was comparatively higher than the research findings of Hossan et al. (2009). A study conducted by Hossan et al. (2009) on the Rakhine Ethnic inhabiting Chittagong Hill Tracts (CHTs) of Bangladesh identified 34 plant species belonging to 24 families. Figure 7 compares medicinal plant utilization by different ethnic communities (i.e., Chakma, Marma, Pankho, and Rakhine) in different parts of Bangladesh. The study's findings disclosed that the Marma ethnic community of the study area highly depends on conventional plant-based medication to remedy various diseases and for therapeutic purposes, which was consistent with the findings of similar research (Alam 1992; Yusuf et al. 2005; Hossan et al. 2009).

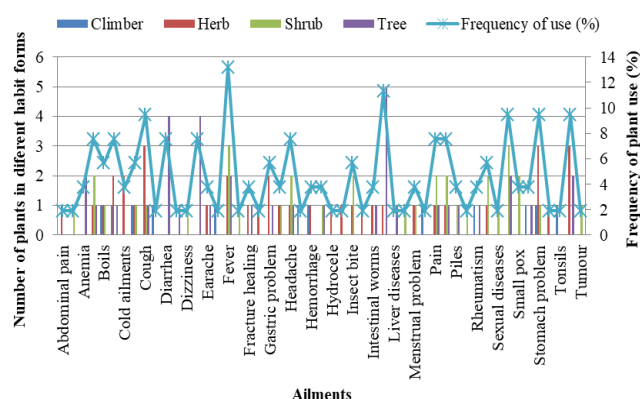


Figure 6. Frequency of medicinal plant species used for curing numerous diseases in the study area

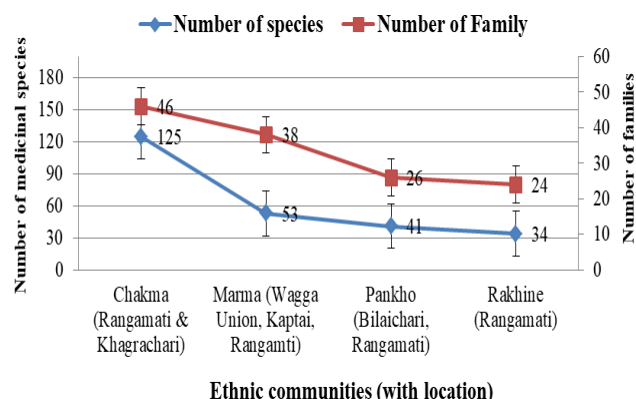


Figure 7. Medicinal plant utilization by different ethnic communities of Bangladesh

Marma ethnic communities of the study area have distinct traditional knowledge of using medicinal plant species for different purposes. The study identified that the Marma ethnic communities utilize different plants and plant parts to treat different diseases and illnesses as remedies in their daily life. The commonly treated disease/illness is fever caused by different flues. Some commonly treated diseases are Gastro-Intestinal Tract (GIT) disorders and respiratory problems such as diarrhea, dysentery, gastric and stomach pain, digestive disorders, cough and cold, influenza, etc. On the other hand, local herbal healers/ traditional practitioners of the Marma community utilize different medicinal plant species for dermatological ailments such as skin disease, jaundice, scurvy, scabies, general weakness with burning and headache, menstrual problems, vomiting, pain, urinary diseases, etc. Our findings consistently support similar research conducted by Yusuf et al. (2005) and Hossan et al. (2009).

From the field observation, it is assumed that many Marma ethnics are exploiting medicinal plants along with various non-wood forest products from the study area. Marma communities exploit medicinal plant species and collect different non-timber species for fuel, fencing, and other household necessities in the study area. These observations indicate that plant resources in the study area (especially medicinal plantations and non-timber forests) are decreasing alarmingly. This alarming decrease is not unique to our study area but is a common scenario in other hill regions of Bangladesh (Dutta et al. 2014a). Therefore, the need for scientific management and sustainable protection of plant resources in the study area is not just important but urgent.

This study recorded 53 medicinal plant species belonging to 38 families from the Wagga Union of Kaptai Upazila, which is comparatively lower than that of Dutta et al. (2014b). Dutta et al. (2014b) recorded 65 plant species having medicinal values from a nearby Botanical Garden and Ecopark located in the hill forests of Sitakunda, Chattogram, Bangladesh. From the study, it was confirmed that herbal healers of the Marma community are habituated to processing the leaves of different medicinal plant species for herbal medicine most of the time because leaves of various medicinal plants are available, easy to collect, easy to process, facile to conserve long-time as paste, juice, liquid or solid forms. Not only the Marma community of the study area but also other ethnic communities of the country utilize the leaves of numerous medicinal plant species, as mentioned by other researchers (Alam 1992; Chakma et al. 2003, 2021; Yusuf et al. 2005; Dutta 2016).

The investigation indicated that numerous medicinal plant species, i.e., *Bryophyllum pinnatum*, *Hibiscus surattensis*, *Jasminum scandens*, *Oroxylum indicum*, *Syzygium cumini*, etc., are utilized by the Marma community for the treatment of asthma, gallstone, and cough; itching and tumor; sexual disease; jaundice, dysentery, and diabetes etc. respectively, which is also reported by Chakma et al. (2021). Meanwhile, this study elucidated that various parts of the *Embllica officinalis* plant are highly utilized by the Marma Communities to treat

several health-related problems, e.g., digestive problems, fever, and skin diseases, which consistently support the results of similar research illustrated by Chowdhury et al. (2008).

Moreover, the study ensured the occurrence of several exotic plant species in the study area, severely harming nature and ecosystems. The study revealed the existence of various exotic plant species, i.e., *Mikania cordata* (Assamlata), *Mimosa pudica* (Lajjaboti), etc., in the study area that grow aggressively on other plants, though those plant species have tremendous medicinal values. Marma community residing across the study area utilizes those exotic plant species daily due to their potential medicinal value. Like Marma community of the study area, different ethnic communities of Bangladesh utilize a substantial number of exotic-medicinal plant species due to their numerous remedial qualities (Dutta et al. 2015). A study carried out by Dutta et al. (2015) reported that Tripura, Ethnic, and Hindu communities of Chattogram, Bangladesh, process several noxious weeds and exotic plant species, e.g., *M. cordata* (Assamlata), *M. pudica* (Lajjaboti), etc. for different medicinal purposes.

The research showed that the traditional ethno-medicinal knowledge of the Marma people and biodiversity was declining alarmingly. Therefore, the traditional ethno-medical knowledge of the Marma people living in the study area must be preserved by taking immediate initiatives and paying immediate attention to conservation strategies. This research is important in promoting sustainable natural resource management and preserving Indigenous Traditional Knowledge (ITK) in the Wagga Union of Kaptai Upazila by actively participating in community engagement and advocating for conservation efforts.

Overall, this study recommends that further research be conducted to preserve the traditional ethnomedicinal knowledge of the Marma community sustainably. It also suggests implementing large-scale cultivation programs of various medicinal plant species in the study area to conserve rare, endangered, and vulnerable medicinal plant species.

In conclusion, this study aimed to enumerate and document the medicinal plant species and their traditional uses by the Marma community in Wagga Union, Kaptai Upazila, Rangamati Hill District of Bangladesh. The study revealed that traditional treatment systems using medicinal plants are still prevalent. The findings indicate that modern scientific studies must be carried out on those plants for their rational scientific use, and steps should be taken to train local herbal healers (*baiddyas*). New compounds can be discovered to treat diseases through proper scientific investigation. Knowledge of traditional plant-based medicine in the Marma community has rapidly declined due to modern medical services, thereby depleting traditional knowledge and cultural diversity. Urgent initiatives must be taken to preserve the heritage of Marma community's plant-based medical practices. Moreover, the study should extend to other parts of the hill district of Bangladesh to discover unknown potential uses of medicinal plant species. Further research is needed to scientifically protect, preserve, and manage medicinal plant

resources and document Indigenous Traditional Knowledge.

During the study, collaborations and synergies with the local leaders and relevant stakeholders were performed to develop strategies for conserving medicinal plant species. Training and workshops were organized to inform the community about the significance of preserving traditional knowledge and issues about sustainable practices. The accomplishment of fruitful training programs on documenting and preserving traditional knowledge regarding medicinal plant utilization confirmed that future generations would benefit from these valuable resources.

The following recommendations were generated after revising the key findings of this explanatory study: (i) Indigenous Traditional Knowledge regarding medicinal plant collection and sustainable utilization should be thoroughly documented to ensure the reversion of plant-based medical practices in the study area. (ii) Regular motivational and awareness-raising programs regarding ethnomedicinal plant species and their benefits would be organized, involving local herbal healers and religious leaders of the ethnic communities. (iii) Protection and preservation of various medicinal plant species should be prioritized for sustainable management of natural resources in the study area. (iv) Large-scale plantation programs of medicinal plant species and sustainable nature management through community involvement should be considered as effective ways to improve the phyto-diversity in the study area.

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Harnessing local wisdom to conserve biodiversity on the southern coast of Gunung Kidul, Indonesia

RAHMA NUR SYAMSI¹, SYARIFAH HASNA ROSYIDA¹, TALITHA NASWA ALLYSA¹, WHENY HANIFAH¹, DIANTI¹, SUNARTO¹, IRFAN ABU NAZAR¹, DARLINA MD. NAIM², AHMAD DWI SETYAWAN^{1,3,✉}

¹Department of Environmental Science, Faculty of Mathematics and Natural Sciences, Universitas Sebelas Maret. Jl. Ir. Sutami 36A, Surakarta 57126, Central Java, Indonesia. Tel./fax. +62-271-663375, ✉email: volatileoils@gmail.com.

²School of Biological Sciences, Universiti Sains Malaysia. 1112, Persiaran Sains, 11800 Gelugor, Pulau Pinang, Malaysia

³Biodiversity Research Group, Universitas Sebelas Maret. Jl. Ir. Sutami 36A, Surakarta 57126, Central Java, Indonesia

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Abstract. *Syamsi RN, Rosyida SH, Allysa TN, Hanifah W, Dianti, Sunarto, Nazar IA, Md. Naim D, Setyawan AD. 2024. Harnessing local wisdom to conserve biodiversity on the southern coast of Gunung Kidul, Indonesia. Asian J Ethnobiol 8: 115-121.* Coastal biodiversity is a crucial component of ecosystems. However, it faces significant threats due to land use changes driven by increasing societal needs. Coastal areas are increasingly shrinking due to changes in land use and exploitation of areas such as the misuse of coastal land for fish ponds which should be designated as conservation areas. This situation impacts the sustainability of local communities and the management of resources, highlighting the role of communities in empowering local wisdom. This study aimed to understand the local wisdom of the coastal community in Kanigoro Village, Saptosari Sub-district, Gunung Kidul District, Yogyakarta Province, Indonesia in managing natural resources and conserving coastal biodiversity. The research used qualitative observational methods, including direct interviews with respondents. Data were collected through direct interviews with a total of 74 respondents, aged between 37-55 years, including five key respondents, and through Focus Group Discussions (FGD) on topics such as local wisdom, technological innovation, community participation, threats or challenges, and conservation strategies to understand the community's views on local biodiversity conservation. The results of this study revealed the presence of 17 protected species from 17 families. They identified three traditional customs still preserved today: *labuhan/larungan*, *musim gugur gunung*, and *rasulan*. The community continues to apply conservation principles rooted in local wisdom in their daily activities, such as prohibiting of catching and utilizing protected species, and forbidding the collection or harvesting of sand and coral to preserve these resources. The community plays an active role in preserving the biodiversity of wildlife and the surrounding environment. Local wisdom has the potential to sustain and strengthen ecosystem integrity, while improving the well-being of local communities by maintaining the availability of coastal biodiversity.

Keywords: Coastal biodiversity, coastal communities, conservation, local wisdom

INTRODUCTION

Indonesia has a very high level of coastal biodiversity, with a coastline length of 91,363.65 km in 2018 (Sui et al. 2020). Coastal areas are divided into several aspects, such as mangrove forests, coral reefs, and seagrass beds. Coastal biodiversity is crucial for survival as it can be utilized directly and sustainably. Over time, coastal biodiversity is increasingly threatened, necessitating the development of conservation strategies (Abidin et al. 2021).

Currently, coastal areas face significant threats due to land use changes driven by the growing demand for biodiversity. Coastal areas are shrinking due to land use changes and the exploitation of areas that should be designated for conservation, such as coral reef degradation caused by human activities and illegal fishing or marine animal capture. This will lead to a decline in the quality and quantity of natural resources and affect the survival of all surrounding life forms. The decline in biodiversity indirectly impacts and drives urgent needs, affecting socio-economic aspects (Purnomo et al. 2020). Therefore, conservation and preservation are necessary as sustainable approaches (Ren et al. 2020). The UN has agreed upon preserving, protecting, and conserving biodiversity within

ecosystems and established Sustainable Development Goals (SDGs).

Local wisdom reflects concern for the environment, natural conditions, traditions, or cultures that can fade and be forgotten over time (Marlina and Astina 2020). Local wisdom is closely related to the role of communities in preserving ecosystems, biodiversity, and local cultural heritage. The presence of communities has a vital element of local wisdom values, which are highly diverse (Supriati and Umar 2020). In environmental management, community involvement, particularly local wisdom, is essential as a sustainable action.

In the Kanigoro Village area, there are several coastal areas or beaches, including Pringjono Beach, Nguyahan Beach, Ngobaran Beach, Dadap Ayam Beach, Ngrenehan Beach, Torohudan Beach, and Ngrawah Beach, with three of them being specifically focused on research related to the empowerment of local wisdom in coastal communities. The value of local wisdom is primarily reflected in the presence of social groups applying conservation principles and natural resource management (Jape and Najar 2024). One example is Ngobaran Beach, well-known for its religious tourism, featuring several temples that attract domestic and international tourists. In addition to tourism,

the temples around Ngobaran Beach host several traditional ceremonies annually (Fatikah 2022). Empowering local wisdom in the community is an alternative approach to managing coastal biodiversity with marine potential. Over time, a coastal community has formed that aids all community elements in introducing effective coastal resource management practices, showing care for active and innovative management methods. Support from the local government is also necessary to enhance community management capabilities (Fitriana et al. 2022). The government should develop policy standards for these activities (Rizal et al. 2022).

By understanding traditional knowledge and practices that have proven effective, we can ensure the preservation of important heritage cultural and ecological legacies. This study aims to understand the local wisdom of coastal communities in Kanigoro Village, Saptosari Sub-district, Gunung Kidul District, Yogyakarta Province, Indonesia in managing natural resources and preserving coastal biodiversity.

MATERIALS AND METHODS

Study area

This study was conducted in March 2024 in Saptosari Sub-district, Gunung Kidul District, Yogyakarta Province, Indonesia (Figure 1). The research was specifically carried out in Kanigoro Village, with data also collected from the coastal residents of Nguyahan Beach, Ngobaran Beach, and Ngerenehan Beach. Gunung Kidul District is geographically located between 110°21' and 110°50' E and 7°46' and 8°09' S. The Saptosari Sub-district is approximately 341 meters above sea level and is about 18 km from Wonosari, the capital of Gunung Kidul District. The population of the Saptosari Sub-district is 38,323, with 18,958 males and 19,365 females, covering an area of 46.72 km². Saptosari Sub-district is divided into seven villages: Jetis, Kanigoro,

Kepek, Krambilsawit, Monggol, Ngloro, and Planjan (Ilmi 2021).

Research preparation

Research preparation included several stages: creating a list of questions using a spreadsheet, which is then used as a tool during direct interviews for data collection. A set of questions is also prepared for Focus Group Discussions (FGD). Preliminary research on data and the study area was conducted before data collection to ensure that the information obtained aligns with the research objectives. Additionally, preparations for surveying the research location were carried out before field observations.

Data collection

Data were collected through direct interviews and field observations at the research site. The data collection process included interviews and Focus Group Discussions (FGD) to understand community views on local wisdom related to coastal biodiversity. In-depth interviews were conducted at several research locations representing Kanigoro Village, involving 74 respondents, including five key informants (Table 1). The interviews aimed to gather direct data on local knowledge of coastal biodiversity, with respondents selected through purposive sampling based on specific characteristics such as age and occupation (Purwanto et al. 2024). Field observations involved exploring the research locations (Figure 2), with information from respondents used during these observations. This included documenting local traditions and customs as well as rare species to strengthen the data on how biodiversity conditions are influenced by local wisdom.

Data analysis

Data were analyzed descriptively. The obtained data were presented in tables containing information from observations, direct interviews, and FGDs (Dueñas et al. 2021).

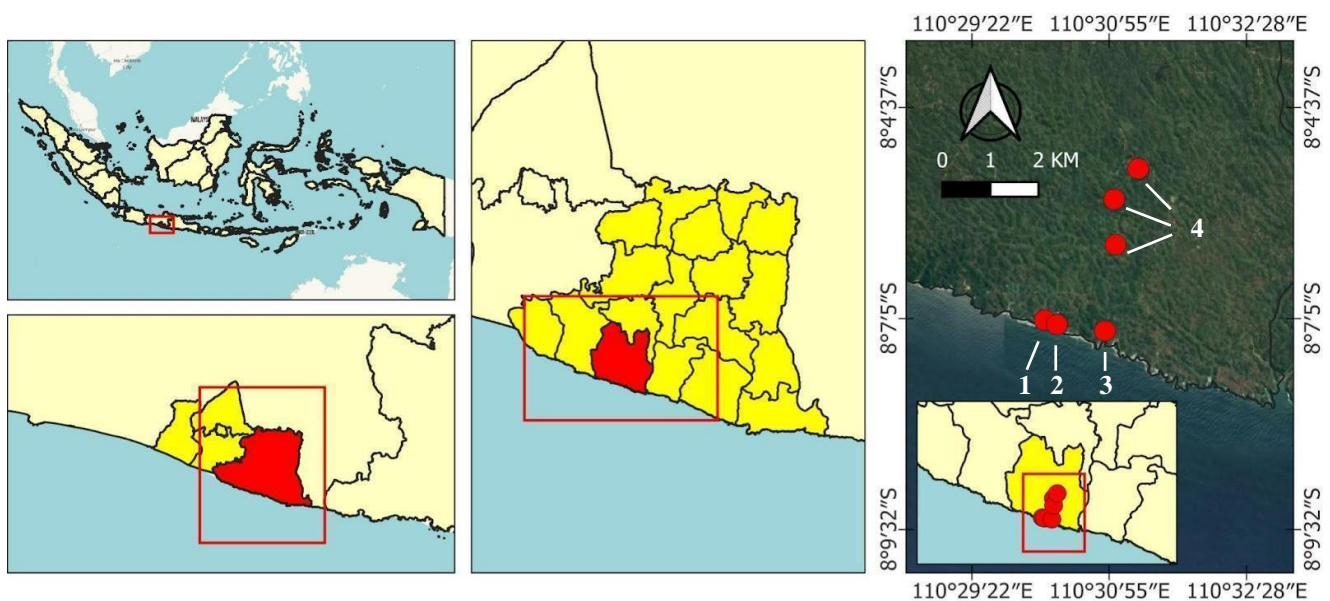


Figure 1. Map of the research area around the coast in Kanigoro Village, namely 1. Nguyahan Beach, 2. Ngobaran Beach, 3. Ngerenehan Beach, and 4. Around the village hall settlement, Saptosari Sub-district, Gunung Kidul, Yogyakarta, Indonesia



Figure 2. Ecosystems of some study areas in Kanigoro Village, Saptosari Sub-district, Gunung Kidul, Yogyakarta, Indonesia: A. Private temple belonging to a resident at Ngobaran Beach; B. Coastal ecosystem at Ngobaran Beach; C. Coastal ecosystem at Ngrenehan Beach; D. Religious site used for tourism at Ngobaran Beach; E. Religious tourism destination at Ngobaran Beach

RESULTS AND DISCUSSION

Respondent demographics

In this study, demographic data were collected from 74 respondents. The majority were 37 to 55 years old, totaling 39 respondents, or 52.7%. This was followed by the elderly age group (≥ 56 years), with 22 respondents, representing 29.7%, and the smallest group was those aged 18 to 36 years, with 13 respondents, or 17.6%. According to Silvano et al. (2020), differences in respondent numbers are influenced by profession, age, and geography. In this study, many respondents were fishermen because the research area is close to the coastal zone, with 33.8% of respondents in this profession. Additionally, a significant number of respondents were farmers and traders, with both professions predominantly occupied by the middle-aged group (37-55 years), representing 20.3% of respondents. Other professions related to the coastal area are listed in Table 1.

Furthermore, most respondents were female, totaling 43 respondents or 58.1%, followed by male respondents, who numbered 31 or 41.9% of the total. This is because female respondents were more frequently encountered at the research site, as they were trading around the beach and participating in beach conservation organizations or groups. These factors explain the significant demographic variability in different regions (Coppock and McClellan 2019).

Protected animals

Based on observations, 17 species from 17 different families are protected by the local community in Kanigoro Village. Table 2 presents the research data, showing several species with the same conservation status according to the IUCN Red List, such as green turtles (*Chelonia mydas* (Linnaeus, 1758)), manta rays (*Manta birostris* (Walbaum, 1792)), monkeys (*Macaca fascicularis* (Raffles, 1821)), whales (*Balaenoptera musculus* (Linnaeus, 1758)), rays (*Mobula* sp.), whale shark (*Rhincodon typus* (Smith, 1828)), all of which have an Endangered (EN) status. This status indicates that these species are at high risk of extinction shortly (Anrozi et al. 2023). In Kanigoro Village's coastal area, some species are rarely found and only appear at certain times (Harjiyatni et al. 2022). In some places, monkeys have already faced extinction due to

deforestation and the conversion of natural habitats into agricultural land, settlements, or other development projects, reducing their natural habitat (Murti and Maya 2021).

Leatherback turtles and red snapper, classified as Vulnerable (VU), risk becoming endangered. Red snapper is still commonly found and distributed in the study area. In contrast, leatherback turtles are only encountered by a few fishermen (Ibad 2023). Additionally, the dwarf gulper shark (*Centrophorus atromarginatus* (Garman, 1913)) is classified as Critically Endangered (CR), meaning it is on the brink of extinction and is rarely found in the study area (Murti and Maya 2021). There are also several species classified as Least Concern (LC), meaning their population and presence are not currently threatened, such as great white egret (*Ardea alba* (Linnaeus, 1758)), pantropical spotted dolphin (*Stenella attenuata* (Gray, 1846)), sea urchin (*Echinoidea* sp.), Malayan krait (*Bungarus candidus* (Linnaeus, 1758)), moonrat (*Echinosorex gymnura* (Raffles, 1822)), lobotes (*Lobotes surinamensis* (Bloch, 1790)), lobster (*Panulirus* spp.). Despite this, these species are protected by the community through measures such as restricting their capture and use to maintain species conservation. Some of these species are still frequently encountered by the local community, with lobster being particularly cultivated as a food source and distributed within the Kanigoro Village community.

Table 1. Demographic data of respondents

Characteristics	Group	Informant	Percentage
Age	Young (18-36)	13	17.6%
	Middle-aged (37-55)	39	52.7%
	Elderly (≥ 56)	22	29.7%
Gender	Female	43	58.1%
	Male	31	41.9%
Occupation	Entrepreneur	5	6.7%
	Farmer	15	20.3%
	Fisherman	25	33.8%
	Housewife	8	10.8%
	Pension	2	2.7%
	Student	4	5.4%
	Trader	15	20.3%

Table 2. Protected animals in the Kanigoro Village area, Saptosari Sub-district, Gunung Kidul, Yogyakarta, Indonesia

Family	Species name	Local name	IUCN status
Ardeidae	<i>Ardea alba</i> (Linnaeus, 1758)	<i>Burung laut (kuntul laut)</i>	LC
Balaenopteridae	<i>Balaenoptera musculus</i> (Linnaeus, 1758)	<i>Paus jeda</i>	EN
Centrophoridae	<i>Centrophorus atromarginatus</i> (Garman, 1913)	<i>Hiu botol</i>	CR
Cercopithecidae	<i>Macaca fascicularis</i> (Raffles, 1821)	<i>Monyet kra</i>	EN
Cheloniidae	<i>Chelonia mydas</i> (Linnaeus, 1758)	<i>Penyu ijo</i>	EN
Myliobatidae	<i>Mobula</i> sp.	<i>Pari</i>	EN
Delphinidae	<i>Stenella attenuata</i> (Gray, 1846)	<i>Lumba-lumba</i>	LC
Dermochelyidae	<i>Dermochelys coriacea</i> (Vandelli, 1761)	<i>Penyu belimbing</i>	VU
Echinoidea	<i>Echinoidea</i> sp.	<i>Bulu babi</i>	LC
Elapidae	<i>Bungarus candidus</i> (Linnaeus, 1758)	<i>Ular weling</i>	LC
Erinaceidae	<i>Echinosorex gymnura</i> (Raffles, 1822)	<i>Landak berbulu</i>	LC
Lobotidae	<i>Lobotes surinamensis</i> (Bloch, 1790)	<i>Ikan kakap batu</i>	LC
Lutjanidae	<i>Lutjanus campechanus</i> (Poey, 1860)	<i>Ikan kakap merah</i>	VU
Myliobatidae	<i>Manta birostris</i> (Walbaum, 1792)	<i>Pari manta</i>	EN
Nephropidae	<i>Panulirus</i> spp.	<i>Lobster</i>	LC
Rhincodontidae	<i>Rhincodon typus</i> Smith, 1828	<i>Hiu lintang</i>	EN
Varanidae	<i>Varanus salvator</i> (Laurenti, 1768)	<i>Biawak air</i>	LC

Note: CR: Critically Endangered, EN: Endangered, LC: Least Concern, VU: Vulnerable



Figure 3. Local wisdom in the form of traditions: A. *Labuhan* or *larungan* at Ngobaran Beach, B. *Gugur gunung* held in the coastal area, C. *Rasulan* held in the coastal area. Sources: <https://jogja.tribunnews.com/>, <https://gunungkidul.sorot.co/>, <https://jogjaholic.com/>

Local wisdom from the community

Local wisdom in the form of traditions

Each beach of this area study has its specific function: Ngobaran Beach is used for Hindu religious practices, Ngrenehan Beach is designated for fishing, where most fishermen dock their boats after fishing, and Ngayahan Beach is designated solely for tourism. Table 3 indicates three local wisdom traditions inherited from ancestors: *Labuhan* or *Larangan*, *Gugur gunung*, and *Rasulan* (Figure 3). These three traditional customs are unique and can attract local and international tourists to visit and learn about the local customs. The preservation of these traditions can positively impact local income and coastal biodiversity (Aminuddin and Burhanuddin 2023).

In Kanigoro Village, traditional customs are still strongly observed. Some customs practiced include *larungan* or *labuhan*, *gugur gunung*, and *rasulan*. *Larangan* is a ritual of floating offerings comprising agricultural products, performed annually on the first of *Suro*. *Suro* is the Javanese new year and is the most important celebration for Javanese people. *Gugur gunung* is a traditional beach cleaning carried out weekly on Fridays by local women. *Rasulan* is an annual tradition in the form of a communal thanksgiving by the Kanigoro Village community.

The community considers the *labuhan* or *larungan* ceremony on the night of first *Suro* as a form of gratitude to Allah S.W.T. (God in Islam) for the blessings and enjoyment of life. This gratitude is expressed through offerings including fruits, vegetables, market snacks, chicken, and even a new set of *kebaya*. *Kebaya* is a type of upper garment traditionally worn by women in Southeast Asia, especially in Indonesia. The *labuhan* or *larungan* ceremony also involves floating gold with the offerings. *Larangan* is also symbolic of cleansing sins and removing bad luck (Dewi et al. 2022). This tradition has been practiced for a long time and is still preserved today, with participation from all age groups. In the context of conservation, the *labuhan* tradition raises public awareness to maintain cleanliness and environmental sustainability around ritual sites, so that the area is indirectly protected from destructive activities such as over-exploitation and tree logging.

The coastal communities of Ngobaran, Ngrenehan, Ngayahan Beaches, and Kanigoro Village also share the tradition of *gugur gunung*, which has been passed down through generations (Afandi et al. 2018). Generally, *gugur gunung* involves village or beach cleaning activities conducted weekly on Fridays. This tradition, primarily led by local women, has been consistently practiced, with its

origins traced back to local PKK women. PKK is an abbreviation for Family Welfare Empowerment, a community organization that empowers women to participate in Indonesia's development. Through *gugur gunung*, the community works together to clean up the environment and prevent damage to nature. This activity contributes to the preservation of biodiversity by creating a cleaner and litter-free environment, especially in areas that are the habitat of animals protected by the Kanigoro community.

The Kanigoro community also observes the *rasulan* tradition, which is held annually and the timing is not specified. *Rasulan* is a rural post-harvest thanksgiving that celebrates the harvest and honors ancestors, teaching respect for the sea as a source of life. *Rasulan* aims to express gratitude to Allah S.W.T. for the blessings and pleasures of life. This tradition involves activities such as communal feasts, village cleaning, a banquet to commemorate an event, ask for blessings, and so on or usually called *kenduri*, recitations, and even *wayang* performances are a traditional Indonesian performing art that is developing rapidly on the islands of Java and Bali for public entertainment. This tradition encourages the preservation of the region and biodiversity, so that the natural habitat of flora and fauna is maintained.

Local wisdom in the form of knowledge

In Kanigoro Village, local wisdom is evident through community knowledge. This knowledge comprises various taboos and prohibitions passed down through generations and still observed by the local community today. Not only are the villagers required to follow these rules, but visitors are also expected to respect and adhere to them while in the village. Many of these regulations significantly benefit the local community by preserving cultural heritage and indirectly protecting the coastal biodiversity (Setiawan and Triyanto 2021). Additionally, enforcing these traditional rules plays a crucial role in safeguarding the ecosystems and environment of Kanigoro Village. These prohibitions and regulations encompass various aspects of life, including behavior and interaction with the surrounding environment, reflecting the local wisdom that the people of Kanigoro Village continue to uphold.

Based on the findings in Table 4, several local traditions have been established in Kanigoro Village. Among these traditions is the prohibition against taking sand from the beach area. This tradition is still practiced today in Kanigoro Village, with the belief that any violation by visitors will bring bad luck. Moreover, this

tradition is an environmental conservation effort to protect the coastal ecosystem. Sand plays a crucial role in protecting the shoreline from erosion and providing habitats for various flora and fauna. Excessive sand extraction can lead to degradation, erosion, and destruction of natural habitats for marine life (Widya 2023). By upholding this tradition, the people of Kanigoro Village strive to ensure that this natural resource remains preserved for future generations and supports environmental sustainability in tourism and other community activities.

Another tradition still in practice is the use of traditional methods for fishing. This tradition is maintained due to its environmentally friendly nature. The use of simple tools like nets and fishing rods (Table 4) helps reduce the exploitation of fish compared to modern equipment, which tends to capture large quantities of fish. This traditional practice helps maintain the balance of fish populations. Cultural and social values are also embedded in this practice, supporting the preservation of marine ecosystems. Despite the lack of technological innovation in Ngobaran, Ngrenehan, and Nguyahan beaches, the community believes that traditional fishing methods effectively conserve the environment and biodiversity (Kutser et al. 2020). Although technology use, such as engines for boats, has evolved, the community's economic and social activities continue to thrive. The local fishing industry meets market demands while preserving traditional practices and limiting the exploitation of newer technologies.

A tradition that remains in place today involves restrictions on fishing on certain days and during specific seasons (Table 4). Fishermen are prohibited from going to sea on *selasa kliwon* and *jumat kliwon* based on a long-standing belief that doing so could result in misfortune. *Kliwon* is the name of the day in *separasar* or also called *pancawara*, a week consisting of five days and used in Javanese and Balinese culture. This tradition indirectly supports marine recovery by reducing overexploitation. Seasonal fishing practices are also rooted in local knowledge of marine life cycles and weather patterns (Pamungkas et al. 2022). These practices ensure that fish populations remain stable and sustainable. Additionally, this tradition emphasizes the importance of the reciprocal relationship between humans and nature, ensuring that marine resources are available for future generations (Hidayat et al. 2024). By adhering to these practices, fishermen support ecological balance and contribute to the economic stability of coastal communities that rely on fisheries as their primary livelihood.

Table 3. Customary traditions in the Kanigoro Village area, Saptosari Sub-district, Gunung Kidul, Yogyakarta, Indonesia

Traditional customs	Type of tradition	Description	Location
<i>Labuhan</i> <i>/Larangan</i>	Cultural	A traditional ceremony involving the washing of offerings, including vegetables, fruits, and other agricultural products, held annually on the first of <i>Suro</i>	Ngobaran Beach, Ngrenehan Beach
<i>Gugur</i> <i>Gunung</i>	Social	The generational tradition of beach cleaning is conducted weekly to maintain the beach's sustainability	Ngrenehan Beach, Ngobaran Beach, Nguyahan Beach
<i>Rasulan</i>	Religious	Annual post-harvest celebration ceremony that includes a communal feast, village cleaning, cultural performances, and <i>gunungan</i>	Ngobaran Beach

Table 4. Local traditions in the Kanigoro Village area, Saptosari Sub-district, Gunung Kidul, Yogyakarta, Indonesia

Local traditions	Description	Location
Prohibition on taking or removing sand and coral reefs	Keeping sand and coral reefs from being exploited. In addition, the local community has a belief that if anyone takes sand or coral reefs from the beach, even a little, they will be punished by nature	Ngrenehan Beach, Ngobaran Beach, Nguyahan Beach
Catching marine life using simple and traditional methods	Fishing still uses traditional methods with nets and fishing rods	Ngrenehan Beach, Ngobaran Beach, Nguyahan Beach
Prohibited from sailing to catch fish on certain days	The rule prohibiting fishing on tuesday <i>kliwon</i> and friday <i>kliwon</i> for fishermen, if violated, is believed to be disastrous	Ngrenehan Beach, Ngobaran Beach, Nguyahan Beach
Sailing during specific seasons and full moon phases	The community uses pattern and seasonal understanding in sailing, such as not during the dry season or high tide because it is difficult to get fish	Ngrenehan Beach, Ngobaran Beach, Nguyahan Beach
Restrictions on fish harvesting	Fish collection should not be excessive, thus disrupting the fish ecosystem in the sea	Ngrenehan Beach, Ngobaran Beach, Nguyahan Beach
Prohibition on littering	The rule of no littering	Ngrenehan Beach, Ngobaran Beach, Nguyahan Beach
Protection of certain plants	Drini plants (<i>Pemphis acidula</i> J.R.Forst. & G.Forst.) on the coastal cliffs are protected and sacred by the local community for generations	Ngobaran Beach Cliff

Traditions prohibiting littering and protecting specific plants are still observed (Table 4). These practices, common in various communities, help maintain environmental cleanliness and biodiversity conservation (Triarmila et al. 2023). The prohibition against littering positively impacts efforts to prevent pollution that could harm coastal ecosystems. Additionally, the protection of certain plants is based on their ecological and spiritual significance. In Kanigoro Village, these practices help safeguard both the environment and cultural heritage. Some traditions, like the protection of the sacred *drini* plant (*Pemphis acidula* J.R.Forst. & G.Forst.) are specific to Ngobaran Beach. These practices reflect the community's identity and pride in preserving their heritage.

Coastal communities are closely connected to the sustainable use of fishery resources. Local wisdom teaches them to understand natural patterns and seasons, enabling sustainable fishing without damaging ecosystems (Zhang and Li 2023). Understanding these patterns ensures fishermen can maintain productive catches without resorting to harmful practices like bombing or poisoning. Conservation, therefore, is not merely a modern concept but an integral part of the community's way of life and coexistence with nature (Gordon et al. 2021). Conservation efforts should thus respect and accommodate the local wisdom ingrained in the community's life for generations.

The study concluded that the data collected from the coastal communities of Nguyahan, Ngobaran, and Ngrenehan identified 17 protected species from 17 different families. Of these, eight species are listed by the IUCN as endangered, with five species critically endangered. The findings show that the community still maintains local wisdom to preserve coastal biodiversity through traditional practices such as the *labuhan*, *gugur gunung*, and *rasulan* ceremonies. These traditions, passed down through generations, include various rules and prohibitions that contribute to cultural and environmental

conservation in the village. Additionally, traditions like *tumpengan*, village cleanups, communal feasts, and religious gatherings preserve cultural heritage and attract tourists, potentially leading to sustainable tourism, protection of national cultural assets, and enhanced well-being for the local community.

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Short Communication: Ethnomedicinal plants used as antiglycemic by tribes around Achanakmar Amarkantak Biosphere Reserve, Madhya Pradesh, India

BHAGWANTA SINGH BAGHEL, MANJULA VERMA, SHIVAJI CHAUDHRY*

Department of Environmental Science, Indira Gandhi National Tribal University, Amarkantak-484 886, Madhya Pradesh, India.
Tel.: +91-94250-15752, *email: shivaji.chaudhry@gmail.com

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Abstract. Baghel BS, Verma M, Chaudhry S. 2024. Short Communication: Ethnomedicinal plants used as antiglycemic by tribes around Achanakmar Amarkantak Biosphere Reserve, Madhya Pradesh, India. *Asian J Ethnobiol* 7: 122-129. The diabetes issue has become severe in Indian society, where most people consume carbohydrate-rich foods. The real problem in addressing the issue of diabetes is the duration of the course of treatment using allopathic medications, which creates problems of side effects and are not affordable for rural people. Hence, people of such regions resort to traditional ethnomedicinal practices as most healers are known to them. The study aims to document the indigenous plants used for treating diabetes around Achanakmar Amarkantak Biosphere Reserve (AABR), Madhya Pradesh, India. The data were collected with a semi-structured questionnaire by interview method with all the selected healers by identifying plants used for diabetes treatment. We interviewed 200 traditional healers across 48 villages in Madhya Pradesh. Forty plant species belonging to 35 genera, and 30 plant families were used as antidiabetics. Most of the plants were Apocynaceae (4), and Malvaceae (3), remaining had less contribution; mostly herbs were used 42.5%, trees 32.5% and shrubs 25%. The most frequent part used was leaf 28%, and the common method of preparation was infusion 33%. The Fidelity Level (FL) was highest at 98% for *Terminalia arjuna* and *Pterocarpus marsupium*, followed by *Bauhinia vahlii* at 92% and *Tinospora cordifolia* and *Moringa oleifera* at 88%. The greatest ICF was ranked at 0.602 for *T. arjuna* and *P. marsupium*, followed by *B. vahlii* at 0.589 and *M. oleifera* at 0.581. Studying indigenous plant ingredients for medicinal benefits and how they work could lead to safe, effective natural drugs through refinement and processing.

Keywords: Diabetes, dosage, ethnobotanical indices, ethnomedicinal plants, traditional healers

INTRODUCTION

Hyperglycemia, or excess of glucose present in human blood, is commonly referred to as diabetes, which is characterized by a reduction in insulin production resulting in diabetes mellitus (ADA 2010). A study conducted in 2017 showed that there were about 462 million people affected by diabetes mellitus throughout the world, which roughly corresponds to 6.28% (Khan et al. 2020). In India, most people follow a carbohydrate-rich diet (Joshi et al. 2014), and sweets are commonly used in times of festivals or celebrations. There has been a rapid rise of urbanization and globalization across the world, and according to UN reports 2018, by 2050, 68% of the world will be urban. The rapid rise in urbanization and increase in population leads to an atmosphere that makes life stressful. Increased population in urban centers will ultimately lead to a competitive and stressful environment for its residents (Srivastava 2009). Though urban areas provide numerous opportunities for their residents for livelihood, there is an increase in stress levels due to competition, which often leads to lifestyle-related disorders and stressful mental conditions (Pelgrims et al. 2021). In turn, this makes the urban population insecure about lifestyle diseases such as diabetes, increased blood pressure, and increased blood cholesterol, thereby increasing the risk of mortality (Pappachan 2011).

Diabetes mellitus itself is a disease that requires long-term allopathic medications; there is a growing concern about the safety of patients on allopathic medicines when they are on long-term treatment. In treating lifestyle-related disorders such as blood pressure and cardiac problems, such side effects may be particularly prominent (Malhotra 2018). A recent review on diabetes covering the antidiabetic medicinal plants reported that patients on oral antihyperglycemic medications were very likely to experience side effects tend to have adverse effects, such as drug resistance, toxicity, and hyperlipidemia (Salehi et al. 2019). There are various groups of allopathic medicines used in the treatment of hyperglycemia; among them, the sulfonylurea groups are known to lose efficacy when administered over six years. There are also known complications for patients when they are on combined medications, such as those of high blood pressure, and known to lead to risk of heart failure and death (Petrie et al. 2018). Additionally, the long-term costs of allopathic treatment are unaffordable for low-income groups in rural areas; in developing countries, most people cannot afford expensive medicines and treatments.

People in certain areas rely heavily on plant-based medication since it is readily available and reasonably priced (Rahman et al. 2022). For tribal, rural, and forest-dependent people, forests contribute to generating alternate forms of income that will serve as important financial

inducements to prevent destruction and offer additional livelihood benefits from preserving and restoring forest ecosystems (Patra et al. 2022). A recent study in Mizoram, India suggested that due to mass deforestation, rural depopulation, and younger generations' lack of interest in traditional treatment methods, traditional medicinal practices have been steadily declining in recent years (Ralte et al. 2024). The use of medicinal plants by the local communities for their healthcare system should be documented (Srivastava 2018). Most of the tribes in India live near forested areas whose lives are dependent on food, fuel, fiber, and medicines from these areas (Newton et al. 2016). In a health survey conducted in Oman, it was found that people held a view that traditional medicines had no side effects over prescription medicines (Al-Saadoon 2015). The WHO states that herbal remedies are the most frequently used traditional medicine and are the first choice of primary health care for 70-80% of people in the African region. One of the main reasons is that wild leafy green leaf grasses used for traditional medicine are essentially free, as most of them grow close to household areas (Ahmed et al. 2023). Traditional herbal medicinal plants show great promise not only for the upcoming discovery of drugs but their value is equally revered by people because of their low side effects and affordability in rural areas worldwide (Salehi et al. 2019).

In India, about 280 medicinal plants are documented to be used for treating diabetes. Different formulation doses are used in Ayurvedic, Homeopathy, Unani, Siddha, and Allopathic medicine. About 175 medicinal plants are found in the Himalayan region of India (Kumar et al. 2019). Most of the works in Central India have been on the documentation of the ethnomedicinal plant species (Roy et al. 2022). There are only very few references regarding the use of medicinal plants to treat certain diseases (Sofowora et al. 2013). However, it is reassuring to note that herbal medicines, which are derived from these plants, are very popular among people due to their fewer adverse effects on health. In India, most of the forests are under varying stages of destruction due to developmental activities. There are several reasons why it is crucial to record native knowledge regarding the use of medicinal herbs. Primarily, it assures that the cultural wealth of indigenous peoples is safeguarded and not lost, benefiting both the current and

coming generations (Boadu and Asase 2017). For primary care, a significant proportion of the population in developing nations still depends on herbal remedies and traditional healers. Up to 90% of people in Africa and 70% in India, respectively, rely on traditional medicine to help them with their medical needs (Benzie and Wachtel-Galor 2011).

However, due to increased urbanization, understanding of their applications has decreased. Many researchers have suggested that urbanization leads to modifications that affect the identification, utilization, and administration of natural resources by diminishing their natural areas. Compared to the less urbanized population, which used and knew more about wild plants (Arjona-García et al. 2021). In a study conducted in Ethiopia, it was found that social and economic conditions are the drivers of preference for traditional medicinal practices (Chali et al. 2021). In Mexico, a similar study reveals that factors like urbanization and modern lifestyle may erode the knowledge of traditional medicinal plants (Arjona-Garcia et al. 2021). A diverse range of plant species are frequently used in ethnomedicinal practices. Local communities can contribute to the preservation of biodiversity by acknowledging the importance of these plants (Alves and Rosa 2007). In an attempt to document the traditional knowledge in relation to anti-hyperglycemic plants used in this biodiversity-rich part of central India, the people living in this part have fewer amenities to modern healthcare and often resort to traditional healers for addressing their ailments.

MATERIALS AND METHODS

Study area

The present study was carried out around Achanakmar Amarkantak Biosphere Reserve (AABR), in six districts of Madhya Pradesh, India, i.e.: Anuppur, Balaghat, Chhindwara, Dindori, Mandla, and Seoni (Figure 1). Out of the six districts and 48 villages, the number of villages in each district is Mandla (14), Dindori (10), Seoni (5), Chhindwara (9), Anuppur (8), and Balaghat (2).

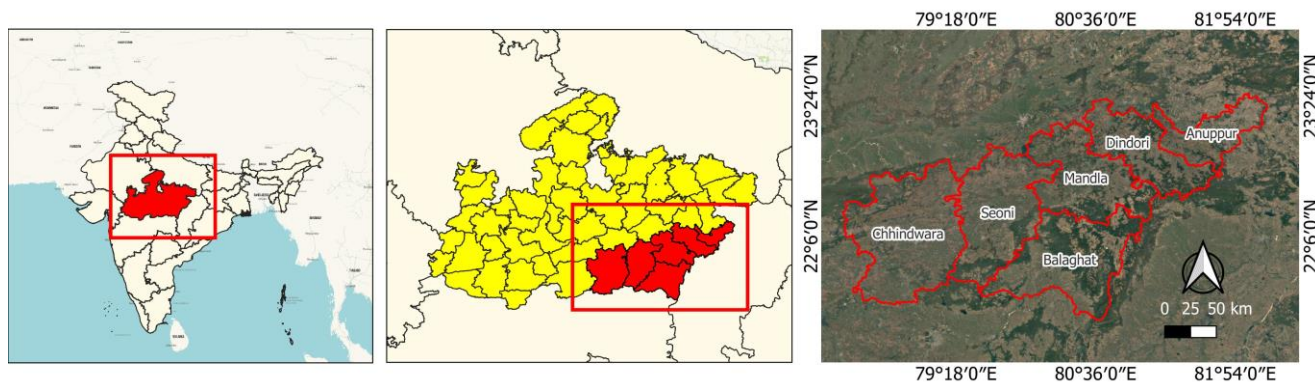


Figure 1. Study area around Achanakmar Amarkantak Biosphere Reserve (AABR), in six districts of Madhya Pradesh, India

Anuppur District had an estimated population of 749,237 as per the 2011 Indian Census. The district experiences a subtropical climate Balaghat District had a population of about 1,701,156 according to the 2011 Census. The Gonds and Baigas, indigenous tribes, form a significant portion of the population. Chhindwara District had a population of 2.09 million as per the 2011 Census. The district is known for its dense forests, wildlife reserves, and sanctuaries that help preserve biodiversity. Dindori District had a population of 704,524, according to the 2011 Census. Tribal populations, particularly the Gond and Baiga tribes, make up a significant portion of the district, contributing to its unique cultural landscape. Mandla District, home to about 1.05 million people, is known for its rich biodiversity. The district has tropical dry deciduous and moist deciduous forests. There are 1.4 million people living in the Madhya Pradesh State's Seoni District. Monsoon rainfall during occur during months June to September which drives the agriculture from otherwise dry weather from October-May. Temperature may soar to 45°C in summer while it may reach 2°C in December (www.cgwb.gov.in)

Data collection

Field survey to identify herbal practitioner prescribing medicine for hyperglycemia (diabetes). A total of 200 practitioners were located across 6 districts of Madhya Pradesh in 48 villages study area (Figure 1). A structured questionnaire was developed following by Dewangan and Sharma (2022) to record local names, plants used, part used, life form, plant source, mode of administration and mode of preparation. Plants used by healers for treatment were identified by comparison of herbarium specimens (Souza and Hawkins 2017) at BSI Allahabad also using field guides i.e. A Tree Spotters: Jungle Tree Field Guides of Central India (Krishen 2014), Common Indian wild Flowers (Khemikar 2000), Wild Edible Fruit Plants of Eastern India (Mahapatra and Panda 2009), Flowers of the Himalaya (Polunin and Stainton 1984), a Field Guide to the Flowering Plants of Central India (Chaudhry et al. 2019).

Data analysis

Ethnobotanical indices such as the Fidelity Level (FL%) and Information consent factor were calculated using the formula below:

$$FL (\%) = \frac{N_p}{N} \times 100 \text{ (Alexiades 1996)}$$

The fidelity Level (FL%) determines the most preferred species by traditional healers. N_p denotes the number of use reports cited for a given species, and N is the total number of use reports cited for a given species. Hence, values closer to 100 would imply their higher use.

The Information Consent Factor (ICF) was calculated as follows:

$$ICF = \frac{Nur-nt}{Nur-1}$$

Number of use citations for each ailment minus the number of species used for that ailment, divided by the number of use citations for each ailment minus one (Rodrigo and Saldanh 2005).

RESULTS AND DISCUSSION

Elucidation of taxonomic diversity

It is critical to document the ethnobotanical knowledge of the Indigenous communities around the globe as this serves as a tool for helping in the conservation of biodiversity and cultural heritage and also aids in pharmacological research (Weldegerima 2009). There are challenges to the preservation of traditional knowledge in present-day contexts, like rural-to-urban migration and adopting a modern lifestyle as opposed to traditional and rural living. Documentation of traditional knowledge on medicinal plants leads to the conservation and sustainable utilization of bioresources and is also shown to be positively correlated to the development of future drugs (Kumar and Singh 2022). It was found that most of the indigenous knowledge in relation to the use of ethnomedicinal plant use lies with communities living in remote and forested areas. Hence, the simplest means to document using the field survey methodologies. The present study conducted across six Madhya Pradesh districts suggests 40 plant species belonging to 35 genera and 30 plant families used as antidiabetic. Among the plant families, the species contribution was Apocynaceae (4), Malvaceae (3), and Fabaceae (3). Combretaceae (2), Lamiaceae (2), and Moraceae also contributed two species, and the remaining 24 families contributed a single species each. In a study conducted in Morocco on ethnomedicinal plants used for diabetes treatment, most antidiabetic species were found to belong to the Lamiaceae (8), followed by Fabaceae (3) (Skalli et al. 2019). Similar results were obtained from the Vindhya region of India (Dharm and Pramod 2017). In a study in Ugandan forests found that in treatment of various ailments, the plant family Fabaceae was the most dominant (Tugume et al. 2016). Hence, it could be concluded that some plants dominate the diabetes treatment, probably due to their availability and medicinal properties.

Habit and parts useful

One of the commonest visual methods of segregation of medicinal plants is on the basis of their habit, i.e., trees, shrubs, and herbs. At the same time, some other forms may exhibit other adaptations, such as epiphytic, parasitic, and lianas (woody climbers); some may even show a preference for aquatic habitats. The life form or the habit analysis of ethnomedicinal plant species reveals that mostly herbs were used 42.5%, followed by trees 32.5%, and the least in the case of shrubs 25% (Table 1). While the plant part used enumeration suggests leaf (28%), bark (20%) was used predominantly, other parts such as root (10%), fruit (8%), other part used in conjunction are bark; leaf (2.5%), bark; seed (2.5%), black leaf (2.5%), bulb (2.5%), leaf; stem (2.5%), leaves; root; bark (2.5%), root; fruit (2.5%), seed (2.5%), stem (2.5%), tuber (2.5%), leaf; bark (2.5%), leaf; root (2.5%), leaf; stem (2.5%), and leaf; root; bark (2.5%) (Figure 2). The most important aspect of traditional ethnomedicine is documentation of its uses, which determines its safety and accuracy, this practice has evolved through centuries of trial-and error methods. Tribal healers

in the research region utilize a variety of remedial preparation, the most common of which are infusion (33%) pills (23%), decoction (22%), powder (12%), and chewing (10%) (Figure 3). Most of these medicinal plants were sourced from the wild at 57.5%, while 22.5% were cultivated, and the remaining 20% were sourced from both wild and cultivated (Table 1). The primary collectors reported that antidiabetic plants based on ease of availability were easy at 45%, moderate at 35%, and difficult at 20%. This reveals that most of these plants either have good natural regeneration or are cultivated. Different parts of plants possess different amounts of active constituents (Rabizadeh et al. 2022) and are being identified by traditional healers across the globe through centuries of trial and error (Petrovska 2012). Recent studies on ethnomedicinal plant use also suggest that useful

alkaloids are found mostly in leaves, which helps the recovery of both human and animal ailments (Mekonnen et al. 2022), and our study also affirms this fact. Hence, it is important to identify the plants and know the parts used and availability with respect to the season. Plants within the same family or even genus may often exhibit comparable chemical constituents and similar therapeutic applications. This intriguing phenomenon is exemplified in the Asteraceae family, where most species in the genus share anti-inflammatory, antimicrobial, and wound-healing properties (Rolnik and Olas 2021). This shared potential across plant families and genera is a fascinating area of study, further enhanced by the development of chemotaxonomy, a branch of taxonomy based on the chemical similarity of plants (Elbalola and Abbas 2024).

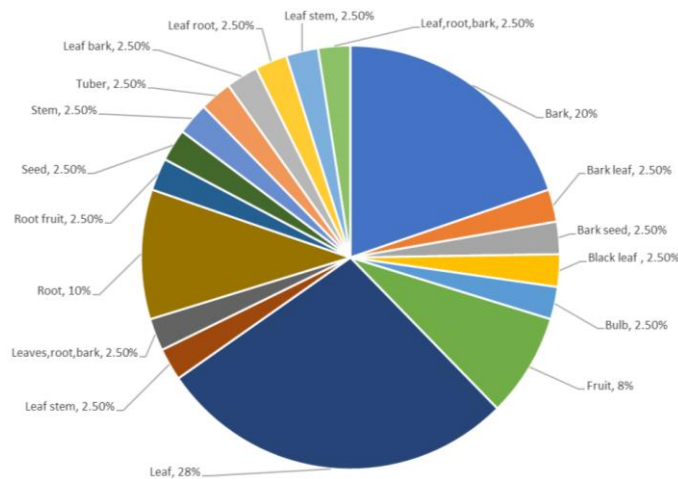


Figure 2. Different plant parts used for antidiabetic treatment

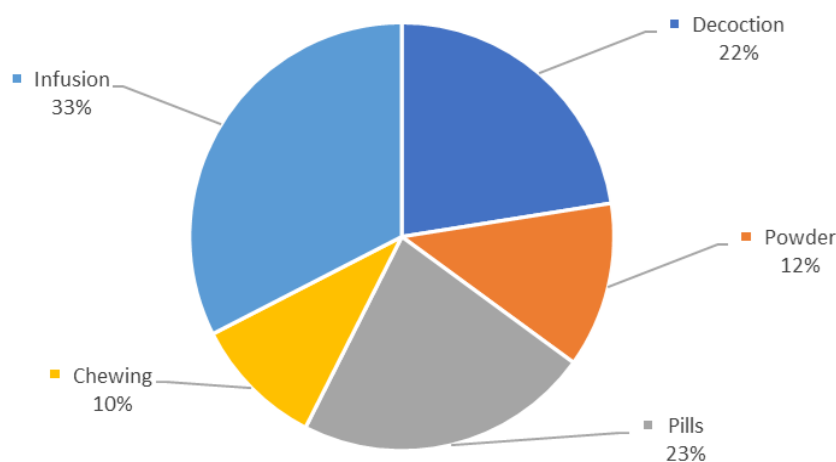


Figure 3. Different modes of administration of antidiabetic formulations

Table 1. Quantitative documentation of ethnomedicinal plant species of Anuppur, Chhindwara, Dindori, Mandla, Balaghat and Seoni Districts, India

Family	Botanical name	Local name	Life form	Part used	Plant source	Finding	Mode of administration	Mode of preparation	FL (%)	ICF
Acanthaceae	<i>Justicia adhatoda</i> L.	<i>Adusa</i>	Shrub	Leaf, root, bark	Cultivated	Moderate	Oral	Its roots, leaves and bark should be chewed and eaten	61.290	0.480
Amaryllidaceae	<i>Allium cepa</i> L.	<i>Lal pyaj</i>	Herb	Bulb	Cultivated	Easy	Oral	The bulb is crushed and juice is drinking	48.148	0.391
Annonaceae	<i>Annona squamosa</i> L.	<i>Sitafal</i>	Shrub	Leaf	Cultivated	Easy	Oral	Grind dry leaf make powder and drink with one glass of water	36.986	0.264
Apiaceae	<i>Trachyspermum ammi</i> (L.) Sprague	<i>Ajawain</i>	Herb	Seed	Cultivated	Moderate	Oral	Grind the dry seeds into powder and make pills and eat them twice a day	36.054	0.250
Apocynaceae	<i>Alstonia scholaris</i> (L.) R.Br.	<i>Kuraya</i>	Herb	Bark	Cultivated and wild	Moderate	Oral	Grind dry bark make powder and drink with one glass of water	30.719	0.152
Apocynaceae	<i>Calotropis procera</i> (Aiton) W.T.Aiton	<i>Akawan</i>	Shrub	Root	Wild	Easy	Oral	Grind the root and drink with warm water	25.786	0.025
Apocynaceae	<i>Carissa spinarum</i> G.Lodd	<i>Karonda</i>	Shrub	Bark	Cultivated and wild	Moderate	Oral	As a decoction Take half a cup in a small disposal of tea	31.579	0.170
Apocynaceae	<i>Gymnema sylvestris</i> R. Br.	<i>Gudmar</i>	Shrub	Leaf	Cultivated and wild	Moderate	Oral	Grind dry leaves and make powder and drink one spoon twice a day	85.185	0.571
Asteraceae	<i>Eclipta prostrata</i> (L.) L.	<i>Bhringraj</i>	Herb	Leaf	Wild	Easy	Oral	Grind the leaves, dissolve them in water and drink it with half a cup of water	35.135	0.035
Burseraceae	<i>Boswellia serrata</i> Roxb.	<i>Salhe</i>	Tree	Bark	Wild	Difficult	Oral	Dry the bark, make a decoction in half a cup of hot water, and drink it	27.389	0.071
Caesalpiniaceae	<i>Caesalpinia sappan</i> L.	<i>Patrang</i>	Herb	Root	Wild	Difficult	Oral	The root has to be dried, ground and then taken in pill form twice a day	28.205	0.093
Combretaceae	<i>Terminalia arjuna</i> (Roxb. Ex DC.) Wight & Arn.	<i>Kahwa</i>	Tree	Bark	Cultivated and wild	Moderate	Oral	Grind dry bark, add one spoon to a glass of Simple water and drink	98.620	0.602
Combretaceae	<i>Terminalia chebula</i> Retz	<i>Harra</i>	Tree	Fruit	Wild	Easy	Oral	You have to dry and grind the fruit, then make a pills and eat it twice a day	36.054	0.250
Convolvulaceae	<i>Convolvulus arvensis</i> L.	<i>Sakhpushpi</i>	Herb	Leaf	Wild	Moderate	Oral	The leaf has to be dried, ground and then taken in pill form twice a day	25.786	0.025
Cucurbitaceae	<i>Momordica charantia</i> L.	<i>Karela</i>	Herb	Leaf	Cultivated	Easy	Oral	Grind dry leaves and make powder and drink one spoon twice a day	76.991	0.547
Dioscoreaceae	<i>Dioscorea bulbifera</i> L.	<i>Bundi kanda</i>	Herb	Tuber	Wild	Difficult	Oral	To make an infusion, crush the tuber pieces with water and then drink it	42.857	0.339
Euphorbiaceae	<i>Euphorbia hirta</i> L.	<i>Dudhi</i>	Herb	Leaf stem	Wild	Easy	Oral	Dry the leaves and stem, then grind it into powder and take it in pill form twice a day	35.135	0.235
Fabaceae	<i>Bauhinia vahlii</i> Wight & Arn.	<i>Mohalain</i>	Tree	Stem	Wild	Difficult	Oral	Dry the stem and grind make powder and drink one spoon twice a day	92.308	0.589
Fabaceae	<i>Dalbergia sissoo</i> Roxb. ex DC.	<i>Shisham</i>	Herb	Leaf	Cultivated and wild	Easy	Oral	Grind dry leaves and make powder and drink one spoon twice a day	42.857	0.339
Fabaceae	<i>Pterocarpus marsupium</i> Roxb.	<i>Beeja, telia beej</i>	Tree	Bark	Wild	Difficult	Oral	Put its stalk in cold water and drink a glass of water after some time	98.020	0.602

Lamiaceae	<i>Ocimum sanctum</i> L.	<i>Tulsi</i>	Herb	Black, leaf	Cultivated	Easy	Oral	Dry the leaves, take half a cup of tea in a small container, and drink it twice a day	31.579	0.170
Lamiaceae	<i>Ocimum tenuiflorum</i> L.	<i>Kali tulsi</i>	Shurb	Leaf	Wild	Moderate	Oral	Dry the leaves, make a decoction in half a cup of hot water, and drink it	73.684	0.530
Malvaceae	<i>Bombax ceiba</i> L.	<i>Semal</i>	Tree	Bark	Wild	Moderate	Oral	Grind dry bark make powder and drink with one glass of water	44.928	0.361
Malvaceae	<i>Helicteres isora</i> L.	<i>Marodfali</i>	Shurb	Leaves, root, bark	Cultivated and wild	Difficult	Oral	Its green leaves and dry root have to be chewed and eaten twice a day. chewing the root bark	51.515	0.418
Malvaceae	<i>Thespesia populnea</i> (L.) Sol. ex Corrêa	<i>Bijnora</i>	Shrub	Bark, leaf	Wild	Difficult	Oral	Grind dry bark and leaves and mix one spoon in a glass of plain water and drink	36.986	0.264
Meliaceae	<i>Azadirachta indica</i> A.Juss.	<i>Neem</i>	Tree	Leaf	Cultivated and wild	Easy	Oral	Boil green leaves in water, then filter and drink a glass of water	78.571	0.552
Menispermaceae	<i>Tinospora cordifolia</i> (Willd.) Hook.f.& Thomson	<i>Gurber, gurbel</i>	Shrub	Leaf, stem	Wild	Moderate	Oral	Dry the leaves and stem, then grind it into powder and take as a decoction	80.180	0.557
Moraceae	<i>Ficus benghalensis</i> L.	<i>Bar</i>	Tree	Fruit	Wild	Easy	Oral	Eat 3 to 4 ripe tree fruits daily	26.582	0.049
Moraceae	<i>Ficus racemosa</i> Willd.	<i>Dumar</i>	Tree	Fruit	Wild	Easy	Oral	Eat 2 to 3 ripe tree fruits daily	41.844	0.328
Moringaceae	<i>Moringa oleifera</i> Lam.	<i>Munga</i>	Tree	Root, fruit	Cultivated	Easy	Oral	Dry the root and fruit, then grind it into powder and take as pills	88.679	0.581
Myrtaceae	<i>Syzygium cumini</i> (L.)	<i>Jam, jamun</i>	Tree	Bark, seed	Wild	Easy	Oral	Grind the bark and seeds and make a decoction and drink it	70.940	0.524
Nyctaginaceae	<i>Mirabilis jalapa</i> L.	<i>Gulbas</i>	Herb	Root	Cultivated	Moderate	Oral	Dry the root then grind it into powder and take as pills	29.870	0.133
Plantaginaceae	<i>Scoparia dulcis</i> L.	<i>Chana buti</i>	Herb	Leaf	Wild	Moderate	Oral	Grind green leaves and drink it with water	27.389	0.071
Poaceae	<i>Cynodon dactylon</i> (L.) Pers.	<i>Maanju ghas</i>	Herb	Root	Wild	Easy	Oral	Boil root in water, then filter and drink a glass of water	26.579	0.049
Rubiaceae	<i>Paederia foetida</i> L.	<i>Pasaran</i>	Herb	Leaf, root	Wild	Moderate	Oral	Dry the root and fruit, then grind it into powder and take as pills	31.579	0.170
Rutaceae	<i>Aegle marmelos</i> (L.) Corrêa	<i>Bel</i>	Tree	Leaf, bark	Cultivated and wild	Easy	Oral	Dry the leaves and bark then grind it into powder and take as a decoction	58.730	0.466
Sapindaceae	<i>Schleichera oleosa</i> (Lour.) Oken	<i>Kosum</i>	Herb	Bark	Wild	Moderate	Oral	Dry the bark then grind it into powder and take as pills	27.389	0.071
Sapotaceae	<i>Madhuca longifolia</i> (L.) J.F.Macbr.	<i>Mahuwa</i>	Tree	Bark	Wild	Easy	Oral	Dry the wet bark then grind it into powder and take as a decoction	58.730	0.466
Solanaceae	<i>Withania coagulans</i> (Stocks) Dunal	<i>Paneer phool</i>	Shurb	Leaf	Wild	Difficult	Oral	Dry the leaf then grind it into powder and take as a decoction	30.719	0.152
Zingiberaceae	<i>Curcuma longa</i> L.	<i>Haldi</i>	Herb	Leaf	Cultivated	Easy	Oral	The green leaf is to be heated in water and drink a glass as tea	51.515	0.418

Interpretation using ethnobotanical indices

Most of the earlier ethnobotanical studies were chiefly concerned with the listing of medicinal plants; gradually, it was realized the ethnobotanical indices were required for cultural consensus, which eventually led to effective doses (Leonti 2022). Hence, a wider consensus on the use of ethnomedicinal plants would imply its wider effectiveness in countering disease and ailments. This eventually led to the discovery of new drugs and therapeutics, which is the basis of one of the popular branches of pharmacy, i.e., ethnopharmacology (Heinrich 2014). Ethnobotanical indices offer us useful insights into the use, knowledge, and popularity of an herbal formulation; this helps us zoom into the use value of a particular medicinal plant in the area. In this study area, tribal healers used 40 species of medicinal plants from 35 genera and 30 different families to treat diabetes (Table 1). The highest Fidelity Level (FL) at 98% was in *Terminalia arjuna* (Roxb. Ex DC.) Wight & Arn. and *Pterocarpus marsupium* Roxb., followed by *Bauhinia vahlii* Wight & Arn. (92%), *Moringa oleifera* Lam. (88%), *Gymnema sylvestris* R. Br. (85%), *Tinospora cordifolia* (Willd.) Hook.f.& Thomson (80%). The highest ICF ranked *T. arjuna* and *P. marsupium* (0.602), followed by *B. vahlii* (0.589), and *M. oleifera* (0.581). The higher FL and ICF values for plants such as *T. arjuna* and *P. marsupium* indicate their greater acceptability and probably efficacy against the diabetics of this part of central India. In a recent review of Ayurveda, Chinese, and Unani medicine review of antidiabetic plants, the herbal formulation of Mehamudgara vati was found to be effective and had a synergistic effect when combined with modern drugs (Murudkar et al. 2022). Some commonly cultivated plants used in the treatment of diabetes were *Aegle marmelos* (L.) Corrêa, *Allium cepa* L., and *Curcuma longa* L., which were found to tally with those in Morocco and other parts of India as well (Devi et al. 2016; Sakli et al. 2019).

In conclusion, ethnomedicinal plants have evolved through centuries of trial and error to heal humans from different ailments; even today, most medicinal plants are from the wild. In the rural and underdeveloped parts of the world, the only source of treatment is probably traditional healers. The destruction of forests and rampant collection from the wild may eventually lead to the disappearance of some species. Hence, some should be brought under cultivation. Worldwide, there is a rise in urbanization and also competition for earning a decent living, which is pushing many young people under stress-related disorders. Diabetes is one such stress-related disorder where current treatment regimens are usually of longer duration, risking the side effects on the patients. In the above study, wild collection was mostly preferred; a few new species, like *P. marsupium*, *T. arjuna*, and *B. vahlii*, had shown higher acceptance with the local healers, suggesting their possible efficacy in treating diabetes. In other words, some plants have higher ethnobotanical indices, meaning there are chances to explore new drugs and formulate better drugs soon.

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Ethnobotany of medicinal plants used by the Javanese community of Mount Merapi National Park, Central Java, Indonesia

ABIZAN RAMADHAN TORIMBANU¹, AFFANDI FIRMAN SAPUTRA¹, AHMAD ASFAR AULIA¹,
ALIFIA NAMIRA UTOMO¹, RAISA NOOR SAFIRA^{2,3}, AHMAD YASA⁴, SURAPON SAENSOUK⁵,
AHMAD DWI SETYAWAN^{1,6,*}

¹Department of Environmental Science, Faculty of Mathematics and Natural Science, Universitas Sebelas Maret. Jl. Ir. Sutami No. 36, Surakarta 57126, Central Java, Indonesia. *email: volatileoils@gmail.com

²Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Sebelas Maret. Jl. Ir. Sutami No. 36, Surakarta 57126, Central Java, Indonesia

³Biodiversity Study Club, Faculty of Mathematics and Natural Sciences, Universitas Sebelas Maret. Jl. Ir. Sutami No. 36, Surakarta 57126, Central Java, Indonesia

⁴Faculty of Medicines, Universitas Sebelas Maret. Jl. Ir. Sutami No. 36 Surakarta 57126, Central Java, Indonesia

⁵WalaiRukhajej Botanical Research Institute, Mahasarakham University. MahaSarakham 44150, Thailand

⁶Biodiversity Research Group, Universitas Sebelas Maret. Jl. Ir. Sutami No. 36, Surakarta 57126, Central Java, Indonesia

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Abstract. Torimbanu AR, Saputra AF, Aulia AA, Utomo AN, Safira RN, Yasa A, Saensouk S, Setyawan AD. 2024. Ethnobotany of medicinal plants used by the Javanese community of Mount Merapi National Park, Central Java, Indonesia. *Asian J Ethnobiol* 7: 130-143. The majority of medicines and health care come from plants. This research explores medicinal plants used by Javanese people on the eastern slopes of Mount Merapi National Park, Central Java, Indonesia, located in two districts, Klaten and Boyolali. This research was carried out by collecting data on respondents' socio-economics and ethnobotany regarding medicinal plants, and identified four key informants using the snowball sampling method. The interviews were also conducted using a questionnaire method to find out information on the use of medicinal plants by the 81 respondents. The data was analyzed using several quantitative ethnobotanical indices. In this research, 73 species of medicinal plants from 35 families were identified. Zingiberaceae dominates with 12 species, followed by Myrtaceae consist five species. Leaves are the most widely used part of the plant, namely around 34%, followed by fruit at 17.8% and tubers at 19.2%. *Cicer arietinum* L. (0.88) and *Vaccinium varingiaefolium* Miq. (0.64) have the most significant number of Relative Frequency Citations (RFC); the highest Informant Consensus Factor (ICF) value was for the SSA disease category (Symptoms, signs, and abnormal clinical and laboratory) with a value of 0.96, the highest Use Value (UV) value was *Allium cepa* and *Allium sativum* with the same value, namely 0.06. The highest Informant Agreement Ratio (IAR) value is 1.00, one of which is by fennel species or *Foeniculum vulgare*.

Keywords: Ethnobotany, health, ICF, medicinal plants, Mount Merapi, RFC, UV

INTRODUCTION

For centuries, humans on this earth have used wild medicinal plants (Al-Laith et al. 2019). The use of these plants is not limited to a specific region or culture but is a global practice that has been in place since ancient times, specifically in ancient Mesopotamia, around 3,000-5,000 years ago (Dafni et al. 2019). The most compelling evidence suggests that the earliest use of medicinal plants dates back 5,000 years, as recorded on Sumerian tablets from Iraq and clay tablets from Nagpur, India. These tablets document 12 medicinal recipes that mention over 250 species of medicinal plants, including several containing alkaloids like poppy, henbane, and mandrake (Cartwright and Armstrong 2020). According to the World Health Organization (WHO) (2013), 80% of the world's population, whether in developed or developing countries, still relies on medicinal plants for most medicines and health care. This global reliance on herbal medicine underscores its significance in every civilization's form of medicine (Salmerón-Manzano et al. 2020).

Recently, many types of medicinal plants have been researched and used further, ranging from minor ailments to even serious ailments (Hong et al. 2015). The use of herbal plants as medicines continues to increase nationally and internationally (Ekor 2015). This can encourage the growth of the traditional medicine industry and business, especially in Indonesia. Traditional medicinal plants, which have long been an integral part of people's lives, play an important role in maintaining health, maintaining stamina, and assisting in treating disease (Ullah et al. 2020). Therefore, the use of traditional medicinal plants has become a strong tradition in most people's lives today (Jamsidhi-Kia et al. 2017). For example, digoxin is used to treat chronic heart issues and comes from a flowering plant called *Digitalis purpurea*. Morphine is used to relieve high pain and comes from the sap of the fruit of *Papaver somniferum*; quinine is used to treat malaria, whereas the compound comes from isolating the bark of *Cinchona* sp. (Patocka et al. 2020).

However, despite their importance, the use and understanding of medicinal plants are often overlooked or

even threatened with extinction (Kaky and Gilbert 2019). Changes in modern lifestyles, urbanization, and the natural environment can threaten the existence of medicinal plants and people's knowledge of these plants. The loss of traditional knowledge from generation to generation regarding medicinal plants can cause significant harm to the health of society. Therefore, the need for conservation efforts and documentation of medicinal plant knowledge is crucial to prevent them from disappearing from the community (Chandra and Uniyal 2021). In this modern era, medicinal plants increasingly receive attention from the scientific and pharmaceutical industries.

Java Island, Indonesia is among the most populous major island in the world; over half of Indonesia's population of nearly 280 million lives on Java (MHA 2023). The population of Java Island mainly comes from Javanese and Sundanese tribes, Javanese dominate the central and eastern provinces, as well as the northern coast in the western provinces (Naim and Syaputra 2011). Central Java Province is dominated by the Javanese tribe (98%) (BPS 2010). According to Arinalhaq and Wibowo (2020), several threats cause land changes in Mount Merapi National Park, Central Java, including natural threats such as volcanic activity and human activities such as sand mining and land clearing for grass cultivation in forest areas. Sutomo and Fardila (2013) stated that natural disasters in the form of fires can affect the composition of plant species in MMNP; plants and grass dominate more in burnt areas, while in intact areas, shrubs and ferns dominate. The increase in land changes can decrease biodiversity, including medicinal plants (Sen and Samantha 2015). The lack of information regarding both species and benefits can reduce human awareness of the richness of medicinal plant species around them. Modernization in the form of switching from traditional medicine to modern

medicine can narrow the area for medicinal plants. For this reason, it is important to carry out this research, namely related to providing a database of medicinal plant species, their benefits, and processing by the community.

This research explores medicinal plants on the eastern slopes of Mount Merapi, specifically in the villages of Musuk, Sruni, and Tegalmulyo, located in Boyolali and Klaten districts of Central Java, Indonesia.

MATERIALS AND METHODS

Study area

This research was carried out in three villages located on the eastern slope of Mount Merapi, Central Java, Indonesia namely Musuk Village ($7^{\circ}41'31.2''\text{S}$ to $110^{\circ}34'45.5''\text{E}$) and Sruni Village ($7^{\circ}42'09.0''\text{S}$ to $110^{\circ}35'21.8''\text{E}$) of Boyolali District as well as Tegalmulyo Village ($7^{\circ}41'53.2''\text{S}$ to $110^{\circ}36'05.8''\text{E}$) in Klaten District (Figure 1). These three villages are mostly used for agricultural land, settlement, forest, and agroforestry because the geographical conditions are influenced by their location on the slopes of Mount Merapi. They have fertile soil that is suitable for planting various types of plants and relatively cool air and temperatures, making them suitable for use as agricultural and residential land (Susilo and Rudiarto 2014). Musuk Villages is more than 600 meters above sea level (masl), and Sruni Village is more than 700 masl. Meanwhile, Tegalmulyo Village is located higher at an altitude of 1,300 masl and is only approximately 3 km from the peak of Mount Merapi (googleearth.com). Almost every house in the village has its home garden planted with fruit, vegetables, and herbal plants. Like other remote villages in Central Java, the population of this village is almost all Javanese, and their livelihood is in agriculture.

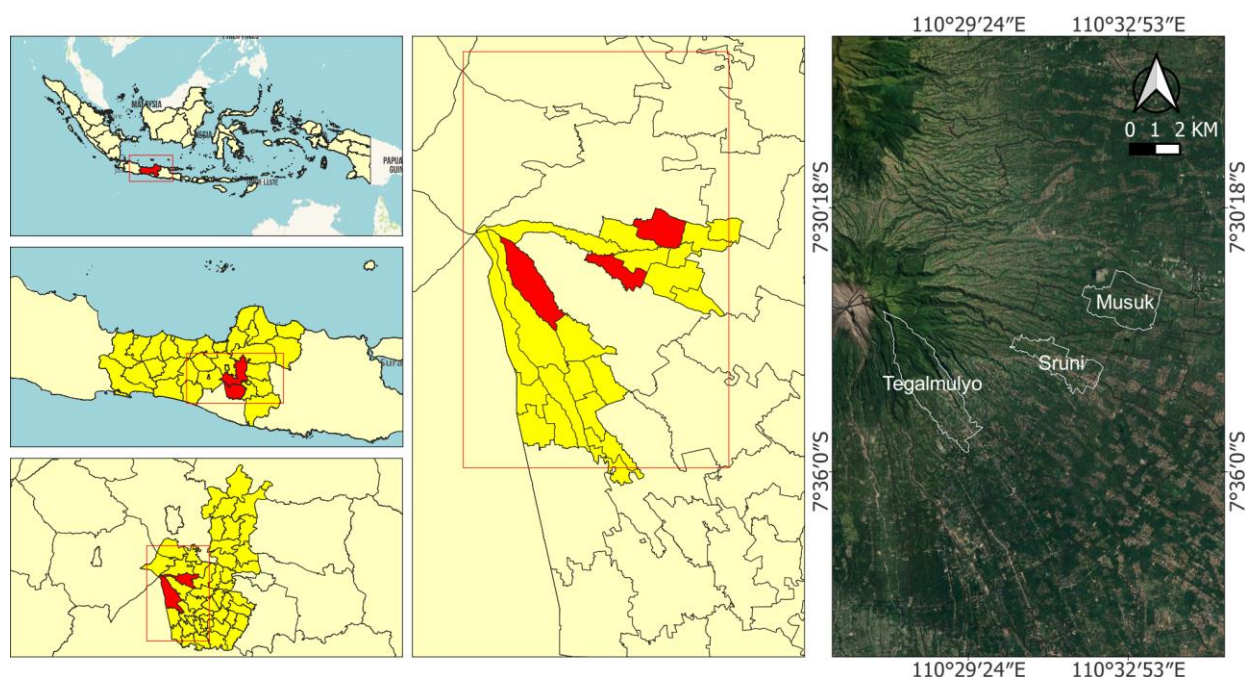


Figure 1. The study area in Tegalmulyo, Srunia, Musuk Villages, Kemalang and Musuk Sub-district, Boyolali, Central Java, Indonesia

Ethnobotanical data collection

This research was carried out using documentation and interviews to collect names and species of medicinal plants. The collection methods used in this research were snowball sampling and purposive sampling. The snowball sampling method is used to find key informants with much information and is taken in a chain or continuously (Seran 2022). This research involved four key informants: (i) an in-depth interview method, and (ii) a questionnaire method with 81 respondents. Meanwhile, the purposive sampling method is used to obtain samples that represent the research objectives and meet the criteria for providing information. The sample limit used in the purposive sampling method was residents living in Musuk, Seruni, or Tegalmulyo Villages. The informants in this study consist of both genders, male and female, with several age groups (under 20 years old, 21-30 years old, 31-40 years old, 41-50 years old, 51-60 years old, and over 60 years old), and several education levels (no education, Elementary School, Junior High School, Senior High School, and University).

In-depth interview

The selection of informants is conducted through the snowball sampling method, which involves identifying key informants. These key informants then provide recommendations for the subsequent individuals to be interviewed (Ramadhani et al. 2023). When identifying key informants, we will gather input from previous informants and customize it to align with factors such as the informant's professional background and daily activities. This approach will enable us to gather comprehensive and well-supported information concerning the utilization of medicinal plants in the village. During the in-depth interview session, we were inquired about the species utilized by local communities, including the specific parts of the plants used and the methods by which they were processed. The insights gleaned from key informants can serve as a valuable guide for conducting interviews with the general respondents. Key informants with extensive knowledge of community habits and plants include the village head, community leader of the *Masyarakat Peduli Api* (Fire Care Society), shaman/herbal medicine seller, and head of the *Kelompok Tani Hutan Agni Mandiri* (Agni Mandiri Forest Farmers Group).

Questionnaire

Questionnaire data was collected from 81 respondents who were interviewed and selected via purposive sampling based on the research area's division, with a particular emphasis on the local villages located on Mount Merapi's east slope. Each respondent was asked questions about known medicinal plants, such as cultivation status (wild or cultivated), habitat found (forest, garden, yard, or rice field), habitus (tree, shrub, herb, climber), plant parts used (seeds, fruit, shoots, leaves, stems, rhizomes, tubers), how to use (raw or processed), and whether they were used to treat any disease.

Data analysis

Relative Frequency Citation (RFC)

The data collected was analyzed quantitatively to calculate the ratio between each type of medicinal plant received and the total number of respondents, using Relative Frequency Citation (RFC); RFC was calculated with the following formula (Butt et al. 2015):

$$RFC = FC/N \quad (0 < RFC < 1)$$

Where: the frequency of citation (FC), the number of informants mentioning the use of the species, divided by the total number of informants participating in the survey (N).

Use Value (UV)

To estimate the measurement used to assess how valuable each species of medicinal plant is for local people, Use Value (UV) was computed using the following formula (Bano et al. 2014):

$$UV_s = \frac{\sum_{i=1}^n U_{is}}{N_s}$$

Where: UV represents the use-value of a given species; U represents the number of uses of species mentioned by respondents, and N is the number of informants who know the value per species. High UV indicates high-use reports for a plant important to the local community. Low UV indicates that there are few reports of its use.

Informant Agreement Ratio (IAR)

This research quantitatively analyzes medicinal plant data using the informant agreement ratio (IAR). IAR measures informants' level of agreement about using certain medicinal plants to treat certain diseases (Wildayati et al. 2016). This research involved 81 informants who provided information about medicinal plants commonly used by the community. The Informant Agreement Ratio (IAR) calculates how much respondents agree with using a medicinal plant for a particular use. IAR can be calculated using the following formula (Chaachouay et al. 2019):

$$IAR = \frac{Nr - Na}{Nr - 1}$$

Where: Nr is the total number of citations for the species, and Na is the number of diseases for which the species has been cited.

Informant Consensus Factor (ICF)

The Informant Consensus Factor (ICF) was used to measure the level of agreement between informants regarding the use of certain plants; it was calculated using the following formula (Heinrich et al. 1998):

$$ICF = \frac{N_{ur} - N_t}{N_{ur} - 1}$$

Where: Nur represents the number of useful reports in each category, and Nt represents the total number of species used by all informants in a given category.

RESULTS AND DISCUSSION

Socio-demographic characteristics

This research involved 81 respondents, including 15 community leaders as key informants. They are a 50-year-old male, neighborhood association head (Ketua RT) who graduated from elementary school, a 50-year-old male, an entrepreneur who graduated from high school, a 50-year-old male, a local farmer who also graduated from high school, and a 45-year-old female, local farmer, who graduated from elementary school. According to the study's findings, the majority of respondents share comparable gender, age, and educational backgrounds. Of the respondents, 62% were men, 39.51% were between the ages of 41 and 50, and 61.73% had completed elementary school. Meanwhile, respondents under the age of 20 and with a university education were rare, accounting for only 2.47 and 1.23%, respectively (Table 1). People with a low level of education, those who have not graduated from elementary, middle, or high school, are the most likely to practice traditional medicine. Adiyasa and Meiyanti (2021) discovered that those who are less knowledgeable about traditional medicine are more likely to take it because they continue to believe in their ancestors. A person's trust in therapy influences their ability to select a safe and beneficial treatment (Wahab et al. 2022). According to Afriliana's (2019) research, women comprehend traditional medicine better than men since they are more motivated to learn about a certain cure. Age also influences people's level of knowledge regarding local wisdom or local plants because it influences a person's mental development, which includes comprehension and thought patterns. Age also

influences a person's attitudes and behavior toward existing and new knowledge (Hidayati et al. 2022).

The communities around MMNP rely on medicinal plants due to their access to natural resources and familiarity with local biodiversity. They utilize various plants, such as ginger, turmeric, and parijoto, which have been employed for generations. Limited access to modern healthcare and dependence on agriculture leads to a preference for affordable traditional medicine. Additionally, cultural values emphasizing respect for nature and ancestral knowledge reinforce the significance of these plants in daily life, particularly for treating minor ailments and maintaining health.

Plant diversity

In the area, 74 species of medicinal plants from 35 families were identified. Table 2 contains ethnomedicinal information for each species, including family name, scientific name, local name, plant part used, preparation, method of application, and disease. Zingiberaceae contributed the most medicinal species, with 12 species (Figure 2), followed by Myrtaceae with 5 species, and Euphorbiaceae, Fabaceae, Lamiaceae, and Poaceae with 4 species.

Table 1. Socio-demographics of respondents

	Variable	Total	Percentage
Gender	Men	50	62%
	Women	31	38%
Age	<20	2	2.47%
	21-30	9	11.11%
	31-40	12	14.81%
	41-50	32	39.51%
	51-60	14	17.28%
	>60	12	14.81%
Education	No education	2	2.47%
	Elementary school	50	61.73%
	Junior High School	13	16.05%
	Senior High School	15	18.52%
	University	1	1.23%

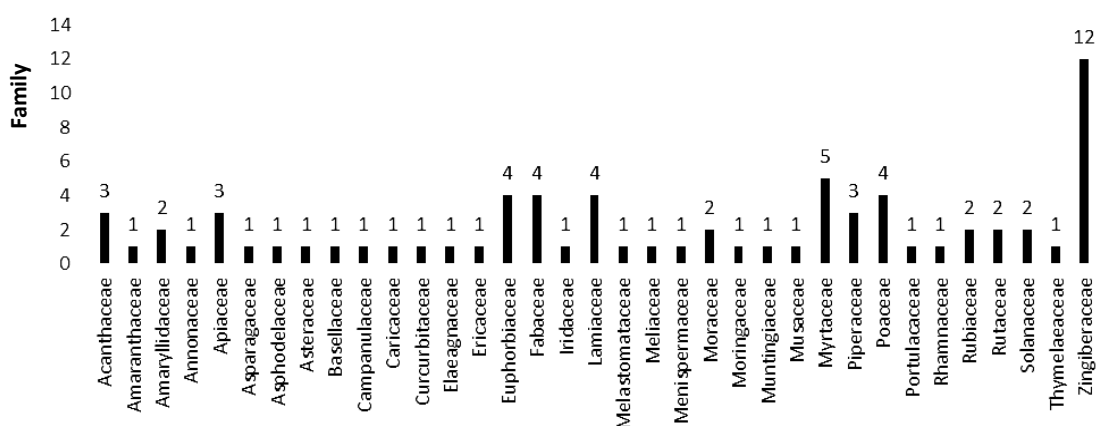


Figure 2. Number of plant species by the family of medicinal plants

Table 2. List of wild medicinal plants

Scientific name	Local name	Family	Habitats	Habitus	Plant parts used	Mode of preparation	Disease	RFC	UV
<i>Acorus calamus</i> L.	Dlingo	Acanthaceae	Yard	Herb	Leaf	Refined	Itching, fever	0.02	0.01
<i>Allium cepa</i> L.	Brambang	Amaryllidaceae	Yard	Herb	Tubers	Refined	Scraping cleans the lungs, improves heart function, flatulence, anti-cancer	0.02	0.06
<i>Allium sativum</i> L.	Bawang putih	Amaryllidaceae	Yard	Herb	Tubers	Eat straight away	Antibiotics, high blood pressure, coughs, colds, and medication for itching	0.57	0.06
<i>Aloe vera</i> (L.) Burm.f.	Lidah buaya	Asphodelaceae	Yard	Herb	Stem (sap)	Smear	Burn medicine	0.02	0.01
<i>Alpinia galanga</i> (L.) wild.	Temugiring	Zingiberaceae	Yard	Herb	Tubers	Smear	Tinea versicolor medicine, body endurance	0.02	0.02
<i>Annona muricata</i> L.	Sirsak	Annonaceae	Yard	Tree	Leaf	Boiled	High blood pressure medication	0.37	0.02
<i>Anredera cordifolia</i> (Ten.) Steenis	Binahong	Basellaceae	Yard	Climber	Leaf	Refined	Cut wound medicine	0.07	0.01
<i>Apium graveolens</i> L.	seledri	Apiaceae	Yard	Herb	Leaf	Boiled	High blood pressure medication	0.12	0.01
<i>Artocarpus heterophyllus</i> Lam.	Murbei	Moraceae	Yard	Tree	Fruit	Mixed with water	Children's smallpox medicine	0.01	0.01
<i>Beta vulgaris</i> subsp. <i>vulgaris</i>	Bit	Amaranthaceae	Yard	Herb	Tubers	Eat straight away, in juice	Facilitate digestion	0.02	0.01
<i>Capsicum frutescens</i> L.	Cabai	Solanaceae	Gardens and yards	Herb	Fruit	Smear	Ulcer	0.02	0.01
<i>Carica papaya</i> L.	Gantung	Caricaceae	Yard	Bush	Leaf	Smear	Anemia medication	0.09	0.01
<i>Cicer arietinum</i> L.		Fabaceae	Yard	Tree	Leaves, fruit	Brewed, eaten straight away	Lowers cholesterol	0.88	0.01
<i>Cinchona</i> sp.	cincau	Rubiaceae	Gardens and yards	Tree	Stem	Refined	Cut	0.22	0.01
<i>Cinnamomum verum</i> J.Presl	Manis jangan	Lamiaceae	Forest and yard	Tree	Tree bark	Boiled	Rheumatism medicine	0.01	0.01
<i>Citrus aurantifolia</i> (Christm.) Swingle	Jeruk nipis	Rutaceae	Yard	Tree	Fruit	Drink straight away	Cough	0.15	0.01
<i>Citrus ×limon</i> (L.) Osbeck	Lemon	Rutaceae	Yard	Tree	Fruit	Drink straight away	Cough, endurance	0.02	0.01
<i>Clinacanthus nutans</i> (Burm.fil.) Lindau	Ambeven /daun ungu	Acanthaceae	Yard	Bush	Leaf	Boiled	Diabetes	0.49	0.01
<i>Clitoria ternatea</i> L.	Telang	Fabaceae	Yard	Climber	Flower	Brewed	Eye, menstrual smoother	0.02	0.01
<i>Cordyline fruticosa</i> (L.) A.Chev.	Andong	Asparagaceae	Yard	Bush	Leaf	Brewed	High blood	0.06	0.01
<i>Cuminum cyminum</i> L.	Jinten putih	Apiaceae	Yard	Herb	Seed	Boiled	Indigestion	0.04	0.01
<i>Curcuma aeruginosa</i> Roxb.	Jahe merah	Zingiberaceae	Yard	Herb	Tubers	Boiled	Rheumatism	0.02	0.01
<i>Curcuma heyneana</i> Valeton & Zijp	Puyang	Zingiberaceae	Yard	Herb	Tubers	Boiled	Anthelmintic	0.21	0.01
<i>Curcuma longa</i> L.	White ginger	Zingiberaceae	Yard	Herb	Tubers	Smear	Diarrhea medicine	0.04	0.01
<i>Curcuma zanthorrhiza</i> Roxb.	Temulawak	Zingiberaceae	Yard	Herb	Tubers	Boiled	Diarrhea, fever	0.54	0.01
<i>Curcuma zedoaria</i> (Christm.) Roscoe	Temu putih	Zingiberaceae	Yard	Herb	Tubers	Smear	Diarrhea medicine	0.05	0.01

<i>Cymbopogon</i> sp.	Sereh	Poaceae	Yard	Herb	Stem	Boiled, drink straight away	Catch a cold and tongue freshener	0.04	0.01
<i>Dendrocalamus asper</i> (Schult.f.) Backer	Bambu	Poaceae	Garden	Tree	Young shoots	Cooked (processed with oil as food)	Cholesterol, heart	0.02	0.01
<i>Elaeagnus latifolia</i> L.		Elaeagnaceae	Forest and yard	Herb	Leaf	Eat straight away, boiled	Prevent hepatitis	0.02	0.02
<i>Elephantopus scaber</i> L.	Tapak liman	Asteraceae	Yard	Herb	Leaf	Boiled	Rheumatism medicine	0.26	0.01
<i>Eleutherine bulbosa</i> (Mill.) Urb.	Bawang dayak	Iridaceae	Yard	Herb	Tubers	Boiled	Asthma	0.02	0.01
<i>Erythrina variegata</i> L.	Dadap	Fabaceae	Yard	Tree	Leaf	Smear	Heat reducer	0.01	0.01
<i>Etlingera elatior</i> (Jack) R.M.Sm.	Combrang	Zingiberaceae	Yard	Herb	Flower	Grated then boiled, brewed, and drunk	Heat medicine	0.06	0.01
<i>Euphorbia pulcherrima</i> Willd. ex Klotzsch	Singkong	Euphorbiaceae	Yard	Bush	Flower	Boiled	Blood sugar	0.02	0.04
<i>Foeniculum vulgare</i> Mill.	Adas	Apiaceae	Yard	Herb	Leaf	Boiled	Breast milk booster	0.02	0.02
<i>Graptophyllum pictum</i> (L.) Griff.	Dandang gendhis	Acanthaceae	Yard	Bush	Leaf	Brewed	Hemorrhoids	0.33	0.01
<i>Hevea brasiliensis</i> (Willd. ex A.Juss.) Müll.Arg.	Karet	Euphorbiaceae	Yard	Tree	Sap	Smear	Cut wound medicine	0.02	0.02
<i>Hippobroma longiflora</i> (L.) G.Don	Kitolot	Campanulaceae	Yard	Herb	Leaf	Drink straight away	Sore eyes	0.01	0.01
<i>Imperata cylindrica</i> (L.) Raeusch.	Alang-alang	Poaceae	Yard	Herb	Root	Boiled, Mashed	Medicine for rheumatism, wounds	0.40	0.01
<i>Jatropha multifida</i> L.	Yodium/Penicilin	Euphorbiaceae	Forest and yard	Herb	Sap	Boiled, smear	Cut wound medicine	0.58	0.04
<i>Kaempferia galanga</i> L.	Kencur	Zingiberaceae	Yard	Herb	Tubers	Eat straight away, boiled, grilled	Increasing children's appetite, cough medicine	0.02	0.01
<i>Manihot esculenta</i> Crantz	Singkong	Euphorbiaceae	Yard	Bush	Leaf	Boiled	Anemia medication	0.38	0.01
<i>Medinilla speciosa</i> (Reinw. ex Blume) Blume	Parijoto	Melastomataceae	Forest	Bush	Fruit	Eat straight away	Pregnancy program	0.06	0.02
<i>Mentha</i> sp.	Legundi	Lamiaceae	Yard	Herb	Leaf	Inhaled	Respiratory illness	0.01	0.01
<i>Mimosa pudica</i> L.	Putri malu	Fabaceae	Yard	Herb	Root	Boiled	Hypertension	0.01	0.01
<i>Morinda citrifolia</i> L.	Pace	Rubiaceae	Yard	Tree	Fruit	Brewed	Anti-cancer	0.16	0.01
<i>Moringa oleifera</i> Lam.	Moringa	Moringaceae	Yard	Tree	Leaf	Boiled	Medicine for aches	0.05	0.01
<i>Morus</i> sp.	Nangka	Moraceae	Yard	Herb	Fruit	Boiled	High blood	0.02	0.01
<i>Muntingia calabura</i> L.	Talok	Muntingiaceae	Yard	Tree	Leaf	Boiled	Itching medicine	0.56	0.01
<i>Musa ×paradisica</i> L.	Pisang	Musaceae	Yard	Herb	Sap	Smear	Wound	0.04	0.01
<i>Persea americana</i> Mill.	Alpukat	Lamiaceae	Yard	Tree	Leaf	Boiled	High blood pressure medication	0.04	0.01
<i>Phaleria macrocarpa</i> (scheff.) Boerl.	Mahkota dewa	Thymelaeaceae	Yard	Tree	Fruit	Boiled	Body endurance	0.02	0.01
<i>Physalis</i> sp.	Ciplukan	Solanaceae	Garden	Herb	Fruit	Eat straight away	Facilitate urination	0.21	0.01
<i>Piper betle</i> L.	Pepper	Piperaceae	Yard	Climber	Leaf	Place it directly inside nose	Nosebleed	0.01	0.01
<i>Piper nigrum</i> L.	Sirih ungu	Piperaceae	Gardens and yards	Climber	Seed	Boiled	Indigestion	0.02	0.01
<i>Piper ornatum</i> N.E.Br.	Betel	Piperaceae	Yard	Climber	Leaf	Refined	Itching medicine	0.02	0.02
<i>Portulaca</i> sp.	Krokot	Portulacaceae	Yard	Herb	Leaf	Boiled	Antidote	0.02	0.01

<i>Psidium guajava</i> L.	Jambu biji	Myrtaceae	Yard	Tree	Leaf	Eat straight away	Diarrhea medicine	0.01	0.01
<i>Sechium edule</i> (jacq.) Sw.	Jipan	Curcubitaceae	Gardens and yards	Tree	Fruit	Smear	Heat reducer	0.07	0.01
<i>Swietenia mahagoni</i> (L.) jacq.	Mahogany	Meliaceae	Yard	Tree	Fruit, seeds	Eat straight away	Hypertension, healthy heart	0.37	0.01
<i>Syzygium aqueum</i> (Burm.fil.) Alston	Jambu air	Myrtaceae	Yard	Tree	Fruit	Boiled	Diarrhea	0.21	0.01
<i>Syzygium aromaticum</i> (L.) Merr. & L.M.Perry	Cengkeh	Myrtaceae	Yard	Tree	Stalk	Boiled, Distilled	Cough	0.20	0.01
<i>Syzygium cumini</i> (L.) Skeels	Duwet putih	Myrtaceae	Yard	Tree	Fruit	Eat straight away	Cough, digestion	0.04	0.01
<i>Syzygium polyanthum</i> (Wight) Walp.	Daun salam	Myrtaceae	Yard	Bush	Leaf	Vegetables	Body endurance	0.01	0.01
<i>Tinospora cordifolia</i> (Willd.) Miers	Brotowali	Menispermaceae	Yard	Herb	Leaf	Boiled	Body endurance	0.01	0.01
<i>Vaccinium varingaefolium</i> Miq.	Centigi	Ericaceae	Forest and yard	Bush	Fruit	Eat straight away	Diabetes	0.64	0.02
<i>Vitex trifolia</i> L.	Mint	Lamiaceae	Forest	Bush	Leaf	Boiled	Itching medicine	0.02	0.01
<i>Zea mays</i> L.	Jagung	Poaceae	Yard	tree	Seed	Boiled	Constipation, diarrhea	0.02	0.01
<i>Zingiber officinale</i> Roscoe	Laos	Zingiberaceae	Yard	Herb	Tubers	Boiled	Stones, colds, endurance	0.12	0.01
<i>Zingiber officinale</i> var <i>officinarum</i> Roscoe	Jahe merah	Zingiberaceae	Garden	Herb	Tubers	Boiled	Stones, colds, endurance	0.07	0.02
<i>Zingiber officinale</i> var <i>rubrum</i> Roscoe	Jahe putih	Zingiberaceae	Yard	Herb	Tubers	Boiled, grilled, drink straight away	Cough medicine	0.26	0.01
<i>Zingiber zerumbet</i> (L.) Roscoe ex Sm.	Kunyit	Zingiberaceae	Forest and yard	Herb	Buds, flowers	Boiled, eat straight away	Inflammation	0.02	0.01
<i>Ziziphus mauritiana</i> Lam.	Bidara	Rhamnaceae	Yard	Tree	Leaves, seeds	Mixed with water	Facilitate digestion, burns	0.14	0.01

Note: Yard means *pekarangan*, Garden means *kebon*, forest garden or *taungya*

The Zingiberaceae family is better known to the public as the ginger plant and has been used as cooking spices, traditional medicine in the form of herbal medicine, cosmetic ingredients, and ornamental plants. The factor that causes this plant to dominate on the slopes of Mt. Merapi is cool weather (Setyawati and Ashari 2017), so these plants can act as body warmer for humans. The Zingiberaceae family is known to have great economic potential, so the cultivation of this plant can generate financial benefits for local communities. As noted by Syamsuri and Alang (2021), numerous ethnic groups in Indonesia have gained valuable insights into the uses of this family through generations of traditional knowledge. This rich cultural heritage underscores the importance of preserving and promoting such practices for both economic and social development.

Aprilianti et al. (2021) add that the soil on these slopes is highly fertile, well-drained, and rich in organic matter, conditions influenced by volcanic activity that releases ash and nutrient-rich lava. This plant also thrives in wet, cool areas with frequent rainfall. The climate of Mt. Merapi's slopes, characterized by high elevation, humidity, and abundant rainfall, effectively meets the plant's needs.

The Myrtaceae family, or what is usually called the guava family, is known for its medicinal properties. In various regions, especially tropical areas such as Central Java, Indonesia, plants from this family are used to treat digestive disorders. Well-known species include guava (*Psidium guajava* L.), water apple (*Syzygium aqueum* (Burm. fil.)), clove (*Syzygium aromaticum* (L.) Merr. & L.M. Perry), white duwet (*Syzygium cumini* (L.) Skeels), and laurel (*Syzygium polyanthum* (Wight) Walp). According to Gunawan et al. (2015), Bay (*Syzygium polyanthum* (Wight) Walp) is growing naturally in TNMM. The Myrtaceae family is widespread in tropical areas and is characterized by rough leaves that contain oil glands so that this plant can survive relatively cold weather; habitus can facilitate the recognition and classification of medicinal plants according to their morphological characteristics.

Habitats

Indonesia boasts the highest number of vascular plants, with over 29,375 species of indigenous plants thriving in diverse settings, including forests, yards, and gardens (Long et al. 2018). Based on the data collected from the respondents (Figure 3), yards are habitats located near human settlements. They are home to 82% of plant species, including mango trees, guava trees, rambutan trees, and coconut trees. Rural populations persist in utilizing traditional remedies through their cultivation, which facilitates convenient access to the plants, is cost-effective, and promotes self-sufficiency within their households (Lestari et al. 2021). Forests are lush, shaded, and fertile ecosystems that support 10% of plant species, including cinnamon, mint, and iodium/penicillin. Gardens are human-created environments that support 8% of plant species, including bamboo shoots, ginger, pepper, and chile. Various factors, particularly demand factors, can influence the habitat of these plants. For instance, plants

grown in home gardens are often used for medicinal purposes, particularly as a first-aid remedy. On the other hand, plants grown in gardens or forests typically require less usage or are seldom used. A likely explanation for the scarcity of plant species is the prevalence of monocultures in plantations, where only a single crop type, such as palm oil, rubber, or coffee, is cultivated. This diminishes the variety of plant species that can thrive in the vicinity since they are compelled to vie for resources and territory with the prevailing crop. Plantations frequently employ pesticides and fertilizers that have the potential to impact the indigenous flora and soil microorganisms negatively.

In addition, the establishment of plantations can result in deforestation and the destruction of habitats for several plant species that are native to the rainforests of Indonesia. These rainforests are known for their very high levels of biological variety (Su et al. 2023). As a result, plantations in Indonesia have the potential to support more plant diversity and contribute to conservation efforts. Alamgir and Alamgir (2017) conducted a study that identified two primary classifications of medicinal plants depending on their habitat: cultivated and wild. Humans deliberately develop and sustain cultivated plants, but wild plants grow spontaneously without human intervention. These plants exhibit variations in their traits and attributes due to variables such as natural selection, environmental stress, and genetic variety. Figure 3 presents an overview of the habitats of the observed plant species. The majority of these species, comprising 80.8%, are found in yard habitats. Notable examples include *Acorus calamus* L., *Allium cepa* L., and *Allium sativum* L. The remaining 9.6% of the species are associated with forest habitats, with representative species such as *Vitex trifolia* L., *Cinnamomum verum* J. Presl, and *Elaeagnus latifolia* L. The plants identified in yard habitats are predominantly cultivated varieties, actively maintained by the community. In contrast, the plants observed in forest habitats are primarily wild species that thrive naturally in their surroundings. Furthermore, the species found in garden habitats comprise a blend of cultivated plants and those that grow wild. This distinction highlights the varying interactions between human cultivation and natural ecosystems.

Habitus

The finding revealed the medicinal plant habitus most widely used by the community is herbs (47.9%), followed by trees (31.5%), shrubs (13.7%), and climbers (6.8%) (Figure 4). Bana et al. (2016) observed that herbaceous plants are frequently employed as therapeutic plants because of their pervasive presence in individuals' yards and gardens. This indicates that people prefer medicinal plants that are easy to cultivate, harvest, and process, such as herbs and trees, compared to plants that require additional support, such as climbers. Additionally, climbers are more challenging to utilize medicinally due to their reliance on other plants for support and growth, distinguishing their characteristics from other plant types (Lestari and Ningrum 2021).

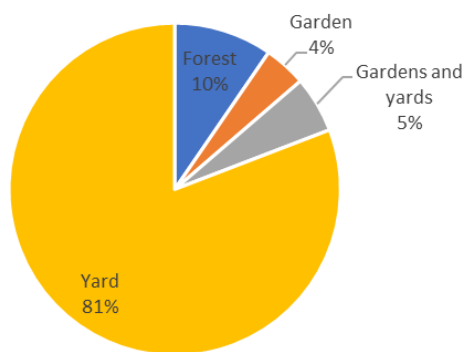


Figure 3. habitat for medicinal uses

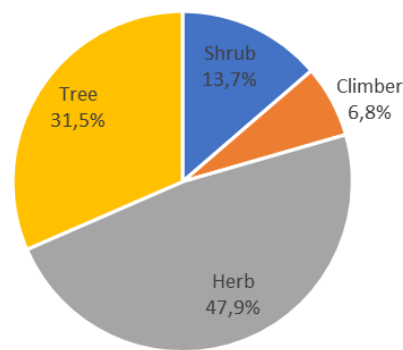


Figure 4. The habitus of medicinal plants

Plant part used

The local communities in the research area utilize several plant components, including leaves, stems, roots, bark, and fruit, for the production of traditional medicine (Figure 5). Leaves are the most commonly utilized plant components, present in 25 species. They are followed by tuber which is found in 14 species, and fruit which is found in 13 species, and. Leaves are commonly utilized as herbal remedies due to their accessibility and consistent availability. Furthermore, the process of extracting and utilizing leaves is straightforward and uncomplicated. Leaves possess numerous health advantages that have been recognized for centuries, providing knowledge about traditional medicine. This recognition of health benefits sets leaves apart from other components of the plant (Mais et al. 2018).

Preparation

There are multiple methods to extract therapeutic properties from plants, each yielding distinct compounds and health advantages. According to Figure 6, the predominant approach involves boiling medicinal herbs like jahe (*Z. officinale*), kunyit (*Z. zerumbet*), and sereh (*Cymbopogon* sp.) in hot water. The resulting boiled water is then used as a remedy for many ailments, such as colds, coughs, fever, ulcers, and inflammation. Boiling is a commonly employed technique in 37% of medicinal plant species. It is a classic and easily achievable method to extract medicinal properties from plants, as highlighted by Widayati and Wulandari (2018). However, the world of herbal medicine is not limited to boiling. Another prevalent method is eat straight away medicinal herbs such as garlic (*Allium sativum* L.), parioto (*Medinilla speciosa* (Reinw. ex Blume) Blume), guava (*Psidium guajava* L.), and duwet (*Syzigium cumini*), either in their raw form or combined with other meals. This approach can enhance the body's immunity, thwart infection, heal wounds, or cleanse the oral cavity; this technique is employed in 9.6% of the total

number of species of medicinal plants. One prevalent method involves steeping therapeutic herbs, such as purple leaves, noni, and horseradish, in warm water and thereafter consuming the resulting infusion (brewed process) as a medicinal remedy for ailments such as hemorrhoids, hypertension, anti-cancer properties, and menstruation relief. This technique is employed for 5.5% of the total number of species of medicinal plants. In addition to that, several techniques are employed with multiple species of medicinal plants, including pulverizing and topically applying them, boiling them as a vegetable, ingesting the liquid or sap and applying it, directly applying it to the body, extracting juice from it, or incorporating it into bath water. The versatility of these methods is sure to intrigue and inspire our curiosity about the possibilities of herbal medicine.

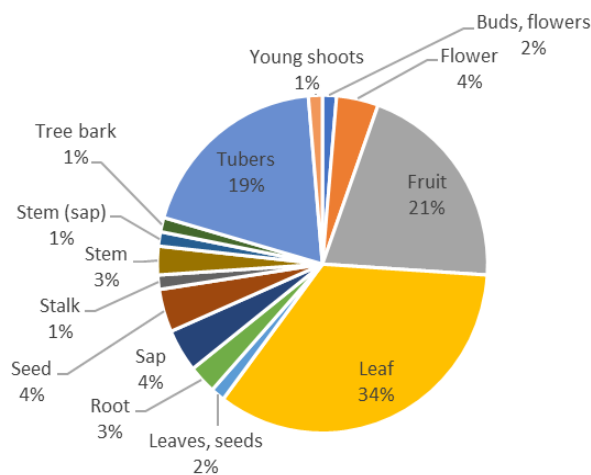


Figure 5. Plant parts are used for medicinal uses

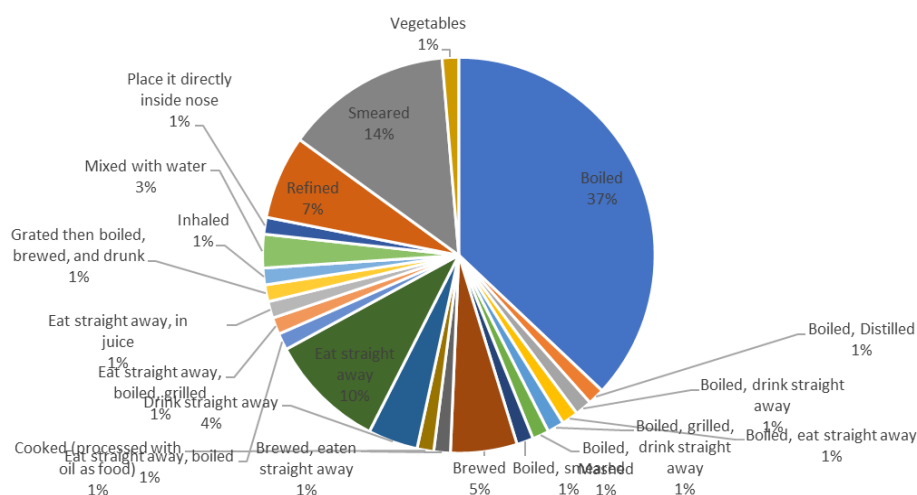


Figure 6. Preparation methods of medicinal plants

Moreover, the many techniques employed in the preparation of medicinal plants demonstrate that each method has distinct merits and drawbacks. The traditional method has several benefits, including simplicity, affordability, and the absence of any need for specialized gear. When performed correctly and in accordance with the required dosage, this approach can also preserve or enhance the effectiveness of medicinal herbs. Nevertheless, older methods have drawbacks such as reduced hygiene, lack of standardization, and susceptibility to contamination or damage. This approach may also lead to the depletion of certain chemical constituents in medicinal plants, particularly those that are volatile or susceptible to decomposition caused by heat or water (Elisma et al. 2020). Hence, it is imperative to innovate and enhance the techniques for processing medicinal plants, ensuring they are contemporary, effective, and of superior quality while still preserving their traditional significance.

Disease treatment

The study found medicinal plants for several diseases, including Respiratory System Diseases (RSD) such as asthma, laryngitis, and lung infections; the most commonly used medicinal plants are garlic (*A. sativum*), *dadap* (*E. variegata*), and *cengkeh* (*S. aromaticum*). Also, medicinal for skin and subcutaneous tissue (DS) diseases such as itching and endocrine diseases, the most commonly used drugs are *dlingo* (*A. calamus*), *sirsak* (*A. muricata*), and *sirih ungu* (*P. nigrum*). In addition, there are also medicinal for endocrine, nutritional, and metabolic diseases (ENM) such as diabetes, mastitis, anti-cancer, hepatitis, low immunity, and low appetite; the most commonly used medicinal plants are *dandang gendhis* (*G. pictum*), and *pace* (*M. citrifolia*). There are medicinal for symptoms and signs related to the circulatory and respiratory system (DCR), such as cough and nosebleed; jeruk nipis (*C. aurantifolia*), jeruk lemon (*C. limon*), and betel (*P. ornatum*) are the most commonly used medicinal plants. Moreover, for symptoms, signs, and abnormal clinical and laboratory (SSA) such as fever, headache, and oral

infections, the most commonly used medicinal plants are *temulawak* (*C. zanthorrhiza*), *kunyit* (*Z. zerumbet*), and garlic (*A. sativum*). There are also medicines for Diseases of the musculoskeletal system and connective tissue (DMC), such as rheumatism. The most commonly used medicinal plants are manis jangan (*C. verum*), tapak liman (*E. saber*), and *alang-alang* (*I. cylindrica*), and drugs for symptoms and signs involving the skin and subcutaneous tissue (SCT) such as burns and skin wounds; the most commonly used medicinal plants are lidah buaya (*A. vera*), *binahong* (*A. cordifolia*), and *karet* (*H. brasiliensis*).

Respiratory, especially asthma, is one of the many diseases Indonesians suffer from. It was recorded by the Ministry of Health that in 2020, 12 million Indonesians had asthma. Garlic is a natural medicine used to treat asthma (Suharti and Yuliyana 2022). Garlic contains allicin ($C_6H_{10}OS_2$), an anti-inflammatory compound that can help relieve asthma. Next is a skin disease. For example, Based on Health Service data, Banjarmasin City's incidence of skin disease (another dermatitis, unspecified/eczema) is included in the top 10 diseases in 8th place with a total of 7,584 incident cases (Purwaningsih 2021). One natural medicine that can cure or reduce skin diseases is purple betel leaves, which contain phenol (C_6H_6O), a compound with anti-bacterial properties.

Coughing is one of the most common diseases in the world, and almost all people have experienced it worldwide. Lime is medicinal because it contains vitamin C, which can soothe the throat when coughing. Fever is also a disease that all humans most often suffer from, a symptom where people will feel a high body temperature above 36°C, the body feels sore, and the tongue feels bitter when eating. *Kunyit* is one of the many natural medicines used to relieve fever, and it contains COX-2 compounds, enzymes that can mediate the increasing temperature in fever. Therefore, the curcumin contained in turmeric has an antipyretic effect. Older people often experience rheumatism, and *manis jangan* (*C. verum*) is one of the medicines for rheumatism because it contains ingredients such as protein, fiber, phosphorus, etc. Burns or skin

wounds are diseases that affect the outer and inner skin tissue. One of the medicines is *binahong* (*A. cordifolia*) because it contains saponin, which is useful as an antiseptic. In previous research, there was an alternative to healing atopic dermatitis wounds with natural extracts. *Binahong* (*A. cordifolia*) leaf extract is used to treat various diseases, one of which is various kinds of wounds, including external wounds caused by scratches from sharp weapons, after surgery, after childbirth, friction scars, and itching (Musyaropah and Supriyatna 2023). However, no specific research has used *binahong* (*A. cordifolia*) leaf extract to heal atopic dermatitis wounds.

Medicinal plants utilized in traditional medicine exhibit a range of specific therapeutic properties, such as antimicrobial, anti-inflammatory, analgesic, antipyretic, immunomodulatory, and antioxidant effects. These properties stem from bioactive compounds, including alkaloids, flavonoids, terpenoids, and tannins. Consequently, these plants are valuable in combating infections, alleviating inflammation and pain, reducing fever, enhancing immune function, and assisting the body in managing stress. This diverse array of benefits underscores the significant role that medicinal plants play in traditional medicine for both the prevention and treatment of various diseases.

The use of medicinal plants should be complemented by scientific validation to ensure safety and efficacy. While many have demonstrated traditional benefits, it is essential to consult healthcare professionals to minimize risks, such as incorrect dosages or drug interactions. Ethnobotanical studies provide valuable insights from empirically validated local knowledge, serving as a foundation for further research and the integration of these plants into formal health systems.

Relative Frequency Citation (RFC)

Species with low Relative Frequency Citation (RFC), such as *Piper betle* L., *Cinnamomum verum* J.Presl, and *Piper ornatum* N.E.Br., (Table 2) suggest that their frequency of occurrence or references in ethnobotanical literature is relatively low. This indicates that, while they may have specific uses in local culture, these species may be less common or less significant in a broader cultural context. However, their unique role in the local culture commands respect. Species with high Relative Frequency Citation (RFC), such as *Allium sativum* L. and *Jatropha multifida* L., indicate that they have a high frequency of occurrence in ethnobotanical surveys or are frequently referenced in ethnobotanical literature. This underscores the important role of these species in everyday life and the sustainability of local culture.

Use Value (UV)

Species with low Use Value (UV), such as *P. betle*, *C. verum*, and *P. ornatum* (Table 2), suggest that their use or practical utility in local culture may be limited to specific contexts or uses. While these species may have specialized roles or uses in local culture, their relatively low frequency in ethnobotanical surveys indicates that their contribution

to everyday life may not be as significant as other species. Conversely, species with high Use Value (UV), such as *A. sativum* and *J. multifida*, indicate that they play an important role in local culture and tradition. Their high frequency in ethnobotanical surveys reflects their widespread use and significance in daily life.

The view that modern medicine offers superior reliability and established standards compared to traditional herbal medicine is well-founded, as it undergoes rigorous clinical trials for safety and efficacy. However, it is essential to recognize that many modern medical practices are rooted in processed medicinal plants. While traditional herbal medicine may lack standardization, its diverse and holistic approaches can effectively complement modern treatments, particularly for chronic and preventive care. Thus, integrating both methods, supported by scientific evidence, can enhance overall health outcomes.

ICF Value

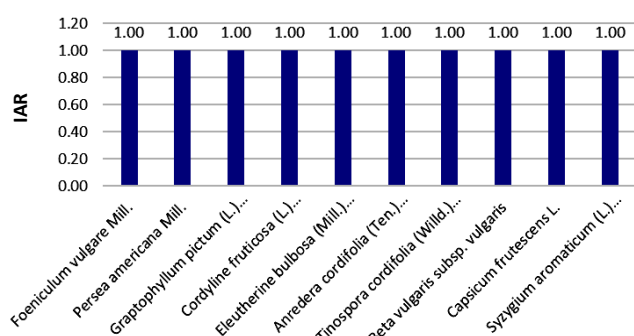
In the observation results in Table 3, the highest ICF value with the specific disease name fever, headache and mouth infection, disease classification, symptoms and signs of clinical and laboratory abnormalities (SSA), is 0.96. People there rarely use medicinal plants to treat constipation and cholesterol. Based on this table, there are only 3 respondent statements and 2 species of medicinal plants related to eye inflammation with the eye and adnexa diseases (EAD) classification, so the lowest total ICF value is 0.50. Based on the results of interview reports, many people there often suffer from hypertension, heart disease, and anemia, with the disease classification being certain infectious and parasitic diseases (CID) and diseases of the skin and subcutaneous tissue (DS) with a total of 89 statements from respondents. Respiratory problems threaten health (Salsabila 2021), so 16 medicinal plants can solve disease with an ICF value of 0.95. Then, the people there are also often affected by diabetes, mastitis, anti-cancer, hepatitis, low immunity, and low appetite, with the classification of endocrine, nutritional, and metabolic (ENM) diseases, and 16 types of medicinal plants can be used, with a total ICF value of 0.93.

IAR Value

The research results showed that the informants agreed upon 52 species of medicinal plants, including *Foeniculum vulgare* Mill, *Persea americana* Mill, *Graptophyllum pictum* (L) Griff, *Cordyline fruticosa* (L.) A. Chew, *Eleutherine bulbosa* (Mill.) Urb, *Anredera cordifolia* (Ten.) Steenis, *Tinospora cordifolia* (Wild.) Miers, *Beta vulgaris* subsp. vulgaris, *Capsicum frutescens* L., and *Syzygium aromaticum* (L) Merr. & L.M.Perry. with an IAR value of 1.00. A high IAR value indicates that all informants agree that the medicinal plant is used to treat the same disease (Figure 7). The advantages of using traditional medicine are that it is relatively safer than conventional medicine, the side effects are relatively low, obtaining these medicinal plants is easy, and they can even be cultivated at home (Melviani et al. 2022).

Table 3. Categories of disease in the study area and the Informant Consensus Factor (ICF)

Classification of diseases	Specific disease name	Number use report	Species number	ICF
Certain infectious and parasitic diseases (CID)	Diarrhea, fungal skin, smallpox, bloated intestinal worms	256	13	0.95
Diseases of the circulatory system (CSD)	Hypertension, heart disease, anemia	294	16	0.95
Diseases of the digestive system (DSD)	Constipation, cholesterol	72	8	0.90
Diseases of the eye and adnexa (EAD)	Eye inflammation	3	2	0.50
Diseases of the genitourinary system (GD)	Bladder infection, menstrual pain, fertility disorder	21	4	0.85
Diseases of the respiratory system (RSD)	Asthma, sore throat, lung infection	52	4	0.94
Diseases of the skin and subcutaneous tissue (DS)	Itch	89	5	0.95
Endocrine, nutritional, and metabolic diseases (ENM)	Diabetes, mastitis, anti-cancer, hepatitis, low immunity, low appetite	230	16	0.93
Symptoms and signs involving the circulatory and respiratory systems (DCR)	Cough, nose bleeding	87	6	0.94
Symptoms, signs, and abnormal clinical and laboratory (SSA)	Fever, headache, mouth infection	143	7	0.96
Diseases of the musculoskeletal system and connective tissue (DMC)	Rheumatism, hemorrhoids	16	6	0.67
Symptoms and signs involving the skin and subcutaneous tissue (SCT)	Skin burns, incision wounds	51	9	0.84

**Figure 7.** IAR (Informant Agreement Ratio) ranks the most important medicinal plant species

Research on medicinal plants in the Mount Merapi region has important implications for conservation efforts. It aids in preserving biodiversity by identifying key species and promotes sustainable management through cultivation to prevent over-exploitation. Additionally, it empowers local communities to protect natural resources and preserves traditional knowledge through the documentation of local wisdom. The findings may also foster the development of medicinal plant-based ecotourism, providing economic benefits to the community and raising awareness about the importance of safeguarding the Mount Merapi ecosystem. It is important to consider criticism of medicinal plant use, we must also acknowledge that it respects traditional knowledge and supports modern medicine. The wide array of pharmaceutical compounds derived from these plants demonstrates their potential to enhance medical science. The challenge is to ensure that their use is backed by rigorous scientific research to validate their benefits and prevent substandard practices.

By merging traditional wisdom with modern innovation, we can effectively advance global health.

In conclusion, based on the research results, 73 species from 35 families were found for medicinal plants used by the community in Mount Merapi National Park, Central Java, Indonesia, with the Zingiberaceae family with the most members, namely 12 species. The part of the plant body that is most widely used for medicine is the leaves. The type of habitat that is widely planted is home gardens (yards), so it is a type of cultivated plant with a habit of herbs and processing by boiling. The index calculated as the highest RFC is *A. sativum* reflects their widespread use and significance in daily life. The highest UV is *A. cepa* (0.06), which indicates the species has the highest use; the highest IAR is *F. vulgare* (1.00), which indicates many people who agree with the use of this species as a medicinal plant, and the highest ICF value is SSA (Symptoms, signs, and abnormal clinical and laboratory) disease 0.96, people there rarely use medicinal plants to treat constipation and cholesterol.

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Diversity and use medicinal plants for traditional women's health care in Kalibawang, Wonosobo District, Indonesia

ANISA NURAINI¹, AQIL HAIDAR RABBANI¹, ANDARU SEKAR JAGATRU¹, ALIFIA NUR AZZAHRA¹, MAULYDA SHOFA AZIZIA¹, AHMAD YASA², SURAPON SAENSOUK³, AHMAD DWI SETYAWAN^{1,4*}

¹Department of Environmental Science, Faculty of Mathematics and Natural Science, Universitas Sebelas Maret. Jl. Ir. Sutami No. 36, Surakarta, Central Java, Indonesia. *email: volatiloils@gmail.com

²Faculty of Medicines, Universitas Sebelas Maret. Jl. Ir. Sutami No. 36, Surakarta 57126, Central Java, Indonesia

³WalaiRukhvej Botanical Research Institute, Mahasarakham University, MahaSarakham 44150, Thailand

⁴Biodiversity Research Group, Universitas Sebelas Maret. Jl. Ir. Sutami No. 36, Surakarta 57126, Central Java, Indonesia

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Abstract. Nuraini A, Rabbani AH, Jagatru AS, Azzahra AN, Azizia MS, Yasa A, Saensouk S, Setyawan AD. 2023. Diversity and use medicinal plants for traditional women's health care in Kalibawang, Wonosobo District, Indonesia. *Asian J Ethnobiol* 7: 145-155. Indonesia, known as a country with "mega-biodiversity" and cultural diversity, has large and diverse natural resources, including medicinal plants that have not been fully explored. These medicinal plants play an important role in primary health care, as well as for women health care in various ethnics across the country. This study aims to determine the plants used for women's health in Kalibawang Sub-district, Wonosobo District, Central Java, Indonesia, with a focus on menstruation, pregnancy, lactation, and postpartum recovery. The research methods include interviews with 106 people who have knowledge of medicinal plants and field observations. The results of the study identified 33 plant species from 17 families for women health care, with the Zingiberaceae family as the mostly used. Plants such as *kunyit* (*Curcuma longa*), *jahe* (*Zingiber officinale*), *katuk* (*Sauropus androgynus*), and *sirih* (*Piper betle*) have an important role in women's reproductive health. *Curcuma longa* ranked highest in SUV (0.557) and RFC (0.038), with a Fidelity Level (FL) of 100%, reflecting consistent use for specific purposes. The study also found that medicinal plants not only provide physical health benefits, but also significant cultural and spiritual values for local communities.

Keywords: Health, mega-biodiversity, traditional medicine, women

Abbreviations: FL: fidelity level, RFC: relative frequency of citation, SUV: species use-value

INTRODUCTION

Indonesia is globally recognized as a "mega-biodiversity" country due to its vast natural resources, including a rich variety of medicinal plants. These plants play a significant role in healthcare, with Indonesia boasting approximately 110 million hectares of forest containing around 28,000 plant species. Among them, 7,000 species are medicinal plants, representing about 90% of Asia's total medicinal plant species (Kusuma et al. 2014; Cahyaningsih et al. 2021). The use of these plants has a long-standing tradition in Indonesia, predating modern medicine and remaining a key source of treatment for humans and animals (Salmerón-Manzano et al. 2020; Jamil et al. 2022).

The ethnobotanical identification of medicinal plants is a vital step in quality assurance for traditional medicine and discovering new therapeutic compounds (Ramdane et al. 2015). Despite the global rise of modern medicine, around 70-80% of the population worldwide continues to rely on medicinal plants for healthcare, driven by factors such as preventive health benefits, perceived safety, and cultural ties (Shanthi and Izzati 2014; Baydoun et al. 2015). In Indonesia, one of the most notable traditional medicines is

jamu, herbal drink used for centuries to maintain health and treat illnesses. Considered safer than chemical-based drugs, *jamu* remains an integral part of Indonesian life, despite its often bitter taste (Sumarni et al. 2019; Fortuna et al. 2023).

In rural areas, natural medicines derived from the local environment are often used to address various ailments (Taek et al. 2019). Medicinal plants also hold a special place in women's healthcare, particularly for prenatal care, childbirth, and postpartum recovery (Susandrini et al. 2021). Women across Indonesia's ethnic groups have traditionally utilized medicinal plants to meet their health needs, solidifying *jamu* as a cultural practice. For instance, *jamu kunyit asam* made from turmeric and tamarind—is widely used to alleviate premenstrual syndrome (PMS) symptoms due to its analgesic and anti-inflammatory properties (Yusuf and Nurkhasanah 2015). Many women also consume *jamu* during the postpartum period to aid recovery (Yunitasari et al. 2017).

Around 50% of Indonesians aged 15 and above regularly consume *jamu* for health purposes. It is available in various forms, such as capsules, infusions, decoctions, and liquid tonics (Pangesti 2021). Among Indonesian women, *jamu* is especially valued for reproductive health. This highlights the potential of medicinal plants as an

affordable and culturally acceptable alternative to synthetic drugs.

The use of medicinal plants in women's health is not unique to Indonesia. Across Southeast Asia and beyond, herbal remedies are widely used to address issues such as fertility, menstrual regulation, and postpartum recovery. In Jordan, for instance, traditional medicine plays a crucial role in women's reproductive health, while in Katsina State, Nigeria, medicinal plants have been used for maternal health care for generations (Nagulapalli et al. 2017). Similarly, in rural Madagascar, communities with limited access to modern medicine rely heavily on medicinal plants for treatment (Rakotoarivelo et al. 2015). Studies in the United States and Australia also indicate that herbal products are used by a significant portion of pregnant women—45% in the U.S. and 36% in Australia (Kissal et al. 2017).

Indonesia's rich biodiversity offers significant potential for research on medicinal plants, especially in addressing health challenges specific to women. These include reproductive disorders, menopausal symptoms, and mental health issues. With growing concerns over the side effects of conventional drugs, medicinal plants provide a safer, natural alternative. Furthermore, such research promotes sustainability, healthcare independence, and the preservation of traditional knowledge.

This study focuses on identifying and documenting local herbal plants used in the Wonosobo area to address women's health issues. Wonosobo, known for its traditional practices, is an ideal location to explore the role of medicinal plants in health care. The research aims to raise awareness about the potential of herbal plants as sustainable treatments, offering affordable and culturally rooted solutions for women's health.

By advancing research on medicinal plants, these findings are expected to contribute not only to scientific

knowledge but also to the well-being of women across diverse communities. Medicinal plants have the potential to improve quality of life by providing natural, cost-effective, and culturally resonant health solutions. In doing so, they reaffirm the enduring value of traditional medicine in a modern world.

MATERIALS AND METHODS

Study area

This research was conducted in four villages in Kalibawang Sub-district, Wonosobo District, Central Java Province, Indonesia, including Dempel Village, Karangsembung Village, Kalialang Village, and Mergolangu Village. The research area is located at coordinates 7°21' N and 109°53' E, with an area of 4,780 hectares or 4.86% of the area of Wonosobo District. The average temperature in this area is 22°C with rainfall of 264.40 mm/month in 2023. Based on BPS data in 2024, Kalibawang Sub-district is a mountainous area with an altitude of 643 to 984 meters above sea level (masl). This area has an average land slope of around 10 to 40%. In general, the land in Kalibawang Sub-district is classified as very fertile, so it has great potential for various types of plant cultivation, such as agriculture, food crops, horticulture, and plantations. The residents here are typical Javanese people who live in remote villages, where almost all of the population are Javanese, some of whom still adhere their Muslim ancestral culture, such as the celebration of the Javanese/Hijri New Year (*Merdi Dusun*), the birth of the Prophet Muhammad SAW (*Muludan*), grave pilgrimages to welcome Ramadan (*Ruwahan*), post-burial rituals (*Sur Tanah, Slametan, Yasinan*), etc.

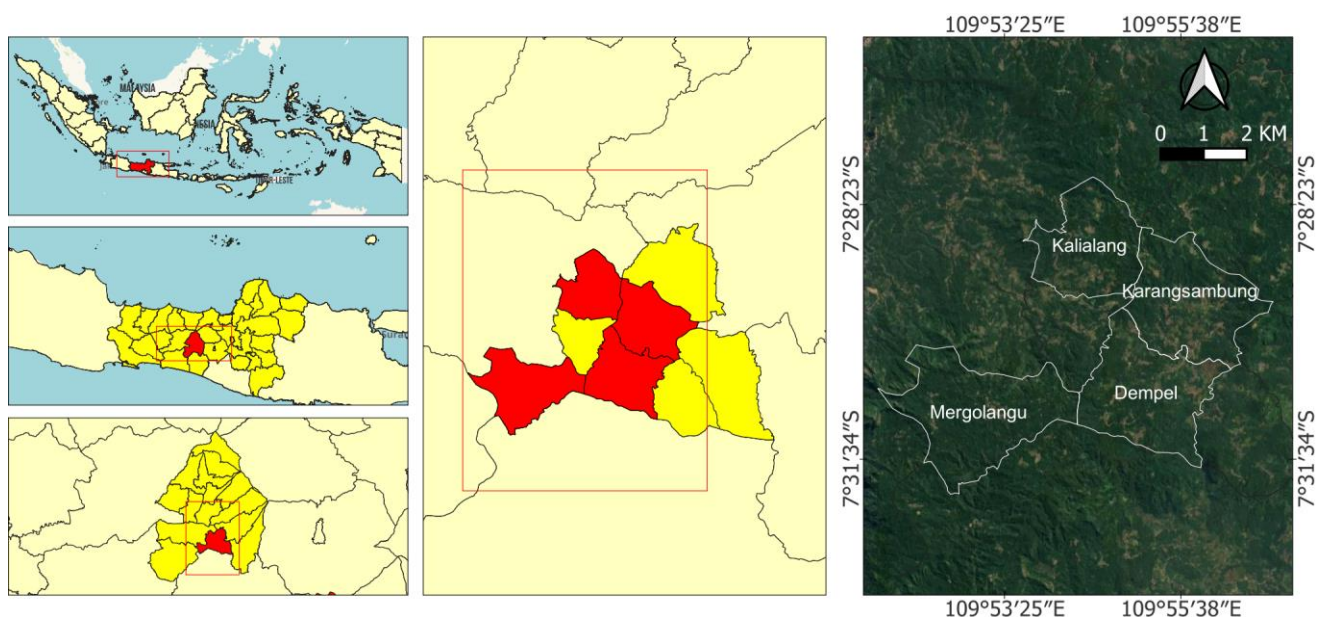


Figure 1. Map of the research area in Dempel, Karangsembung, Kalialang, Mergolangu Villages in Kalibawang Sub-district, Wonosobo District, Central Java, Indonesia

Procedures

This study uses primary data collected through semi-structured interviews and observations at the research location in October 2024. Interviews are the main method for collecting primary data in qualitative research (Adhabi and Anozie 2017). The purpose of this interview is to collect data related to etomedics. Based on data from the Central Statistics Agency (BPS) in 2024, the population of Kalibawang Sub-district was 27,101 people, consisting of 13,951 men and 13,150 women. The criteria for informants in this study were men or women who had good verbal skills and knew information about the use of plants for women's health, aged over 17 years old, had a minimum elementary school education, and were domiciled in the research area. The interviews focused on the traditional use of plants in maintaining women's health, including local plant names, categories of use, plant parts used, forms, preparation methods, and how to apply them. The local plant names that had been obtained were then identified by their scientific names using Plants of the World Online (POWO). In addition to interviews, field observations and plant documentation were also carried out to directly identify the types of plants that grow and are used by the local community for the purpose of maintaining women's health. Data from this observation aims to enrich information regarding plant availability and plant utilization patterns for women's health.

Data analysis

This study uses quantitative analysis with three quantitative indices applied, namely SUV, RFC, and FL in accordance with previous research by Utamingrum et al. (2020) and Kosimov et al. (2023):

$$\text{SUV} = \frac{\sum U_i}{N}$$

$$\text{RFC} = \frac{F_c}{N}$$

$$\text{FL} = \frac{I_p}{F_c} \times 100$$

SUV (Sum of Use Value) value shows the total benefits of a particular plant species utilized by the community. Where U_i value is the number of categories of utilization of a particular plant species and N is the total number of respondents. RFC (Relative Frequency of Citation) value is used to determine the relative frequency of the community knowing the benefits of a particular plant species. Where F_c is the frequency of mentioning a particular plant species and N is the total number of respondents. FL (Fidelity Level) value is used to determine the most popular plant species for a particular use purpose. Where I_p is the number of mentions of a specific utilization category of a plant species and F_c is the frequency of mentioning a particular plant species for various utilization categories.

RESULTS AND DISCUSSION

Respondent demographics

This study involved 106 respondents consisting of various age groups, ranging from teenagers to the elderly. Respondents were obtained through direct interviews in each village, which was the location of the study. The selection of the number of respondents was based on the aim of obtaining representative results and reflecting the actual conditions in the field. By involving diverse respondents, it is hoped that the results of this study can provide a comprehensive picture of the population and distribution of herbal plants as well as the level of public knowledge about plants that can be used for women's health. These results are expected to describe the condition of the population accurately, so that they can be used as a basis for generalizing the results of the study and contributing to the development of herbal plant-based health programs in the region.

There are several variables that reflect the characteristics of the respondents in this study. Based on demographic data (Table 1), the majority of respondents were female, namely 88 people (83.02%), while male informants were only 18 people (16.98%). The dominance of female respondents in this study was due to topics that were closely related to women's health or the important role they play in the family, especially in the context of health care and decision-making related to household health. In research that focuses on women's health, especially the use of herbal plants and traditional medicines, women often have a central role, because women are the ones who deal most with traditional medicine for themselves and other family members. In terms of age, most respondents were in the adult age group, namely 31-40 years old as many as 25 people (23.58%), 41-50 years old as many as 26 people (24.53%), and 51-60 years old as many as 26 people (24.53%). This age group tends to have more life experience and a good understanding of the health problems faced, especially related to reproductive health, menopause, and other health problems often experienced by adult women. Women are also more involved in the application of traditional herbal-based medicine, which has been known since childhood as part of the culture or family tradition.

In terms of education level, the majority of respondents have low education, with 52.83% elementary school graduates and 31.13% junior high school graduates. Meanwhile, respondents who have university education are only 1.89%. This shows that most respondents come from rural backgrounds with limited access to higher education. In terms of employment, the majority of respondents are housewives, as many as 67 people (63.21%), which shows that this study focuses on aspects of household life or family welfare. There are only a few respondents who work as laborers (3.77%) or teachers (1.89%), and there is 1 student (0.94%). Overall, the distribution of these variables shows that this study involves a community dominated by adult women with lower levels of education and economy, and have significant roles in the household and surrounding community.

Table 1. Demographics of respondents from the peoples in Kalibawang Sub-district, Wonosobo District, Central Java, Indonesia

Parameter	Specification	Frequency	Percentage
Total of respondents		106	100%
Gender	Male	18	16.98%
	Female	88	83.02%
Age	<20	3	2.83%
	21-30	17	16.04%
	31-40	25	23.58%
	41-50	26	24.53%
	51-60	26	24.53%
	>60	9	8.49%
Education	Elementary School	56	52.83%
	Junior High School	33	31.13%
	Senior High School	15	14.15%
	University	2	1.89%
Occupation	Housewife	67	63.21%
	Farmer	18	16.98%
	Entrepreneur	14	13.21%
	Laborer	4	3.77%
	Teacher	2	1.89%
	Student	1	0.94%

Utilization of medicinal plants for women's health

Information on medicinal plants used for women's health in Kalibawang Sub-district, Wonosobo is presented in Table 2. The table shows the types of plants, local names, parts used, how to make and use them. The data obtained showed that there were 17 families with 33 plant species used in Kalibawang Sub-district, namely Dempel, Karangsembung, Kalialang, and Mergolangu Village. The types of families available were Apiaceae, Fabaceae, Amaranthaceae, Zingiberaceae, Menispermaceae, Rutaceae, Cucurbitaceae, Poaceae, Phyllanthaceae, Moringaceae, Piperaceae, Lamiaceae, Euphorbiaceae, Primulaceae, Maliaceae, Araceae, and Acanthaceae. The diversity of medicinal plants used for women's health is in line with research conducted by Magtala et al. (2023), which found 50 families and 153 species of medicinal plants in Philippines. However, based on this, it shows that the types of medicinal plants used by the people of Kalibawang Sub-district are not that many. The small number of species obtained during the study indicates a shift in community preferences from traditional medicine using medicinal plants to modern medicine based on chemicals to overcome various health problems. This can occur due to modernization so that only a few medicinal plants are still used.

In traditional medicine, people in Kalibawang Sub-district have utilized various types of plants from various families to overcome women's health problems, including postpartum, pregnancy, lactation, menstruation, leucorrhea,

and immunity. Plants used for postpartum include *bengle* (*Zingiber cassumunar*), *brotowali* (*Tinospora crispa*), *temulawak* (*Curcuma xanthorrhiza*), *dlingo* (*Acorus calamus*), *lengkuas* (*Alpinia galanga*), *kunyit* (*Curcuma longa*), *kencur* (*Kaempferia galanga*), *sirih* (*Piper betle*), *bunga telang* (*Clitoria ternatea*), and *kapulaga* (*Elettaria cardamomum*). Plants used for pregnancy include *akar fatimah* (*Labisia pumila*), *lengkuas* (*Alpinia galanga*), *kunyit* (*Curcuma longa*), and *jahe* (*Zingiber officinale*). Plant used for lactation include *bayam* (*Amaranthus sp.*), *adas* (*Foeniculum vulgare*), *jipang* (*Sechium edule*), *daun singkong* (*Manihot esculenta*), *bunga telang* (*Clitoria ternatea*), *kacang hijau* (*Vigna radiata*), *kacang panjang* (*Vigna unguiculata*), *kelor* (*Moringa oleifera*), *katuk* (*Sauropus androgynus*), *kemukus* (*Piper cubeba*), and *lengkuas* (*Alpinia galanga*). Plants used for menstruation include *erutkaya* (*Ricinus communis*), *bunga telang* (*Clitoria ternatea*), *kemangi* (*Ocimum basilicum*), *kumis kucing* (*Orthosiphon aristatus*), *mahoni* (*Swietenia macrophylla*), *malikinang* (*Phyllanthus urinaria*), *lengkuas* (*Alpinia galanga*), *kunir* (*Curcuma longa*), *kunyit putih* (*Curcuma zedoaria*), *kapulaga* (*E. cardamomum*), *kencur* (*Kaempferia galanga*), and *jahe* (*Zingiber officinale*). Plant used for leucorrhea include *sirih* (*Piper betle*) and *alang-alang* (*Imperata cylindrica*). The last category of plant utilization for immunity includes *kamijara/serai* (*Cymbopogon citratus*), *mojo* (*Aegle marmelos*), *kapulaga* (*Elettaria cardamomum*), *jeruk nipis* (*Citrus aurantiifolia*) and *kencur* (*Kaempferia galanga*).

Based on the research results, it is known that the most dominant family utilized by the community is Zingiberaceae (Figure 2). Zingiberaceae family is the most dominant because it contains active compounds that are efficacious in overcoming various women's health conditions, such as relieving pain, facilitating breast milk, and accelerating postpartum recovery. Species in the Zingiberaceae family that are often utilized by the Kalibawang community include *A. galanga*, *C. longa*, *C. xanthorrhiza*, *C. zedoaria*, *E. cardamomum*, *K. galanga*, *Z. cassumunar*, and *Z. officinale*. Zingiberaceae, which is famous for several of its members such as *Z. officinale*, *A. galanga*, and *C. longa*, is known to have properties as an anti-inflammatory, analgesic, and galactagogue (increase breast milk production). *Zingiber officinale* is often used to reduce pain and cramps during menstruation, while *C. longa* is used in postpartum care to help the body recover and prevent infection. This is in line with research conducted by (Nikmawati et al. 2024), which states that *C. longa* has anti-inflammatory and antioxidant properties. *Curcuma longa* and tamarind have an effect on the ability of postpartum mothers to heal perineal lacerations. The use of various types of plant species in traditional medicine for women's health shows the diversity of ethnopharmacological knowledge in society.

Table 2. Medicinal plants used for women's health in Kalibawang Sub-district, Wonosobo District, Central Java, Indonesia

Family	Scientific name	Local name	SUV	RFC	Life form	Use Category (FL)	Utilized part	Preparation	Application
Acanthaceae	<i>Strobilanthes crispus</i> (L.) Blume	<i>Keji beling</i>	0.009	0.009	Shrub	Postpartum (100%)	Leaf	Boiled	Oral
Amaranthaceae	<i>Amaranthus</i> sp.	<i>Bayam</i>	0.009	0.066	Herb	Lactation (100%)	Leaf	Cooked	Oral
Apiaceae	<i>Foeniculum vulgare</i> Mill.	<i>Adas</i>	0.009	0.085	Herb	Lactation (100%)	Leaf	Cooked	Oral
Araceae	<i>Acorus calamus</i> L.	<i>Dlingo</i>	0.009	0.075	Herb	Postpartum (100%)	Rhizome	Pounded	Topical
Cucurbitaceae	<i>Sechium edule</i> (Jacq.) Sw.	<i>Jipang</i>	0.009	0.057	Climber	Lactation (100%)	Fruit	Cooked	Oral
Euphorbiaceae	<i>Manihot esculenta</i> Crantz	<i>Singkong</i>	0.009	0.009	Shrub	Lactation (100%)	Leaf	Cooked	Oral
Euphorbiaceae	<i>Ricinus communis</i> L.	<i>Erukaya/jarak</i>	0.009	0.009	Shrub	Menstruation (100%)	Leaf	Boiled	Oral
Fabaceae	<i>Clitoria ternatea</i> L.	<i>Bunga telang</i>	0.009	0.009	Climber	Postpartum (100%)	Flower	Brewed	Oral
Fabaceae	<i>Tamarindus indica</i> L.	<i>Asem ireng</i>	0.019	0.075	Tree	Lactation (38%), Menstruation (100%)	Fruit	Infusion	Oral
Fabaceae	<i>Vigna radiata</i> (L.) R.Wilczek	<i>Kacang hijau</i>	0.009	0.009	Herb	Lactation (100%)	Seed	Boiled	Oral
Fabaceae	<i>Vigna unguiculata</i> subsp. <i>Sesquipedalis</i> (L.) Verdc.	<i>Lembayung/kacang panjang</i>	0.009	0.019	Climber	Lactation (100%)	Leaf	Raw, Cooked	Oral
Lamiaceae	<i>Ocimum basilicum</i> L.	<i>Kemangi</i>	0.009	0.019	Shrub	Menstruation (100%)	Leaf	Raw	Oral
Lamiaceae	<i>Orthosiphon aristatus</i> (Blume) Miq.	<i>Kumis kucing</i>	0.009	0.009	Herb	Menstruation (100%)	Leaf	Boiled	Oral
Malingaceae	<i>Swietenia macrophylla</i> G.King	<i>Mahoni</i>	0.009	0.028	Tree	Menstruation (100%)	Seed	Raw	Oral
Menispermaceae	<i>Tinospora crispa</i> (L.) Miers ex Hook.fil. & Thomson	<i>Brotowali</i>	0.009	0.75	Climber	Postpartum (100%)	Stem	Infusion	Oral
Moringaceae	<i>Moringa oleifera</i> Lam.	<i>Kelor</i>	0.009	0.085	Tree	Lactation (100%)	Leaf	Cooked	Oral
Phyllanthaceae	<i>Phyllanthus urinaria</i> L.	<i>Malikinang/meniran</i>	0.009	0.009	Shrub	Menstruation (100%)	Leaf	Boiled	Oral
Phyllanthaceae	<i>Sauropus androgynus</i> (L.) Merr.	<i>Katuk</i>	0.009	0.538	Shrub	Lactation (100%)	Leaf	Cooked	Oral
Piperaceae	<i>Piper betle</i> L.	<i>Sirih</i>	0.019	0.358	Climber	Postpartum (11%), Leucorrhea (100%)	Leaf	Boiled, Pounded	Topical
Piperaceae	<i>Piper cubeba</i> L.fil.	<i>Kemukus</i>	0.009	0.075	Herb	Lactation (100%)	Fruit	Boiled	Oral
Poaceae	<i>Cymbopogon citratus</i> (DC.) Stapf	<i>Kamijara/serai</i>	0.019	0.075	Herb	Postpartum (38%), Immunity (100%)	Stem/Leaf	Boiled, Tea	Oral
Poaceae	<i>Imperata cylindrica</i> (L.) Raeusch.	<i>Alang alang</i>	0.009	0.009	Herb	Leucorrhea (100%)	Root	Boiled	Oral
Primulaceae	<i>Labisia pumila</i> (Blume) Fern.-Vill.	<i>Akar fatimah</i>	0.009	0.009	Shrub	Pregnancy (100%)	Root	Boiled	Oral
Rutaceae	<i>Aegle marmelos</i> (L.) Corrêa	<i>Mojo</i>	0.009	0.019	Tree	Immunity (100%)	Fruit	Boiled	Oral
Rutaceae	<i>Citrus aurantifolia</i> (Christm.) Swingle	<i>Jeruk nipis</i>	0.009	0.009	Tree	Immunity (100%)	Fruit	Infusion, Tea	Oral
Zingiberaceae	<i>Alpinia galanga</i> (L.) Willd.	<i>Lengkuas</i>	0.019	0.019	Herb	Pregnancy (100%), Menstruation (50%)	Rhizome	Infusion	Oral
Zingiberaceae	<i>Curcuma longa</i> L.	<i>Kunir/kunyit</i>	0.038	0.557	Herb	Postpartum (8%), Pregnancy (25%), Lactation (12%), Menstruation (100%)	Rhizome	Infusion	Oral
Zingiberaceae	<i>Curcuma xanthorrhiza</i> D.Dietr.	<i>Temulawak</i>	0.009	0.123	Herb	Postpartum (100%)	Rhizome	Infusion	Oral
Zingiberaceae	<i>Curcuma zedoaria</i> (Christm.) Roscoe	<i>Kunyit putih</i>	0.009	0.009	Herb	Menstruation (100%)	Rhizome	Infusion	Oral
Zingiberaceae	<i>Elettaria cardamomum</i> (L.) Maton	<i>Kapulaga</i>	0.019	0.047	Herb	Menstruation (60%), Immunity (100%)	Seed	Boiled	Oral
Zingiberaceae	<i>Kaempferia galanga</i> L.	<i>Kencur</i>	0.028	0.142	Herb	Postpartum (40%), Menstruation (60%), Immunity (100%)	Rhizome	Infusion	Oral
Zingiberaceae	<i>Zingiber cassumunar</i> Roxb.	<i>Bengle</i>	0.009	0.075	Herb	Postpartum (100%)	Rhizome	Pounded	Topical
Zingiberaceae	<i>Zingiber officinale</i> Roscoe	<i>Jahe</i>	0.019	0.34	Herb	Pregnancy (42%), Menstruation (69%)	Rhizome	Boiled	Oral

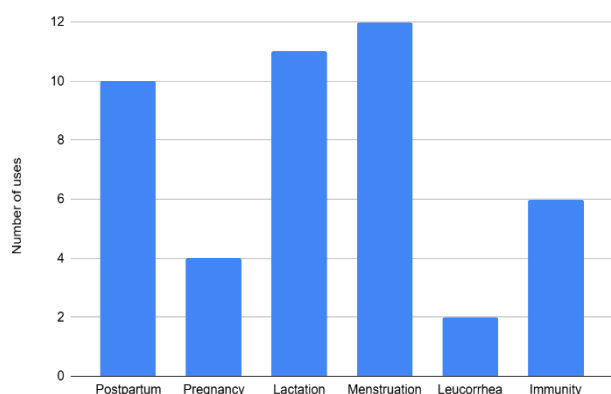


Figure 2. Number of plants used for each disorder related to women's health care in Kalibawang, Wonosobo District, Indonesia

The types of plants obtained during the study showed diverse life forms, namely shrubs, herbs, climbers, and trees. Based on Table 2 above, it is known that herbaceous plants are more commonly found because herbaceous plants tend to be easily found in many habitats, including gardens, fields, and yards. The use of herbs is also preferred in medicinal plants based on research Yemele et al. (2015), because of its higher effectiveness in treating diseases compared to other forms of growth. Herbs are short plants with soft, green, and smooth stems without woody tissue. Herbs complete their life cycle in one or two seasons. Generally, plants have few or no branches. These branches can be easily removed from the ground. Herbs contain quite a lot of nutritional benefits, including vitamins and minerals, so they can be part of a healthy balanced diet. Herbs usually have a faster life cycle than trees or vines. This makes them easier to cultivate and harvest, so they are more widely used traditionally and better known as medicinal plants.

Various plant species are used to support women's health by utilizing various parts of the plant (Figure 3), including leaves (40%), rhizomes (22.9%), fruits (14.3%), seeds (8.6%), roots (5.7%), stems (5.7%), and flowers (2.9%). The leaves are the most commonly used, such as from *S. crispus*, *Amaranthus* sp., *F. vulgare*, *M. esculenta*, and *O. basilicum*, widely used for lactation, menstruation, and postpartum recovery. These data show that leaves are the most dominant part used in traditional medicine practices to support women's health in the community. The predominance of leaf use may be explained by the fact that leaves are the site of photosynthesis and therefore the storage of most secondary metabolites (Kankara et al. 2015). Although leaf use appears to be less harmful to plant biodiversity than the use of whole plants, it may also contribute to global warming effects by reducing carbon dioxide uptake and oxygen production.

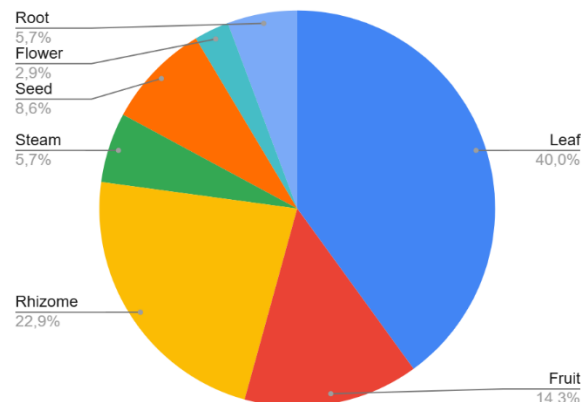


Figure 3. Plant parts used for women's health care in Kalibawang, Wonosobo District, Indonesia

Specific Use Value (SUV), Relative Frequency of Citation (RFC), and Fidelity Level (FL)

The SUV (Specific Use Value) is used to measure the extent of a plant's benefits in a specific context, thereby determining the importance of a plant species for particular purposes (Ifnaini et al. 2023). In this study focusing on ethnobotany or traditional medicine, SUV reflects the utility or popularity of the plant within the community. The SUV calculation involves comparing the number of specific uses within a certain category, such as women's health, against the total recorded uses. The higher the SUV of a species, the more frequently the plant is used or considered important by the community for specific health needs, such as supporting lactation or postpartum recovery. Thus, the SUV helps researchers assess the level of trust and utilization of plants in traditional medicine across various health categories. Plants with high SUV values indicate that they are widely used for various purposes by respondents. In this data *C. longa* ranks highest with an SUV of 0.038 (Figure 4). This means that *C. longa* is often used in many contexts, both as a traditional medicine for various health conditions and as a cooking ingredient. *C. longa* is known for its anti-inflammatory, antioxidant properties, and ability to improve digestion, making it a top choice for many species traditional medicine. In second place, *S. androgynus* has an SUV of 0.028, indicating that have a wide variety of uses, especially in the context of increasing breast milk production and women's health after childbirth. *Sauropus androgynus* has long been considered an effective natural breast milk-producing plant, making it popular among breastfeeding mothers. Meanwhile, *P. betle* with an SUV of 0.019 remains a significant plant. *P. betle* are known for their antiseptic properties, so they are often used in the treatment of minor infections, such as vaginal discharge, as well as to maintain oral and dental health. This shows that despite their heterogeneity in use *C. longa* and *P. betle* still have an important place in traditional health practices.

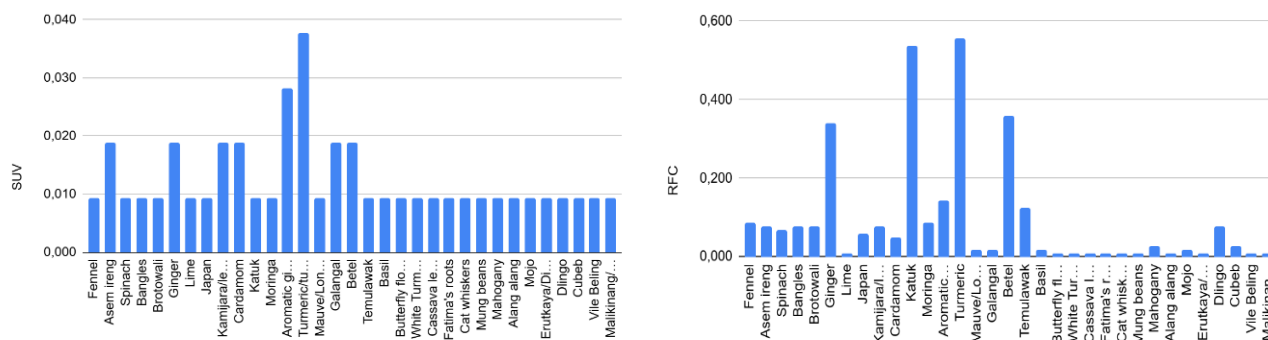


Figure 4. SUV and RFC for women's health care in Kalibawang, Wonosobo District, Indonesia

Relative Frequency of Citation (RFC) measures how often a plant species is mentioned by respondents. The higher the RFC value, the more often the plant is recognized by the community. In this case, *C. longa* is again the most dominant with the highest RFC value of 0.557. This indicates that *C. longa* is a plant that is very well known and appreciated by respondents for its various uses, especially for treating menstrual disorders, inflammation, and as a general tonic. *Sauropus androgynus* has the second highest RFC value, at 0.538. This shows that *S. androgynus* has specific uses that are highly valued in some communities. Meanwhile, *P. betle* with an RFC of 0.358, although less mentioned, still has an important place, especially among mothers who need natural solutions to clean the feminine area. This shows that although katuk is better known in certain contexts, it has a very significant role in the field.

Fidelity Level (FL) reflects the specificity of plant use, indicating how consistently each species is associated with a specific purpose. In this category, *S. androgynus*, *C. longa*, and *P. betle* all achieved an FL of 100%. This shows that whenever these plants are mentioned, they are always associated with a specific and important use, emphasizing their reliability and special role in traditional and cultural medicinal practices. These high FL values indicate that the importance of these plants is not only broad, but also targeted, as each mention refers to a well-defined and consistent application.

Herbal plants such as *S. androgynus*, *C. longa*, *Z. officinale*, and *P. betle* have long been used in traditional medicine to support women's health. This plant is the most common and often found by local people. *Sauropus androgynus* is known as a plant that is very useful for facilitating breast milk production for breastfeeding mothers. *Sauropus androgynus* contain around 7% protein and 19% crude fiber, and contain vitamin K, pro-vitamin A (beta-carotene), vitamin B, and vitamin C. The minerals contained in it include calcium (2.8%), iron, potassium, phosphorus, and magnesium which help improve maternal health after giving birth and improve the quality of breast milk (Dolang et al. 2021). In addition, *S. androgynus* contain steroid and polyphenol compounds that can increase prolactin levels, a hormone that plays a role in facilitating breast milk production. This increase in prolactin levels can help increase, accelerate, and facilitate

breast milk production (Syhadat et al. 2020). In addition, *S. androgynus* can also help maintain healthy skin and reduce the risk of anemia in women thanks to their iron and antioxidant content. With these various benefits, *S. androgynus* is a popular choice in women's health care. In addition to *S. androgynus*, other plants that are often used by people to facilitate breast milk include *Amaranthus* sp., *M. oleifera*, *F. vulgare*, and *V. unguiculata* subsp. *sesquipedalis*, people there often call them *mbayung* or *lembayung*.

Kunyit (*Curcuma longa*) is a plant that is well-known in women's health because of its curcumin content, which has anti-inflammatory and antioxidant properties. *C. longa* is widely used by the community to overcome menstrual pain, digestive disorders, and maintain the health of reproductive organs. Based on the results of the interview, *C. longa* mixed with *C. xanthorrhiza* is used by the community to overcome post-delivery bleeding. *Z. officinale* is also useful in relieving menstrual pain and nausea in pregnancy thanks to gingerol which is an anticoagulant, namely preventing blood clotting, thereby preventing blockage of blood vessels (Sugiarti et al. 2014). *Z. officinale* can be consumed in the form of tea or as an addition to cooking, it is best drunk 2 times a day for vaginal discharge and menstruation. Some other plants that are used during menstruation include *T. crispata*, *O. aristatus*, and *O. basilicum*.

In addition, *sirih* (*P. betle*) also has special uses in women's health, especially in maintaining the cleanliness and health of the feminine area. *Piper betle* are known to have natural antiseptic properties thanks to the eugenol and tannin content which are effective in killing bacteria. Depending on personal hygiene and health needs because the flavonoid compounds act as antioxidants, anti-inflammatories, and antibacterials, while the tannins in green *P. betle* function as antidiarrheals, antiseptics, and antifungals (Dewi 2020). The benefits of these four plants as a whole help maintain women's reproductive health, strengthen the immune system, and reduce physical discomfort that women often experience at various stages of life.

In addition to *S. androgynus*, *C. longa*, *Z. officinale*, and *P. betle*, there is important information about *bengle* (*Zingiber cassumunar*) obtained during interviews with respondents in Karangsambung village. *Zingiber*

cassumunar is a plant that is often used in traditional medicine, especially in treating the health of pregnant women and babies. Based on interviews, *Z. cassumunar* is pounded and then rubbed on the forehead or chest of pregnant women or babies to ward off ‘*sawan*’ (a disorder believed to be caused by evil energy) or to protect them from negative influences. This application is done once a day for one week as part of a prevention ritual. The use of this bangle plant is still very common in rural communities that hold fast to beliefs in traditional health that have been passed down from generation to generation. *Z. cassumunar* contains active compounds such as essential oils, flavonoids, and curcuminoids which have anti-inflammatory, antiseptic effects, and help relieve certain symptoms in babies and pregnant women (Pratiwi and Ningsih 2022). In Kalibawang Sub-district, *Z. cassumunar* is more commonly found and is still an important part of local traditions, especially in the context of reproductive health and baby care. This confirms that the use of medicinal plants is not only functional from a medical perspective, but also has deep cultural and spiritual meaning for local communities.

Based on the research results, people in Kalibawang Sub-district still widely use herbal plants to support their health, namely in the categories of lactation and menstruation. For lactation, the most widely used plant is *S. androgynus*, which is known to be effective in facilitating breast milk production. Meanwhile, for menstruation, people mostly use *C. longa* because of its high curcumin content, which is effective as an anti-inflammatory and analgesic, making it effective for relieving menstrual pain and facilitating menstruation. The use of *S. androgynus* and *C. longa* is traditionally believed to have a positive effect

in supporting the health of breastfeeding mothers and overcoming menstrual problems. The use of this common herbal medicine is also influenced by local midwives who prescribe herbal medicines that have been passed down from generation to generation. Meanwhile, for other health problems, such as postpartum, pregnancy, leukorrhea, and immunity, only a few plants are still used by the local community. This is due to the tendency of people who have chosen modern medicine at the nearest health center.

Preparation and application of plants

The preparation stage refers to how each part of the plant is processed to make medicine, with several methods used depending on the intended use of the plant and the nature of its active compounds. Based on the observation results presented in Figure 6, there are several methods used to prepare plants into medicine. These methods consist of boiling, infusion, cooking, raw, tea, brewing, and pounding. Boiling is a common technique, where plant parts such as leaves, stems, or roots are soaked in water and heated to extract their active components. This method was used for 33.3% of plants, including *S. crispus*, *R. communis*, *L. pumila*, *T. indica*, *S. androgynus*, *C. longa*, and *A. calamus*. Boiling is used as the most common method because it is a simple process to do and it is believed that boiling will dissolve the compound content in the plant so that its properties can be absorbed more effectively when consumed. In addition, based on research Kankara et al. (2015), it is also known that pregnant women and breastfeeding mothers are advised to consume warm foods and drinks so that the boiling method is the choice for processing medicinal plants.

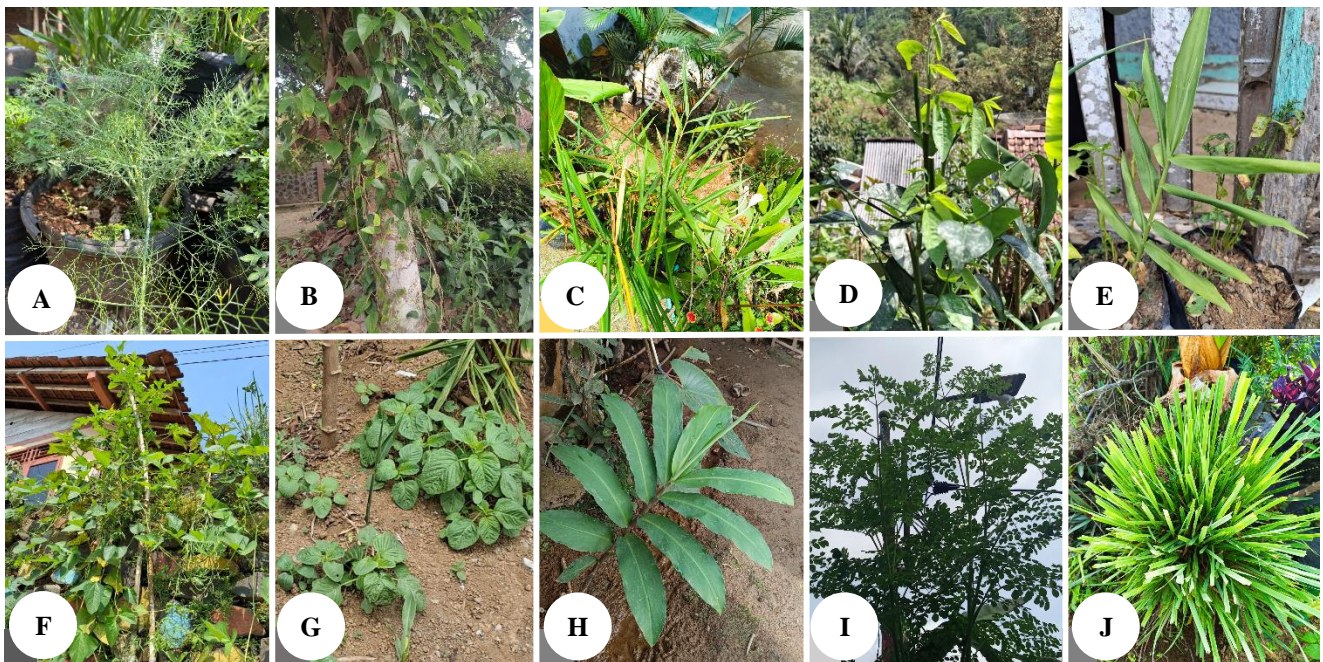


Figure 5. List of herbal plants for women’s health care in Kalibawang, Wonosobo District, Indonesia: A. *Foeniculum vulgare*; B. *Piper betle*; C. *Zingiber officinale*; D. *Sauropus androgynus*; E. *Zingiber cassumunar*; F *Vigna unguiculata* subsp. *Sesquipedalis*; G. *Amaranthus* sp.; H. *Alpinia galanga*; I. *Moringa oleifera*; J. *Cymbopogon citratus*

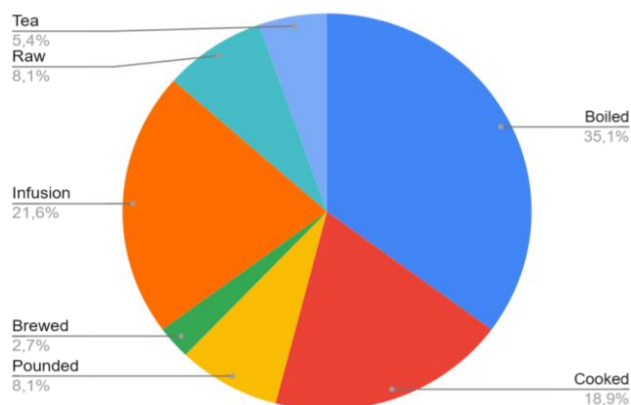


Figure 6. Plant preparation for women's health care in Kalibawang, Wonosobo District, Indonesia

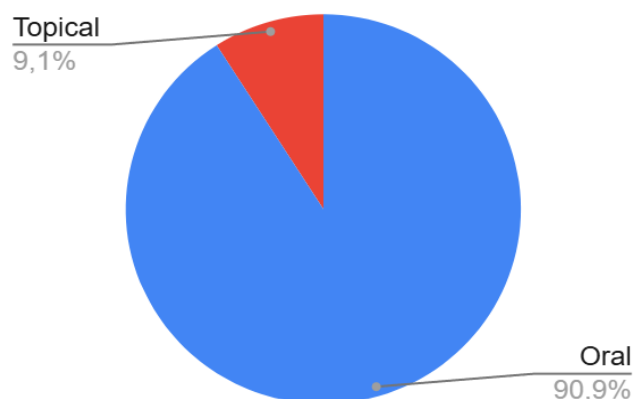


Figure 7. Plant application for women's health care in Kalibawang, Wonosobo District, Indonesia

Then with the cooking method is another popular approach, which includes 18.2% of the plants, with examples such as *Amaranthus* sp., *F. vulgare*, *M. esculenta*, *M. oleifera*, *Z. officinale*, *Z. cassumunar*, *P. betle*, and *O. basilicum*, where various heating methods release beneficial properties. Infusion is a gentler extraction process, used for 21.2% of plants such as *T. indica*, *A. galanga*, *S. macrophylla*, and *P. cubeba*, where plant parts are steeped in hot water to extract active ingredients. Brewing is a similar method where flowers such as *C. ternatea* are prepared as tea, and tea preparation specifically refers to the brewing of plants such as *C. citratus*. Some plants (6.1%), such as *M. oleifera* and *S. macrophylla*, are used raw without processing, while pounding is applied to 6.1% of plants, including *T. crispata* and *S. crispus*, to extract essential oils or extracts for topical use. Other specific preparations include *V. radiata* as infusion and tea (3%), *M. esculenta* as decoction and tea (3%), and *C. ternatea* as decoction and pounding (3%).

Based on the data displayed in Figure 7, medicinal plants used for women's health are consumed orally and topically. Most plants with a percentage of 90.9% are used orally. Oral application is the dominant method, where medicines are consumed to provide systemic effects, such as increasing lactation or regulating menstrual symptoms. This is common in plants that are processed through various methods, including boiling, cooking, infusion and brewing. Oral use carried out by the people of Kalibawang Sub-district such as *Amaranthus* sp., *M. oleifera*, *F. vulgare*, *S. androgynus*, and *V. unguiculata* which are cooked into *urap* or soup (*sayur bening*). It is recommended to consume it 1-2 times a day during breastfeeding to maintain optimal breast milk supply. In addition to being consumed in the form of cooking, medicinal plants are also drunk in the form of herbal medicine or tea such as *C. longa*, *C. xanthorrhiza*, and *Z. officinale* which can be drunk 2-3 times a week or as needed. In contrast, only a small number of plants are used topically (9.1%), which is applied by pounding and then applying externally, such as *P. betle*, *Z. cassumunar*, and *A. calamus*. In the use of *P. betle*, information was obtained from the community that the use of boiled *P. betle* water is

recommended 2-3 times a week. This topical application, although less common, is specifically intended for direct therapeutic effects on the skin or surface-level diseases. These data indicate that most of the medicinal plants in this dataset are intended for oral use rather than topical application.

In conclusion, this study is that there are around 17 families consisting of 33 plant species used by the community for women's health, with the Zingiberaceae family as the dominant family. Plants such as *Curcuma longa*, *Zingiber officinale*, *Sauropus androgynus*, and *Piper betle* play an important role in women's reproductive health, from overcoming menstrual problems to supporting postpartum recovery. The Specific Use Value (SUV) shows *Curcuma longa* as the most frequently used (0.038), followed by *Sauropus androgynus* (0.028) and *Piper betle* (0.019). The Relative Frequency of Citation (RFC) confirms the dominance of *Curcuma longa* (0.557), followed by *Sauropus androgynus* (0.538), and *Piper betle* (0.358), with all three having a Fidelity Level (FL) of 100%, indicating consistent use for specific purposes. The rhizomes of *C. longa* and *Z. officinale* are the most commonly used due to their anti-inflammatory, antioxidant, and breast milk production properties. In addition, *Z. cassumunar* plant has emerged, which is quite well-known in Wonosobo but not very familiar outside the area, reflecting that the use of medicinal plants not only has physical health benefits but also contains important cultural and spiritual values. The dominant community uses medicinal plants in the form of leaves, processed by boiling and applied orally.

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