

Ethnobotanical study of medicinal plants used by local communities in the Upper Bengawan Solo River, Central Java, Indonesia

FURQON DARMA NURCAHYO¹, HAFIZH MUHAMAD ZEN¹, HANIFA SABILA RAHMA¹,
ADITYA TRIYANTO^{2,3}, AHMAD YASA⁴, DARLINA MD. NAIM⁵, AHMAD DWI SETYAWAN^{1,6,*}

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

²Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Sebelas Maret. Jl. Ir. Sutami 36A, Surakarta 57126, Central Java, Indonesia

³Biodiversity Study Club, Faculty of Mathematics and Natural Sciences, Universitas Sebelas Maret. Jl. Ir. Sutami 36A, Surakarta 57126, Central Java, Indonesia

⁴Faculty of Medicine, Universitas Sebelas Maret. Jl. Ir. Sutami 36A, Surakarta 57126, Central Java, Indonesia

⁵School of Biological Sciences, Universiti Sains Malaysia. 1112, Persiaran Sains, 11800 Gelugor, Pulau Pinang, Malaysia

⁶Biodiversity Research Group, Universitas Sebelas Maret. Jl. Ir. Sutami 36A, Surakarta 57126, Central Java, Indonesia

Manuscript received: 18 November 2023. Revision accepted: 8 April 2024.

Abstract. Nurcahyo FD, Zen HM, Rahma HS, Triyanto A, Yasa A, MD Naim D, Setyawan AD. 2024. Ethnobotanical study of medicinal plants used by local communities in the Upper Bengawan Solo River, Central Java, Indonesia. *Intl J Bonorowo Wetlands* 14: 25-36. Medicinal plants are all plants with properties that can cure certain diseases. World Health Organization (WHO) states that more than 80% of the world's population still uses medicinal plants, including the communities living around Bengawan Solo River, Indonesia. This river is the longest river in Java, and it is significant in maintaining biodiversity, including the surrounding fauna and flora, particularly medicinal plants. This study aims to explore the diversity and uses of medicinal plants in three subdistricts along the Upper Bengawan Solo River (Sidodadi, Ngringo and Palur), focusing on documentation and understanding of medicinal plants used by local communities. Ninety informants, including 5 key and 85 general respondents (aged 21-78), were selected using purposive and snowball samplings. Semi-structured interviews and participatory observations gathered ethnobotanical data to be presented descriptively and analyzed quantitatively, including demographics, use values and informant consensus factor. Villagers in the three sub-districts utilize 88 medicinal plant species for various ailments. The majority of medicinal practices rely on traditional methods and oral transmission for knowledge transfer. Leaves (51.1%) and fruits (25%) are the primary plant parts used, processed mainly through boiling (68.5%) and direct consumption (23.9%). Boiling is the most preferred method for combining multiple plants since it is considered the easiest and most cost-effective method. *Zingiber officinale* Roscoe, *Alpinia galanga* (L.) Wild., and *Curcuma longa* L. are the most commonly utilized plants. This study highlights the importance of preserving traditional medicinal plant knowledge along the Bengawan Solo River to inform conservation efforts, support community health, and guide policy for mutual benefits and biodiversity conservation.

Keywords: Informant consensus factor, local knowledge, medicinal plants, use value

INTRODUCTION

The region under ASEAN (the Association of Southeast Asian Nations) is among the areas with the highest biological diversity on Earth. Within the ASEAN region, three countries are among the world's seventeen megadiversity countries, four countries are among the twenty-five biodiversity hotspots, and it has the highest coral reef diversity globally. Numerous endemic species of plants and animals occur in the region due to biogeographic, geological, climatic, and ecological conditions. Indonesia, one of the ten nations constituting ASEAN, is a politically and economically diverse regional entity. Indonesia is the most biologically rich country in the region and ranks second in terms of global biodiversity after Brazil (Keong 2015).

Biodiversity is vital to the welfare of people worldwide because it plays a major role in human development and well-being. One important role of biodiversity is the medicinal uses generated from a large diversity of plant species. Medicinal plants refer to plant species utilized for medicinal purposes in various contexts, such as food, condiments,

perfumes, and cosmetics, in both allopathic and traditional medical systems. According to Astutik et al. (2019), medicinal plants are one of the most valuable non-timber forest products since they significantly improve access to cheap healthcare and livelihood stability. A recent research by the World Health Organization (WHO) estimates that over 80% of the world's population still receives basic medical treatment from medicinal plants. Several communities still depend on medicinal plants since they are thought to be able to treat both minor and severe illnesses (Fitrianti and Partasamita 2020).

Ethnobotany is the scientific study of traditional knowledge and customs of people in relation to the medicinal, religious, and other uses of plants, encompassing the relationship between plants, cultural beliefs, and conservation practices in accordance with the knowledge of local communities (Panigrahi et al. 2021). This includes the utilization of medicinal plants for treating various diseases, their classification, and management. The reliance on plant-based medicine underscores the importance of ethnobotany as a discipline examining the intricate relationship between people and plants.

Medicinal ethnobotany is a specialized field within ethnobotany that focuses on the use of plants for healthcare (Cunningham 2001). This field plays a vital role in medical science since natural ingredients have long been used as sources of medicinal drugs, for example, salicylates (willow bark), ergotamine (infected rye), quinine (*Cinchona*), and *Digitalis* (foxglove). Medicinal ethnobotany can be used as a starting point for bioprospecting research on medicinal plants, which are promising for drug discovery and development to be used in biotechnology and pharmaceutical industries (Rintelen et al. 2017). Nonetheless, finding drugs from natural sources is complex and involves molecular, biological, phytochemical, and botanical methods (Sharma et al. 2019).

For ages, tribal and folk societies worldwide have relied on medicinal plants to meet their basic medical needs (Kumar 2020). The conventional therapeutic methodology, rooted in the utilization of botanical resources by indigenous societies, has been consistently upheld and transmitted intergenerationally, flowing from the elder members to the younger ones (Awan et al. 2021). The ethnobotanical knowledge of medicinal plants also exists in the communities living along the Bengawan Solo River, Central Java Province, Indonesia. The Bengawan Solo River Basin is one of Indonesia's largest river basins, characterized by high biodiversity, particularly in medicinal plants. The communities around the Bengawan Solo River use the riverbanks to cultivate medicinal plants with potential in traditional medicine and for environmental conservation efforts (Susilowati and Puspitasari 2023). Further, the traditional market here also facilitates the trade of medicinal plant materials between farmers and users (Ammar et al. 2021).

Despite the abundance of medicinal plant resources in Bengawan Solo River Basin, concerns arise regarding the people's knowledge, specifically regarding its sustainability in cultivation and usage. Therefore, it is necessary to conduct an ethnobotany study to ascertain the knowledge and utilization of plants, especially therapeutic plants. This study aims to gather information on the types of medicinal plants used by the people of three districts along the Bengawan Solo River. We expected the result of this study might be useful for the conservation efforts of traditional medicinal plants, support the development of sustainable policies in natural resource management, and provide guidance for educational programs and outreach to the community regarding the prudent and sustainable use of medicinal plants, thereby fostering environmental stewardship and community well-being.

MATERIALS AND METHODS

Study period and area

The study was conducted from 23 October 2023 to 5 November 2023 in three villages of Central Java, Indonesia, i.e., (i) Sidodadi Village, Masaran Sub-district, Sragen District at $7^{\circ}28'57.6''$ S and $110^{\circ}54'07.9''$ E; (ii) Ngringo Village, Jaten Sub-district, Karanganyar District at $7^{\circ}33'24.8''$ S and $110^{\circ}52'23.8''$ E; and (iii) Palur Village, Mojolaban Sub-district, Sukoharjo District at $7^{\circ}34'19.6''$ S and $110^{\circ}51'36.7''$ E. These three villages were located in the river basin of the Upper Bengawan Solo River (Figure 1), and are typical of rural areas with agriculture and labor as predominant professions (Subroto and Ningrum 2020; pers. comm.).

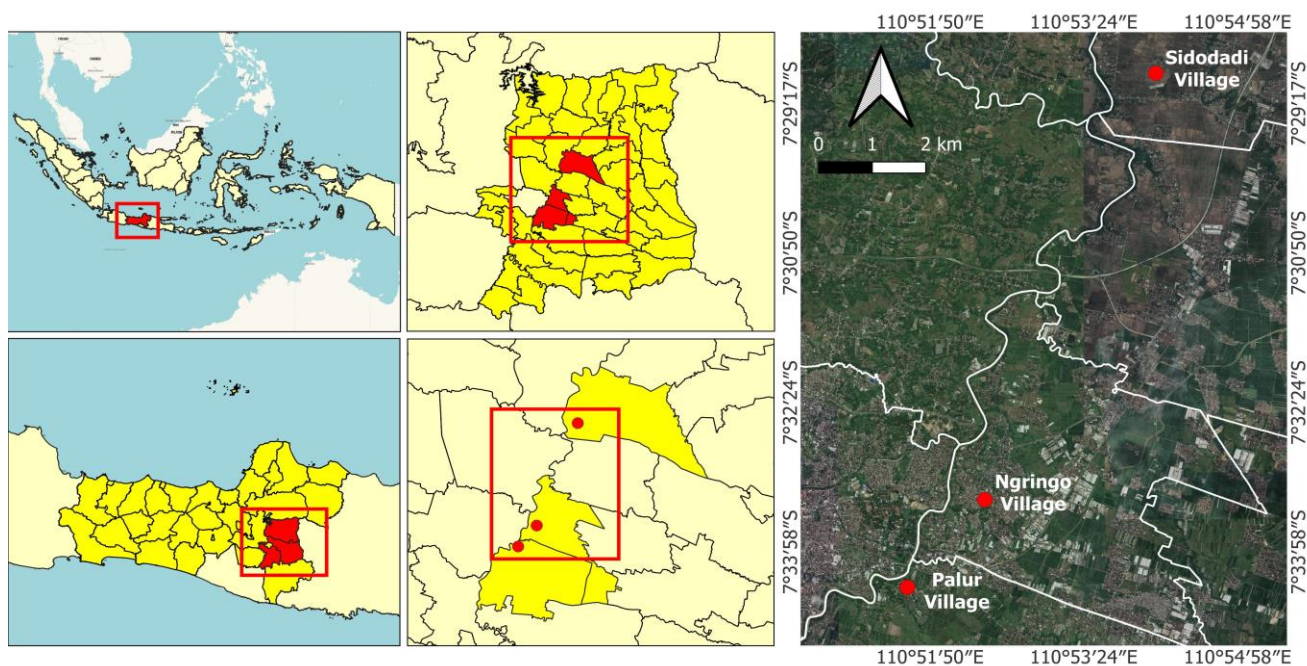


Figure 1. Map of the study area along Bengawan Solo River, Central Java, Indonesia, indicating the sampling sites in Sidodadi Village, Ngringo Village, and Palur Village

Data collection

Information on traditional uses of plants was collected from respondents consisting of 5 key informants and 85 general respondents. The snowball sampling was used to gather deeper information from key informants. Key informants consisted of folk healers (2 people), members of the family welfare education community (PKK) (2 people), and heads of the village (1 person). Key informants are individuals with specialized knowledge or experience related to the research topic. They are selected because of their expertise or experience, which can provide valuable insights into the study. Key informants are typically involved in in-depth interviews or group discussions to gain a deeper understanding of the topic being researched. Meanwhile, general respondents are individuals or groups who provide responses or information in the research. They may need to gain specialized knowledge or experience about the research topic, but they are invited to participate in surveys, interviews, or observations as part of the study. The purpose of general respondents is to provide data that can be analyzed to understand trends or patterns in the population being studied.

Interviews were done to collect information on the diversity and usage of medicinal plants while adhering to established ethnobotanical criteria. During the interview process, recording and taking notes were carried out. Information on the uses and diversity of medicinal plants was obtained from interviews using the in-depth, semi-structured, and participative observation methods, following the existing ethnobotanical guidelines, plant part used, cured diseases, how to process, how to apply, how/source to obtain, information obtained from where and since when consumption methods are presented descriptively in tables and graphs, analyzed in terms of frequency and percentage, and then presented descriptively. The scientific name of each species identified was crosschecked with online databases, including Plant of the World Online (<https://powo.science.kew.org/>) and GBIF (Global Biodiversity Information Facility) (<https://www.gbif.org/>)

Data analysis

Data was analyzed qualitatively and quantitatively. Qualitative analysis used descriptive statistics by grouping plants based on their use category (Miles and Huberman 2019). Quantitative analyses were conducted to investigate the importance of each species using two indices: Use Value (UV) and Informant Consensus Factor (ICF).

Use Value (UV)

The relative importance of each plant species known locally for herbal medicine is expressed as Use Value (UV) (Kefifa et al. 2020). UV is calculated using the following formula.

$$UV = \sum \frac{U}{N}$$

Where: The value of a species is UV, while the number of use reports cited by each informant is U, and the total number of informants interviewed for a plant is n.

Informant Consensus Factor (ICF)

ICF was used to see the level of agreement among the respondents (Adam et al. 2020). In term of use of the plant to treat particular disease, Informant Consensus Factor (ICF) was calculated using the following formula.

$$ICF = \frac{[Nur - Nt]}{Nur - 1}$$

Where: Nur is the number of reports of use for a particular disease category, and Nt is the number of taxa used for a disease category by all informants.

RESULTS AND DISCUSSION

Demographic profile of the respondents

A total of 90 informants, consisting of 5 key informants and 85 general respondents, 66 women and 24 men, were interviewed (Table 1). All respondents are of Javanese ethnicity. Based on age, the respondents were divided into 5 categories: <20, 21-30, 31-40, 41-50, 51-60, 61-70, and >70 years. Of the 90 respondents, 16 were elementary school graduates, 18 were junior high school graduates, 38 were high school graduates, and 18 were university graduates. The majority of the respondents from this study were women; this is because women mostly conducted household activities, and they often use traditional ingredients that generally have medicinal properties, such as *Salam* leaves (*Syzygium polyanthum*). Because of this, most female respondents know more about the use and benefits of medicinal plants than male respondents (Razafindraibe et al. 2013).

Diversity of medicinal plants

The villagers in the studied areas in Sidodadi Village, Ngringo Sub-district, and Palur Sub-district utilize 88 species of medicinal plants belonging to 76 genera and 44 families to treat diseases (Table 2, Figure 2). According to the results of the interviews, most of the population still uses medicinal plants as an alternative medicine. Some medicinal plants are cultivated in yards and community gardens or purchased elsewhere. The villagers use various parts of medicinal plants such as rhizomes/roots, leaves, tubers, flowers, and fruits. Compounds found in medicinal plants have antimicrobial and anticancer effects (Kaushik et al. 2020).

Table 1. The demographic structure of the respondents

Parameter	Classification	Frequency	Percentage (%)
Gender	Male	24	27
	Female	66	73
Age	< 20	1	1
	21-30	8	9
	31-40	13	14
	41-50	20	22
	51-60	29	32
	61-70	14	16
Education	>70	5	6
	Elementary School	16	18
	Junior High School	18	20
	Senior High School	38	42
	University	18	20

Table 2. Medicinal plants used by local communities in the Bengawan Solo River basin (Sidodadi, Ngringo, and Palur Villages), Central Java, Indonesia

Scientific name	Local name	Family	Growth form	Part used
<i>Allium sativum</i> L.	Bawang	Amaryllidaceae	Herbaceous	Tuber, leaves
<i>Aloe vera</i> (L.) Burm.f.	Lidah Buaya	Asphodelaceae	Herbaceous	Entire Part
<i>Alpinia galanga</i> (L.) Wild.	Lengkuas	Zingiberaceae	Herbaceous	Rhizome
<i>Alternanthera littoralis</i> P.Beauv.	Krokot Putih	Amaranthaceae	Herbaceous	Fruit
<i>Andrographis paniculata</i> (Burm.fil.) Nees	Sambiloto	Acanthaceae	Herbaceous	Leaves
<i>Annona muricata</i> L.	Sirsak	Annonaceae	Tree	Leaves
<i>Annona squamosa</i> L.	Srikaya	Annonaceae	Tree	Leaves
<i>Anredera cordifolia</i> (Ten.) Steenis	Binahong	Basellaceae	Shrub	Leaves
<i>Apium graveolens</i> L.	Seledri	Apiaceae	Herbaceous	Leaves
<i>Artocarpus altilis</i> (Parkinson) Fosberg	Sukun	Moraceae	Tree	Fruit
<i>Averrhoa bilimbi</i> L.	Belimbing Wuluh	Oxalidaceae	Tree	Fruit
<i>Averrhoa carambola</i> L.	Belimbing	Oxalidaceae	Tree	Fruit
<i>Azadirachta indica</i> A.Juss.	Nimba	Meliaceae	Tree	Leaves
<i>Biancaea sappan</i> (L.) Tod.	Kayu Secang	Fabaceae	Tree	Wood
<i>Boesenbergia rotunda</i> (L.) Mansf.	Temu Kunci	Zingiberaceae	Herbaceous	Rhizome, leaves
<i>Carica papaya</i> L.	Pepaya	Caricaceae	Herbaceous	Fruit, leaves
<i>Cinnamomum verum</i> J. Presl	Kayu Manis	Lauraceae	Tree	Wood
<i>Citrus × aurantiifolia</i> (Christm.) Swingle	Jeruk Nipis	Rutaceae	Tree	Fruit, leaves
<i>Citrus hystrix</i> DC.	Jeruk	Rutaceae	Tree	Fruit, leaves
<i>Citrus × limon</i> (L.) Osbeck	Jeruk Lemon	Rutaceae	Tree	Fruit, leaves
<i>Clitoria ternatea</i> L.	Telang	Fabaceae	Shrub	Flower
<i>Coriandrum sativum</i> L.	Ketumbar	Apiaceae	Herbaceous	Seed
<i>Cosmos caudatus</i> Kunth	Kenikir	Asteraceae	Herbaceous	Leaves
<i>Cucumis sativus</i> L.	Timun	Cucurbitaceae	Shrub	Fruit
<i>Cuminum cyminum</i> L.	Jinten	Apiaceae	Herbaceous	Seed
<i>Curcuma aeruginosa</i> Roxb.	Temuireng	Zingiberaceae	Herbaceous	Rhizome
<i>Curcuma longa</i> L.	Kunyit	Zingiberaceae	Herbaceous	Rhizome
<i>Curcuma xanthorrhiza</i> Roxb.	Temulawak	Zingiberaceae	Herbaceous	Rhizome
<i>Curcuma zedoaria</i> (Christm.) Roscoe	Kunyit Putih	Zingiberaceae	Herbaceous	Rhizome
<i>Cymbopogon citratus</i> (DC.) Stapf	Serai	Poaceae	Herbaceous	Stem
<i>Dracaena angustifolia</i> (Medik.) Roxb.	Suji Andong	Asparagaceae	Shrub	Leaves
<i>Eclipta prostrata</i> (L.) L.	Urang-Aring	Asteraceae	Herbaceous	Leaves
<i>Elephantopus scaber</i> L.	Tapak Liman	Asteraceae	Herbaceous	Leaves
<i>Eleutherine bulbosa</i> (Mill.) Urb.	Bawang Dayak	Iridaceae	Herbaceous	Leaves
<i>Erythrina variegata</i> L.	Dadap	Fabaceae	Tree	Leaves
<i>Ficus elastica</i> Roxb.	Karet Kebo	Moraceae	Tree	Leaves
<i>Garcinia mangostana</i> L.	Manggis	Clusiaceae	Tree	Fruit
<i>Gynura procumbens</i> (Lour.) Merr	Sambung Nyawa	Asteraceae	Herbaceous	Leaves
<i>Leuenerbergeria bleo</i> (Kunth) Lodé	Tujuh Bilah	Cactaceae	Herbaceous	Leaves
<i>Jasminum sambac</i> (L.) Aiton	Melati	Oleaceae	Shrub	Flower
<i>Jatropha gossypifolia</i> L.	Jarak Tintir	Euphorbiaceae	Shrub	Leaves
<i>Kaempferia galanga</i> L.	Kencur	Zingiberaceae	Herbaceous	Rhizome
<i>Lavandula</i> sp.	Lavender	Lamiaceae	Herbaceous	Flower
<i>Leucaena leucocephala</i> (Lam.) de Wit	Petai Cina	Fabaceae	Tree	Fruit
<i>Malus domestica</i> (Suckow) Borkh.	Apel Hijau	Rosaceae	Tree	Fruit
<i>Mangifera indica</i> L.	Mangga	Anacardiaceae	Tree	Leaves
<i>Manihot esculenta</i> Crantz	Singkong	Euphorbiaceae	Shrub	Leaves
<i>Manilkara zapota</i> (L.) P.Royen	Sawo	Sapotaceae	Tree	Fruit
<i>Mentha × piperita</i> L.	Mint	Lamiaceae	Herbaceous	Leaves
<i>Momordica charantia</i> L.	Pare	Cucurbitaceae	Shrub	Fruit
<i>Morinda citrifolia</i> L.	Mengkudu	Rubiaceae	Tree	Fruit
<i>Moringa oleifera</i> Lam.	Kelor	Moringaceae	Tree	Leaves
<i>Morus alba</i> L.	Murbei	Moraceae	Tree	Fruit
<i>Muntingia calabura</i> L.	Kersen	Elaeocarpaceae	Tree	Fruit
<i>Musa paradisiaca</i> L.	Pisang	Lamiaceae	Herbaceous	Leaves
<i>Ocimum basilicum</i> L.	Kemangi	Lamiaceae	Herbaceous	Leaves
<i>Olea europaea</i> L.	Zaitun	Oleaceae	Tree	Fruit
<i>Orthosiphon aristatus</i> (Blume) Miq.	Kumis Kucing	Lamiaceae	Herbaceous	Leaves

<i>Panax ginseng</i> C.A.Mey.	<i>Gingseng</i>	Araliaceae	Herbaceous	Rhizome
<i>Pandanus amaryllifolius</i> Roxb. ex Lindl.	<i>Pandan</i>	Pandanaceae	Herbaceous	Leaves
<i>Peperomia pellucida</i> (L.) Kunth	<i>Sirih Cina</i>	Piperaceae	Herbaceous	Leaves
<i>Persea americana</i> Mill.	<i>Alpukat</i>	Lauraceae	Tree	Leaves
<i>Phaleria macrocarpa</i> (Scheff.) Boerl.	<i>Mahkota Dewa</i>	Thymelaeaceae	Tree	Flower
<i>Phyllanthus buxifolius</i> (Blume) Müll.Arg.	<i>Seligi</i>	Phyllanthaceae	Shrub	Leaves
<i>Phyllanthus urinaria</i> L.	<i>Meniran</i>	Phyllanthaceae	Herbaceous	Leaves
<i>Physalis angulata</i> L.	<i>Ciplukan</i>	Solanaceae	Herbaceous	Fruit
<i>Piper betle</i> L.	<i>Sirih Hijau</i>	Piperaceae	Herbaceous	Leaves
<i>Piper ornatum</i> N.E.Br.	<i>Sirih Merah</i>	Piperaceae	Herbaceous	Leaves
<i>Piper retrofractum</i> Vahl	<i>Cabe Puyang</i>	Piperaceae	Herbaceous	Leaves
<i>Platyterium bifurcatum</i> (Cav.) C.Chr.	<i>Tanduk Rusa</i>	Polypodiaceae	Herbaceous	Leaves
<i>Portulaca oleracea</i> L.	<i>Krokot</i>	Portulacaceae	Herbaceous	Fruit
<i>Psidium guajava</i> L.	<i>Jambu Biji</i>	Myrtaceae	Tree	Leaves
<i>Punica granatum</i> L.	<i>Delima</i>	Lythraceae	Shrub	Fruit
<i>Ruellia tuberosa</i> L.	<i>Pletekan</i>	Lamiaceae	Herbaceous	Leaves
<i>Salacca zalacca</i> (Gaertn.) Voss	<i>Salak</i>	Arecaceae	Shrub	Fruit
<i>Sauropus androgynus</i> L.	<i>Katuk</i>	Phyllanthaceae	Herbaceous	Leaves
<i>Smallanthus sonchifolius</i> (Poepp. & Endl.) H.Rob.	<i>Daun Insulin</i>	Asteraceae	Herbaceous	Leaves
<i>Strobilanthes crispata</i> (L.) Blume	<i>Keji Beling</i>	Achantaceae	Herbaceous	Leaves
<i>Swietenia mahagoni</i> (L.) Jacq.	<i>Mahoni</i>	Meliaceae	Tree	Fruit
<i>Syzygium polyanthum</i> (Wight) Walp.	<i>Salam</i>	Myrtaceae	Tree	Leaves
<i>Tamarindus indica</i> L.	<i>Asam Jawa</i>	Fabaceae	Tree	Fruit
<i>Tinospora cordifolia</i> (Willd.) Miers	<i>Brotowali</i>	Menispermaceae	Shrub	Leaves
<i>Triphasia trifolia</i> (Burm.fil.) P.Wilson	<i>Jeruk Kingkit</i>	Rutaceae	Tree	Fruit
<i>Vitis vinifera</i> L.	<i>Anggur</i>	Vitaceae	Tree	Fruit
<i>Zingiber officinale</i> Roscoe	<i>Jahe</i>	Zingiberaceae	Herbaceous	Rhizome
<i>Zingiber officinale</i> var. <i>rubrum</i> Theilade	<i>Jahe Merah</i>	Zingiberaceae	Herbaceous	Rhizome
<i>Zingiber zerumbet</i> (L.) Roscoe ex Sm.	<i>Lempuyang</i>	Zingiberaceae	Herbaceous	Rhizome
<i>Ziziphus mauritiana</i> Lam.	<i>Bidara</i>	Rhamnaceae	Shrub	Leaves

According to the interviews, the villagers use many plant species as traditional medicine. *Zingiber officinale*, widely known as ginger, is the most commonly used plant. Ginger is easy to care for and grow because it has roots in rhizomes that grow quickly. According to Lestari et al. (2021), ginger can be used to treat cough and hypothermia and improve immunity. Ginger is also a widely used culinary spice that has a long history of usage in herbal remedies and medicine dating back thousands of years (Shahrajabian et al. 2019). In addition to ginger, there are other rhizomes belonging to the Zingiberaceae family that are often used by the community. *Kaempferia galanga*, known as kencur in the local language, is used to treat coughs, ulcers, and hypothermia. In some places, it is also known as fragrant ginger or sand ginger (Wang et al. 2021). *Curcuma longa*, or turmeric, can treat stomachache, acid reflux, dysmenorrhea and cough and warm the body. The plant has limited rhizomatous propagation in its natural habitat, and overexploitation and deforestation have further decreased the plant population (Subositi et al. 2020). *Curcuma xanthorrhiza* or *temulawak* can treat nausea, acid reflux, wound healing, increased immunity, appetite booster, and stomach aches. Numerous active chemicals in these plants have various biological effects (El Alami et al. 2020). *Curcuma zedoaria*, or white turmeric, treats indigestion, colds, and asthma. *Curcuma aeruginosa*, a well-known rhizomatous medicinal plant known as *temuireng* by local people, is used to treat vaginal

discharge, stomachache, and acid reflux (Khumaida et al. 2019). *Alpinia galanga* or galangal relieves arthritis, pain relief, immunity, and indigestion. The *Z. officinale* var. *rubrum* or red ginger treats stomach ache and cough. Furthermore, some research indicates that red ginger possesses antibacterial, immunomodulatory, antihypertensive, antihyperlipidemia, and anti-hyperuricemia properties (Raising et al. 2023). *Zingiber zerumbet* or lempuyang is used in the local language to reduce fever.

Allium sativum or onion is used to treat gastric diseases. The community uses *Eleutherine bulbosa*, or *Bawang Dayak*, to treat infections, cholesterol, and hypertension. *Panax ginseng* or *Ginseng* is consumed to relieve inflammation, headaches and improve immunity. *Annona muricata* (soursop) and *Piper betle* (betel leaf) are plants frequently utilized by communities in various contexts, including traditional medicine. Soursop leaves and betel leaves play a specific role in addressing certain health conditions. Soursop leaves are believed to potentially lower blood pressure in hypertensive patients (Putri 2022), while betel leaves are recognized for their natural antibacterial properties (Afridi et al. 2021). *Aloe vera*, commonly known as *Lidah Buaya*, is widely used by communities to aid in the healing of skin wounds (Sánchez et al. 2020). Papaya (*Carica papaya*), specifically its leaves, is utilized by many people to control blood sugar levels in the body.

Furthermore, the community often uses *Ciplukan* (*Physalis angulata*) to treat asthma (Daltro et al. 2021).

Growth form and plant part used

The people in Sidodadi, Ngringo, and Palur Villages generally use traditional methods and herbal plants for treatment. The knowledge in these three villages is mostly passed down through generations and oral transmission. Medicinal plants with herbaceous growth type dominate with a total of 44, followed by trees with 31, and shrubs with 13 species (Table 2). The diversity in growth types reflects the complexity of the medicinal plant ecosystem. Shrub plants demonstrate high adaptability to various environmental conditions, while tree plants provide long-term benefits. Climber plants require support, while herbaceous plants with lower growth contribute uniquely to the diversity of medicinal plant resources. Growth forms in medicinal plants include various plant shapes and structures that can provide information about the adaptation of these plants (Fiorello 2020). Some common growth forms in medicinal plants involve morphological characteristics such as root, rhizome, leaf, and flower types.

Understanding these differences is crucial for managing and conserving natural resources and their optimal utilization in traditional medicinal practices.

In terms of plant parts, the most frequently used part of the plant is the leaves, with 48.94% (Figure 3). The use of leaves as medicine become a profound phenomenon in ethnobotanical knowledge worldwide. Plant leaves are often the main focus of traditional medicine because they are rich in bioactive compounds that provide health benefits. A recent ethnobotanical study conducted by Yeung et al. (2018) provides in-depth insights into using leaves in various traditional healing practices worldwide. Various people use plant leaves to cure various diseases and maintain holistic health. For example, neem or *Azadirachta indica* are used for various medicinal purposes in India (Uzzaman 2020). In Africa, plant leaves such as moringa (*Moringa oleifera*) and *Katuk* (*Sauropus androgynus*) have an important role in traditional medicine (Moyo et al. 2015).

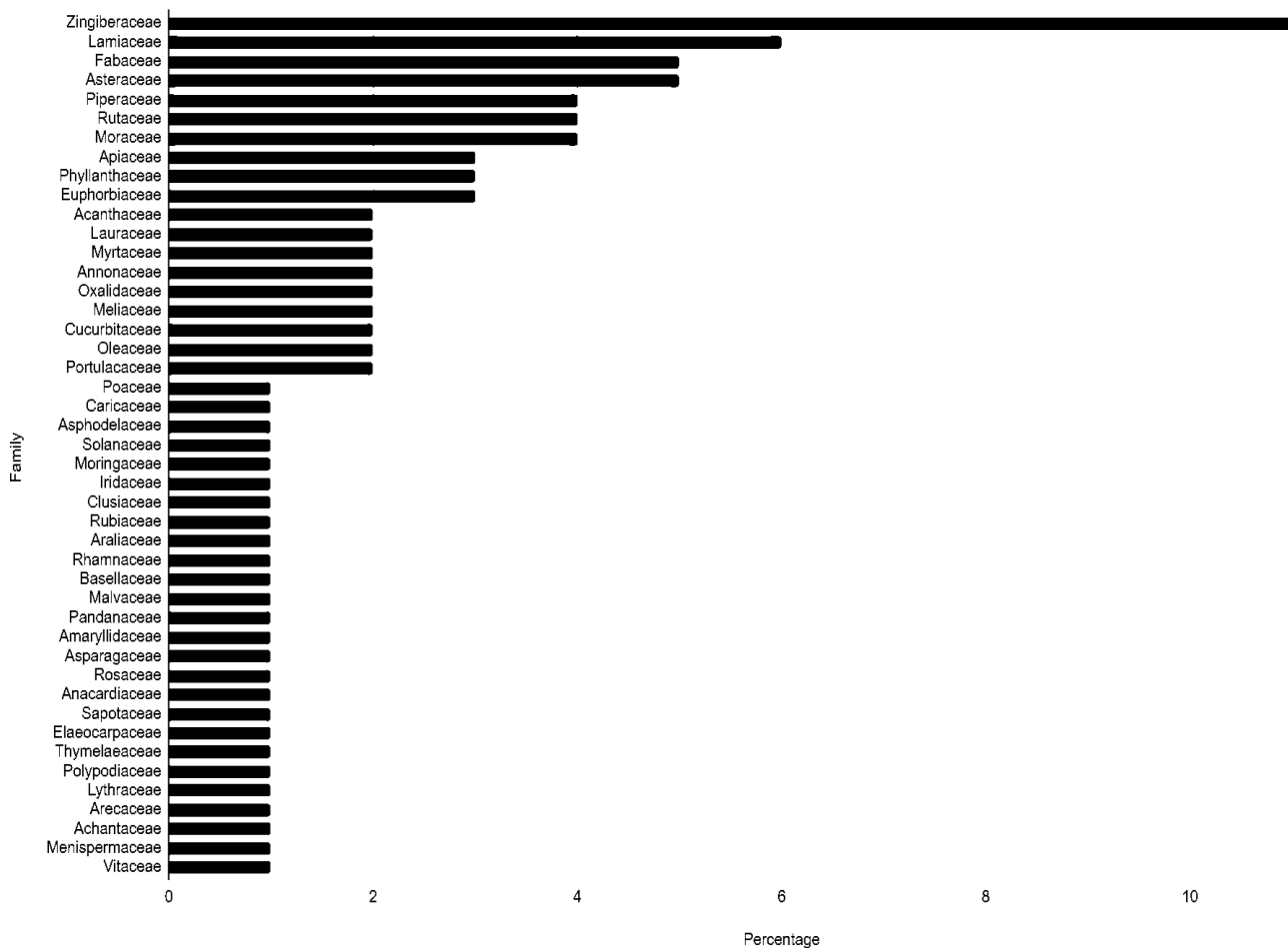


Figure 2. Family of medicinal plants used by the people of Sidodadi Village, Ngringo Village, and Palur Village, Central Java, Indonesia

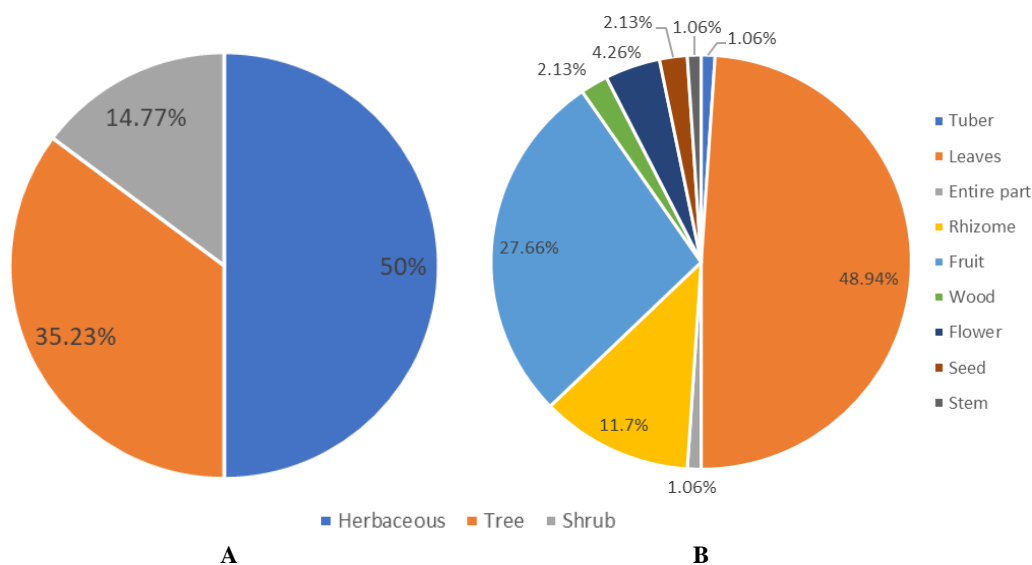


Figure 3. A. Growth form and B. Parts of medicinal plants used by the people of Sidodadi Village, Ngringo Village, and Palur Village, Central Java, Indonesia

The fruit is the second most commonly used part, accounting for 25.6%. Using fruits as part of plants in ethnobotany is closely related to preserving biodiversity, providing food sources, and being used as medicinal worldwide (Suwardi and Navia 2023). Local communities continue to utilize fruit parts of medicinal plants and fulfill the sociocultural needs and people's livelihood (Shai et al. 2020). The medicinal part of plants in the form of fruit is typically extracted to harness its essence. For example, *Citrus × aurantiifolia* (family Rutaceae), native to Southeast Asia, is primarily grown in tropical and subtropical climates and is mostly used as a medicine and food additive because of its fragrant aroma (Galovičová et al. 2022). Thus, the use of medicinal fruit plants in the global context of ethnobotany indicates significant potential to provide solutions in health and environmental conservation.

The next most commonly used plant part is the rhizomes at 14.4%, followed by other parts such as flowers at 4.4%, seeds at 2.2%, and entire part of plants at 1.1%. Therefore, using flowers, rhizomes, and seeds in ethnobotany globally reflects the diversity of traditional knowledge within communities regarding using plant natural resources for various purposes, ranging from food to traditional medicine worldwide (Qadir and Raja 2021). For example, the rhizome of *Z. officinale* is used to treat coughs, warm the body, and as body immunity. In the flower part, *Jasminum sambac* is used to treat inflammation (El Shiekh et al. 2021). The stem of *Cymbopogon citratus* is often used to treat diabetes and cholesterol and increase body immunity. The seed of *Coriandrum sativum* is used to treat hypertension.

Preparation and application methods

The processing methods commonly used by the community in the studied area are boiling (68.5%) and

direct consumption (23.9%) (Figure 4). Boiling is widely used in the preparation of herbal medicine because this process enhances the extraction of active ingredients from medicinal plants, thereby increasing the efficacy of the medicine (Ssenku et al. 2022). In addition to boiling, many people in the studied area also use the direct consumption method, which requires no processing or tools, making it the simplest way. Plants consumed directly are usually fruits like oranges, green apples, and starfruit, which can be eaten without processing. However, there are also methods like crushing/grinding, as seen in the processing of *dadap* leaves (*Erythrina variegata*) for treating fever, and other methods such as burning, smearing, etc.

Rural communities employ various methods for processing medicinal plants, with boiling being the most common. People experimented with various plants to understand their biological effects. Through these trials, knowledge about specific plants and their application methods for particular disorders has been passed down through generations via oral transmission. Eventually, the information on medicinal plants was scientifically recorded in ethnobotanical field studies (Süntar 2020).

Use Value (UV)

Use Value (UV) is calculated to assess ethnobotanical data by determining the relative importance of plants in the area based on the number of use reports per informant for particular plant species divided by the total number of informants surveyed (Nisa et al. 2022). The Use Value (UV) was calculated as $UV = \sum U/n$ to determine the relative importance of locally known plant species, with high values indicating significance, and further analysis involved a comparative assessment of use values between two regions using a scatterplot and quadrants (Matejić et al. 2020).

Table 3. Preparations, applications, and diseases cured by medicinal plants used by the people of Sidodadi, Ngringo, and Palur Villages, Central Java, Indonesia

Scientific name	Preparation	Application methods	Disease	UV
<i>Allium sativum</i> L.	Direct consumption	Oral	Stomachache	0.1
<i>Aloe vera</i> (L.) Burm.f.	Others	Externally	Diarrhea, antibacterial, inflammation	0.6
<i>Alpinia galanga</i> (L.) Wild.	Boiled	Oral	Joint inflammation, digestive disorders	0.4
<i>Alternanthera littoralis</i> P.Beauv.	Boiled	Oral	Dysentery	0.1
<i>Andrographis paniculata</i> (Burm.fil.) Nees	Boiled	Oral	Inflammation, hypertension, diabetes mellitus	0.4
<i>Annona muricata</i> L.	Boiled	Oral	Stomachache, lung disease, diabetes mellitus, uric acid, diabetes, kidney stones, inflammation, rheumatism	1
<i>Annona squamosa</i> L.	Boiled	Oral	Uric acid, digestive disorders	0.2
<i>Anredera cordifolia</i> (Ten.) Steenis	Pounded/mashed	Oral	Wound, stomachache	0.2
<i>Apium graveolens</i> L.	Boiled	Oral	Kidney stones, hypertension, hepatitis	0.3
<i>Artocarpus altilis</i> (Parkinson) Fosberg	Boiled	Oral	Acid reflux	0.1
<i>Averrhoa bilimbi</i> L.	Direct consumption	Oral	Hemorrhoids, hypertension	0.2
<i>Averrhoa carambola</i> L.	Direct consumption	Oral	Hypertension, digestive disorders	0.2
<i>Azadirachta indica</i> A.Juss.	Boiled	Oral	Stomachache	0.1
<i>Biancaea sappan</i> (L.) Tod.	Boiled	Oral	Itchy skin	0.1
<i>Boesenbergia rotunda</i> (L.) Mansf.	Boiled	Oral	Cough, pharyngitis	0.2
<i>Boesenbergia rotunda</i> (L.) Mansf.	Boiled	Oral	Cancer	0.1
<i>Carica papaya</i> L.	Boiled	Oral	Cancer, meteorism, joint pain, hypertension, symptoms of dengue fever	0.7
<i>Cinnamomum verum</i> J. Presl	Boiled	Oral	Joint inflammation, cholesterol, cough	0.4
<i>Citrus × aurantiifolia</i> (Christm.) Swingle	Direct consumption	Oral	Cough	0.2
<i>Citrus × limon</i> (L.) Osbeck	Direct consumption	Oral	Pharyngitis	0.1
<i>Citrus hystrix</i> DC.	Boiled	Oral	Cough, inflammation	0.4
<i>Clitoria ternatea</i> L.	Others	Externally	Diabetes mellitus	0.1
<i>Coriandrum sativum</i> L.	Boiled	Oral	Hypertension	0.1
<i>Cosmos caudatus</i> Kunth	Boiled	Oral	Hypertension	0.1
<i>Cucumis sativus</i> L.	Direct consumption	Oral	Diabetes mellitus	0.1
<i>Cuminum cyminum</i> L.	Boiled	Oral	Cough	0.1
<i>Curcuma aeruginosa</i> Roxb	Boiled	Oral	Vaginal discharge, stomachache, acid reflux	0.4
<i>Curcuma longa</i> L.	Boiled	Oral	Stomachache, acid reflux, dysmenorrhea, warming, cough	0.6
<i>Curcuma xanthorrhiza</i> Roxb.	Boiled	Oral	Nausea, acid reflux, stomachache	0.7
<i>Curcuma zedoaria</i> (Christm.) Roscoe	Boiled	Oral	Digestive disorders, common cold, asthma	0.4
<i>Cymbopogon citratus</i> (DC.) Stapf	Boiled	Oral	Diabetes mellitus, cholesterol, hypertension, common cold, bloated stomach, digestive disorders	1
<i>Dracaena angustifolia</i> (Medik.) Roxb.	Boiled	Oral	Cancer	0.1
<i>Eclipta prostrata</i> (L.) L.	Boiled	Oral	Ulcer, wound	0.2
<i>Elephantopus scaber</i> L.	Boiled	Oral	Stiffness	0.1
<i>Eleutherine bulbosa</i> (Mill.) Urb.	Direct consumption	Oral	Infection, cholesterol, hypertension	0.3
<i>Erythrina variegata</i> L.	Pounded/mashed	Topical	Fever	0.1
<i>Ficus elastica</i> Roxb.	Boiled	Oral	Itchy skin, skin rash, internal disease	0.2
<i>Garcinia mangostana</i> L.	Boiled	Oral	Diabetes mellitus, uric acid, cholesterol	0.3
<i>Gynura procumbens</i> (Lour.) Merr	Boiled	Oral	Ulcer	0.1
<i>Jasminum sambac</i> (L.) Aiton	Boiled	Oral	Inflammation	0.1
<i>Jatropha gossypifolia</i> L.	Boiled	Oral	Inflammation	0.2
<i>Kaempferia galanga</i> L.	Boiled	Oral	Ulcer, cough, hypothermia	0.3
<i>Lavandula</i> sp. L.	Others	Externally	Headache	0.2
<i>Leucaena leucocephala</i> (Lam.) de Wit	Direct consumption	Oral	Wound	0.2
<i>Leuenergeria bleo</i> (Kunth) Lodé	Boiled	Oral	Cancer, uric acid	0.2
<i>Malus domestica</i> (Suckow) Borkh.	Direct consumption	Oral	Hepatitis	0.1
<i>Mangifera indica</i> L.	Boiled	Oral	Uric acid	0.1
<i>Manihot esculenta</i> Crantz	Boiled	Oral	Joint inflammation	0.2
<i>Manilkara zapota</i> (L.) P.Royen	Direct consumption	Oral	Diarrhea	0.1
<i>Mentha × piperita</i> L.	Direct consumption	Oral	Cough	0.1
<i>Momordica charantia</i> L.	Boiled	Oral	Cough, influenza	0.1
<i>Morinda citrifolia</i> L.	Direct consumption	Oral	Hypertension, stomachache, cancer	0.3
<i>Moringa oleifera</i> Lam.	Boiled	Oral	Cancer, mastitis, cholesterol, hypertension	0.4
<i>Morus alba</i> L.	Direct consumption	Oral	Blood sugar, hepatitis	0.2
<i>Muntingia calabura</i> L.	Direct consumption	Oral	Constipation	0.1
<i>Musa paradisiaca</i> L.	Boiled	Oral	Wound	0.1

<i>Ocimum basilicum</i> L.	Boiled	Oral	Inflammation	0.1
<i>Olea europaea</i> L.	Others	Oral	Cholesterol	0.1
<i>Orthosiphon aristatus</i> (Blume) Miq.	Boiled	Oral	Hypertension	0.1
<i>Panax ginseng</i> C.A.Mey.	Boiled	Oral	Inflammation, headache	0.3
<i>Pandanus amaryllifolius</i> Roxb. ex Lindl.	Boiled	Oral	Toothache, cough	0.2
<i>Peperomia pellucida</i> (L.) Kunth	Boiled	Oral	Inflammation	0.3
<i>Persea americana</i> Mill.	Boiled	Oral	Kidney stones	0.1
<i>Phaleria macrocarpa</i> (Scheff.) Boerl.	Boiled	Oral	Cancer, diabetes mellitus	0.1
<i>Phyllanthus buxifolius</i> (Blume) Müll.Arg.	Boiled	Oral	Cough, joint pain, osteoporosis	0.3
<i>Phyllanthus urinaria</i> L.	Boiled	Oral	Stiffness, kidney stones	0.2
<i>Physalis angulata</i> L.	Direct consumption	Oral	Asthma, fever, kidney stones, hypertension	0.5
<i>Piper betle</i> L.	Boiled	Oral	Joint pain, vaginal discharge, cholesterol, cough, inflammation, itchy skin	0.1
<i>Piper ornatum</i> N.E.Br.	Boiled	Oral	Nosebleed, fever, diabetes mellitus, kidney stones	0.4
<i>Piper retrofractum</i> Vahl	Boiled	Oral	Fever	0.2
<i>Platycerium bifurcatum</i> (Cav.) C.Chr.	Direct consumption	Oral	Wound	0.1
<i>Portulaca oleracea</i> L.	Boiled	Oral	Digestive disorders	0.1
<i>Psidium guajava</i> L.	Boiled	Oral	Stomachache, diarrhea, hypertension	0.3
<i>Punica granatum</i> L.	Direct consumption	Oral	Cancer	0.1
<i>Ruellia tuberosa</i> L.	Boiled	Oral	Hypertension	0.1
<i>Salacca zalacca</i> (Gaertn.) Voss	Direct consumption	Oral	Stomachache	0.1
<i>Sauropus androgynus</i> L.	Boiled	Oral	Mastitis	0.1
<i>Smallanthus sonchifolius</i> (Poepp. & Endl.) H.Rob.	Boiled	Oral	Diabetes mellitus	0.1
<i>Strobilanthes crispata</i> (L.) Blume	Boiled	Oral	Stomachache, Kidney stones	0.1
<i>Swietenia mahagoni</i> (L.) Jacq.	Direct consumption	Oral	Diabetes mellitus	0.1
<i>Syzygium polyanthum</i> (Wight) Walp.	Boiled	Oral	Stomachache, cholesterol, hypertension, uric acid	0.4
<i>Tamarindus indica</i> L.	Direct consumption	Oral	Cough, diabetes mellitus, dysmenorrhea	0.3
<i>Tinospora cordifolia</i> (Willd.) Miers	Pounded/mashed	Oral	Fever	0.1
<i>Triphasia trifolia</i> (Burm.fil.) P.Wilson	Direct consumption	Oral	Cough	0.1
<i>Vitis vinivera</i> L.	Direct consumption	Oral	Hypertension	0.1
<i>Zingiber officinale</i> Roscoe	Boiled	Oral	Cough, hypothermia, common cold	0.4
<i>Zingiber officinale var. rubrum</i> Theilade	Boiled	Oral	Stomachache, cough	0.2
<i>Zingiber zerumbet</i> (L.) Roscoe ex Sm.	Boiled	Oral	Fever	0.1
<i>Ziziphus mauritiana</i> Lam.	Boiled	Oral	Fever, diabetes, mellitus, hypertension	0.3

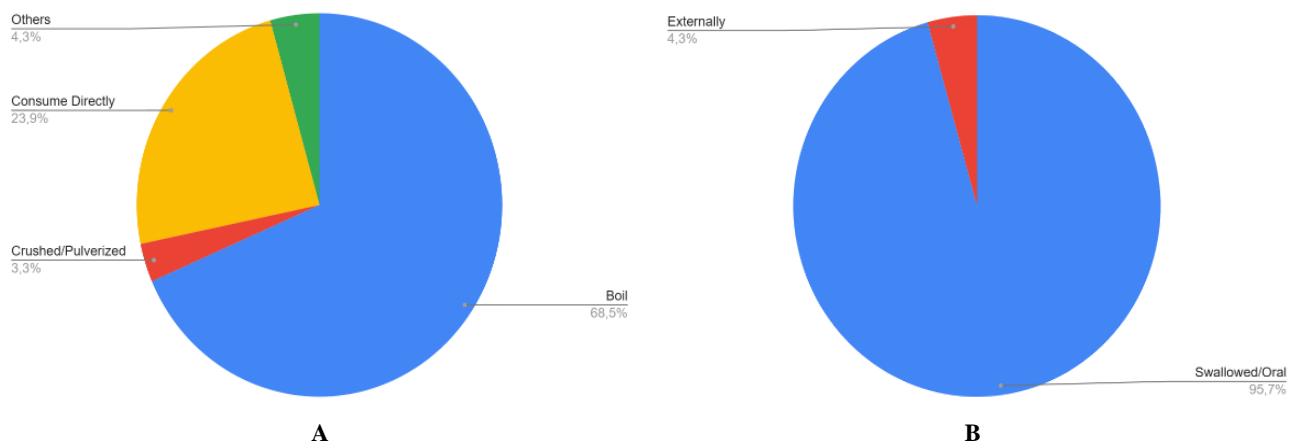


Figure 4. A. Methods of preparation and B. Application of medicinal plants by the people of Sidodadi Village, Ngringo Village, and Palur Village, Central Java, Indonesia

The Use Values (UV) of medicinal plants in the studied area ranged between 0.1 and 1. The average UV value for all plants is 0.228. Higher UV value indicates that the plant is considered more important and is used more frequently based on user reports. In this study, the plants with the highest UV are lemongrass (*A. muricata*; UV = 1) and soursop leaves (*C. citratus*; UV = 1), each with 10 uses

reports, followed by betel leaf (*P. betle*; UV = 1) with 9 uses. Other plants with high UV values include papaya (*C. papaya*) and temulawak (*C. xanthorrhiza*) with use value = 0.7, then *lidah buaya* (*A. vera*) and turmeric (*Curcuma longa*) have use value = 0.6, and the last is *ciplukan* (*Physalis angulata*; UV = 0.5) (Figure 5). This suggests that these plants have significant importance in traditional

community use. Table 3 shows that most medicinal plants only treat a specific type of disease, which may be influenced by the community's limited understanding of other functions of these plants. UV values can also be interpreted by the number of use reports and the variety of diseases each plant can treat; some plants may have low UV but offer diverse benefits. This study also illustrates that respondents' knowledge about the use of medicinal plants is influenced by factors such as age and accessibility to medicinal plants. Additionally, most recorded plants have more than one use report, indicating the diverse benefits of local medicinal plants.

Informant Consensus Factor (ICF)

The Informant Consensus Factor (ICF) was utilized to gauge consensus among informants regarding the usage of plants for specific ailments, with values ranging from 0 to 1, where value of 1 signifies the highest level of agreement (Cauca and Balinando 2021). Low ICF values, close to 0, indicate random plant selection or a lack of information exchange among informants, while values approaching 1 signify a well-defined selection criterion in the community or information exchange among informants (Muhakr et al. 2024). ICF was used to evaluate the homogeneity in the ethnomedicinal data recorded from traditional health

practitioners based on ailments treated and plant species used (Ssenku et al. 2022).

High values of the Informant Consensus Factor (ICF) indicate the effectiveness of a medicinal plant species in addressing specific health conditions. For example, *Psidium guajava* (guava), with an ICF value of 0.94 for diarrhea, suggests that this plant is specifically effective in addressing diarrhea issues (Vivekananda 2023). Meanwhile, the ICF value of 0.92 for *C. longa* indicates the plant's effectiveness in treating dysmenorrhea (Table 4).

Most of the communities in the studied area use two or three parts of plants to prepare medicines to treat single or multiple ailments. Usage categories, namely cysts, low blood pressure (hypotension), and appetite enhancement, have the highest ICF of 1.00. Still, these categories rank the lowest in usage reports (2, 2, 2, and 3, respectively) and the number of species used (1 species for each category). Usage categories with more than 20 usage reports include cough (127 usage reports, 17 species), diarrhea (34 reports, 3 species), and inflammation (21 reports, 15 species) (Table 3). The lowest agreement among informants was observed in kidney disorders, as indicated by the lowest ICF value of 0.14, followed by blood sugar with an ICF of 0.2. Therefore, this study suggests that the level of knowledge shared among the users of medicinal plants for treating particular ailments in the research area is low.

Table 4. Informant Consensus Factor (ICF) for different medicinal plant use categories

Ailment category	Nur	Nt	ICF	Frequently used species
Cyst	2	1	1	<i>Cinnamomum verum</i> J. Presl
Internal Disease	2	1	1	<i>Citrus × limon</i> (L.) Osbeck
Low Blood Pressure	2	1	1	<i>Piper retrofractum</i> Vahl
Appetite	3	1	1	<i>Curcuma xanthorrhiza</i> Roxb.
Diarrhea	34	3	0.94	<i>Psidium guajava</i> L.
Dysmenorrhea	15	2	0.92	<i>Curcuma longa</i> L.
Nosebleed	12	2	0.91	<i>Piper ornatum</i> N.E.Br.
Vaginal Discharge	11	2	0.9	<i>Piper betle</i> L.
Hypothermia	41	6	0.88	<i>Zingiber officinale</i> Roscoe
Cough	127	17	0.87	<i>Zingiber officinale</i> Roscoe

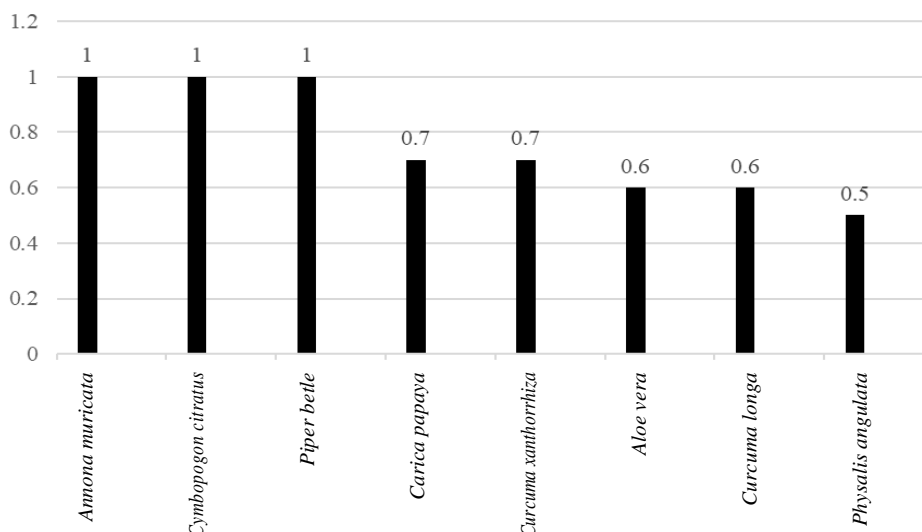


Figure 5. Eight medicinal plants with the highest use values

In conclusion, the local people living along the Bengwan Solo River in Sidodadi, Ngringo, and Palur Villages, Central Java, Indonesia, rely on a diverse array of medicinal plants, indicated by the uses of 88 species from 76 genera and 44 families for treating various diseases. The predominant use of leaves (51.1%) and fruits (25%) as medicinal plant parts reflects the community's traditional knowledge, largely transmitted orally across generations. Boiling (68.5%) is the primary method for plant preparation, with direct consumption (23.9%) being another common approach. The ease, cost-effectiveness, and cleanliness of boiling make it the preferred method. Ginger (*Z. officinale*) is the most frequently used plant, known for treating coughs, providing warmth to the body, and enhancing immunity. Other plants, such as turmeric (*C. longa*), *kencur* (*K. galanga*), and various citrus fruits, are also widely utilized for their medicinal properties. The community employs these plants to address various health issues, including respiratory problems, digestive disorders, and inflammation. The preparation (boiled, direct consumption, and pounded/mashed), application methods (oral, externally), and diseases treated vary across different plant species. Overall, this study highlights the rich traditional knowledge and reliance on medicinal plants within these villages, emphasizing the need to preserve and further explore the potential of these natural remedies.

ACKNOWLEDGEMENTS

We extend our gratitude to the people who participated in this study as respondents from the villages of Sidodadi, Ngringo, and Palur in Central Java, Indonesia, and to other parties who assisted in preparing this research publication.

REFERENCES

- Adam M, Ahmed AA, Yagi A, Yagi S. 2020. Ethnobotanical investigation on medicinal plants used against human ailments in Erkowit and Sinkat areas, Eastern Sudan. *Biodiversitas* 21 (7): 3255-3262. DOI: 10.13057/biodiv/d2110748.
- Afridi M, Muhammad IMR, Ahmad T, Hussain A, Akram M, Ghotekar S, Marasini BP. 2021. Ethno-medicinal uses of *Piper betel*—A review. *Adv J Chem Sect B* 3: 199-208. DOI: 10.22034/ajcb.2021.276229.1079.
- Ammar LA, Kurniawati B, Anggorowati D, Cahyaningsih AP, Setyawan AD. 2021. Ethnobotanical study of the medicinal plant by local communities in karst area of Pacitan District, East Java, Indonesia. *Intl J Trop Drylands* 5 (2): 84-93. DOI: 10.13057/tropdrylands/t050205.
- Astutik S, Pretzsch J, Kimengsi JN. 2019. Asian medicinal plants' production and utilization potentials; A review. *Sustainability* 11 (19): 5483. DOI: 10.3390/su11195483.
- Awan AA, Akhtar T, Ahmed MJ, Murtaza G. 2021. Quantitative ethnobotany of medicinal plants uses in the Jhelum valley, Azad Kashmir, Pakistan. *Acta Ecol Sin* 41 (2): 88-96. DOI: 10.1016/j.chnaes.2020.09.002.
- Cauca ES, Balinado LO. 2021. Determination of use-value, informant consensus factor, and fidelity level of medicinal plants used in Cavite, Philippines. *Asian J Biol Life Sci* 10 (2): 443-453. DOI: 10.5530/ajbls.2021.10.59.
- Cunningham AB. 2001. *Applied Ethnobotany: People, Wild Plant Use, and Conservation*. Earthscan Publications Ltd, Routledge.
- Daltro SRT, Santos IP, Barros PL, Moreira DRM, Tomassini TCB, Ribeiro IM, Dos Santos RR, Meira CS, Soares MBP. 2021. In vitro and in vivo immunomodulatory activity of *Physalis angulata* concentrated ethanolic extract. *Planta Med* 87 (01/02): 160-168. DOI: 10.1055/a-1237-4268.
- El Alami A, Fattah A, Chait A. 2020. Medicinal plants used for the prevention purposes during the Covid-19 pandemic in Morocco. *J Anal Sci Appl Biotechnol* 2 (1): 4-11. DOI: 10.48402/imist.prsm/jasab-v2i1.21056.
- El Shiekh RA, Hussein D, Atta AH, Mounier SM, Mousa MR, Abdel-Sattar E. 2021. Anti-inflammatory activity of *Jasminum grandiflorum* L. subsp. *floribundum* (Oleaceae) in inflammatory bowel disease and arthritis models. *Biomed Pharmacother* 140: 111770. DOI: 10.1016/j.biopha.2021.111770.
- Fiorello I, Del Dottore E, Tramacere F, Mazzolai B. 2020. Taking inspiration from climbing plants: methodologies and benchmarks—a review. *Bioinspir Biomim* 15: 031001. DOI: 10.1088/1748-3190/ab7416.
- Fitrianti T, Partasamita R. 2020. Medicinal plants of Cintaratu Village, Pangandaran, West Java. *Pros Sem Nas Masy Biodiv Indon* 6 (1): 625-634. DOI: 10.13057/psnmbi/m060124. [Indonesian]
- Galovičová L, Borotová P, Vukovic NL, Vukic M, Kunová S, Hanus P, Kowalczewski PL, Bakay L, Kačaniová M. 2022. The potential use of *Citrus aurantifolia* L. essential oils for decay control, quality preservation of agricultural products, and anti-insect activity. *Agronomy* 12 (3): 735. DOI: 10.3390/agronomy12030735.
- Kaushik S, Jangra G, Kundu V, Yadav JP, Kaushik S. 2020. Anti-viral activity of *Zingiber officinale* (Ginger) ingredients against the Chikungunya virus. *Virusdisease* 31 (3): 270-276. DOI: 10.1007/s13337-020-00584-0.
- Kefifa A, Saidi A, Hachem K, Mehalhal O. 2020. An ethnobotanical survey and quantitative study of indigenous medicinal plants used in the Algerian semi-arid region. *Phytothérapie* 18 (3-4): 204-219. DOI: 10.3166/phyto-2018-0077.
- Keong CY. 2015. Sustainable resource management and ecological conservation of mega-biodiversity; The Southeast Asian Big-3 Reality. *Intl J Environ Sci Dev* 6 (11): 876-882. DOI: 10.7763/ijesd.2015.v6.715.
- Khumaida N, Syukur M, Bintang M, Nurcholis W. 2019. Phenolic and flavonoid content in ethanol extract and agro-morphological diversity of *Curcuma aeruginosa* accessions growing in West Java, Indonesia. *Biodiversitas* 20 (3): 656-663. DOI: 10.13057/biodiv/d200306.
- Kumar A. 2020. Phytochemistry, pharmacological activities and uses of traditional medicinal plant *Kaempferia galanga* L. An overview. *J Ethnopharmacol* 253: 112667. DOI: 10.1016/j.jep.2020.112667.
- Lestari D, Koneri R, Maabuat PV. 2021. Keanekaragaman dan pemanfaatan tanaman obat pada pekarangan di Dumoga Utara, Kabupaten Bolaang Mongondow, Sulawesi Utara. *Jurnal Bios Logos* 11: 82-93. DOI: 10.35799/Jbl.11.2.2021.32017. [Indonesian]
- Matejić JS, Stefanović N, Ivković M, Živanović N, Marin PD, Džamić AM. 2020. Traditional uses of autochthonous medicinal and ritual plants and other remedies for health in Eastern and Southeastern Serbia. *J Ethnopharmacol* 261: 113186. DOI: 10.1016/j.jep.2020.113186.
- Miles MB, Huberman AM. 2019. *Qualitative Data Analysis: A Sourcebook of New Methods*. Sage Publications, Washington DC, USA.
- Moyo M, Aremu AO, Van Staden J. 2015. Medicinal plants: An invaluable, dwindling resource in sub-Saharan Africa. *J Ethnopharmacol* 174: 595-606. DOI: 10.1016/j.jep.2015.04.034.
- Muhakr MAYM, Ahmed IM, El hassan GOM, Yagi S. 2024. Ethnobotanical study on medicinal plants in Melit area (North Darfur), Western Sudan. *J Ethnobiol Ethnomed* 20: 3. DOI: 10.1186/s13002-023-00646-9.
- Nisa U, Triyono A, Ardiyanto D, Novianto F, Fitriani U, Jannah WDM, Astana PRW, Zulkarnain Z. 2022. Ethnopharmacological study of medicinal plants indigenous knowledge about low back pain therapy in Sumatra, Indonesia. *J Appl Pharm Sci* 12 (9): 178-188. DOI: 10.7324/JAPS.2022.120921.
- Panigrahi S, Rout S, Sahoo G. 2021. Ethnobotany: A strategy for conservation of plant. *Ann Rom Soc Cell Biol* 25 (6): 1370-1377.
- Putri NR. 2022. Etnomedisin daun sirsak sebagai obat tradisional di Kel Dadok Tunggul Hitam Kec Koto Tengah Padang Sumatera Barat. *Universe* 3 (2): 114-124. DOI: 10.24036/universe.v3i2.173. [Indonesian]
- Qadir SU, Raja V. 2021. Herbal medicine: Old practice and modern perspectives. In: Bhat RA, Hakeem KR, Dervash MA (eds).

- Phytomedicine. Academic Press, London, UK. DOI: 10.1016/B978-0-12-824109-7.00001-7.
- Raising R, Ayuwardani N, Hermawatiningsih OD, Hariningsih Y, Maritha V, Indrasari T. 2023. Pengelolaan hasil Tanaman Obat Keluarga (TOGA) jamu instan jahe merah (*Zingiber officinale* var. *rubrum*). INDRA: Jurnal Pengabdian Kepada Masyarakat 4 (1): 6-9. DOI: 10.29303/indra.v4i1.176. [Indonesian]
- Razafindraibe M, Kuhlman AR, Rabarison H, Rakotoarimanana V, Rajeriarison C, Rakotoarivelo N, Randrianarivony T, Rakotoarivony F, Ludovic R, Randrianasolo A, Bussmann RW. 2013. Medicinal plants used by women from Agnalazaha littoral forest (Southeastern Madagascar). J Ethnobiol Ethnomed 9: 73. DOI: 10.1186/1746-4269-9-73.
- Rintelen KV, Arida E, Häuser C. 2017. A review of biodiversity-related issues and challenges in megadiverse Indonesia and other Southeast Asian countries. Res Ideas Outcomes 3: e20860. DOI: 10.3897/rio.3.e20860.
- Sánchez M, González-Burgos E, Iglesias I, Gómez-Serranillos MP. 2020. Pharmacological update properties of *Aloe vera* and its major active constituents. Molecules 25 (6): 1324. DOI: 10.3390/molecules25061324.
- Shahrajabian MH, Sun W, Cheng Q. 2019. Clinical aspects and health benefits of ginger (*Zingiber officinale*) in both traditional Chinese medicine and modern industry. Acta Agric Scandinavica Sect B 69 (6): 546-556. DOI: 10.1080/09064710.2019.1606930.
- Shai KN, Ncama K, Ndhlovu PT, Struwig M, Aremu AO. 2020. An exploratory study on the diverse uses and benefits of locally-sourced fruit species in three villages of Mpumalanga Province, South Africa. Foods 9 (11): 1581. DOI: 10.3390/foods9111581.
- Sharma P, Manchanda R, Goswami R, Chawla S. 2019. Biodiversity and therapeutic potential of medicinal plants. In: Shukla V, Kumar N (eds). Environmental Concerns and Sustainable Development: Volume 2. Springer, Singapore. DOI: 10.1007/978-981-13-6358-0_2.
- Ssenku JE, Okurut SA, Namuli A, Kudamba A, Tugume P, Matovu P, Wasige G, Kafeero HM, Walusansa A. 2022. Medicinal plant use, conservation, and the associated traditional knowledge in rural communities in Eastern Uganda. Trop Med Health 50: 39. DOI: 10.1186/s41182-022-00428-1.
- Subositi D, Kurnianingrum N, Mujahid R, Widiyastuti Y. 2020. *Kaempferia galanga* L. A medicinal plant used by Indonesian Ethnic Groups: Genetic diversity based on Inter-Simple Sequence Repeats (ISSR). Agrivita 42 (1): 45-52. DOI: 10.17503/agrivita.v42i1.1850.
- Subroto A, Ningrum V. 2020. The conceptual dynamic model of rural development towards sustainable self-sufficiency. In: Bianchi C, Luna-Reyes LF, Rich E (eds). Enabling Collaborative Governance through Systems Modeling Methods: Public Policy Design and Implementation. Springer Cham, Switzerland. DOI: 10.1007/978-3-030-42970-6_4.
- Süntar I. 2020. Importance of ethnopharmacological studies in drug discovery: Role of medicinal plants. Phytochem Rev 19 (5): 1199-1209. DOI: 10.1007/s11101-019-09629-9.
- Susilowati, Puspitasari D. 2023. Penggalakan vaksin COVID-19 pada kaum milenial dan penataan lingkungan melalui penanaman TOGA di Dusun Jatiteken, Desa Laban, Sukoharjo. Jurnal Pengabdian Kepada Masyarakat (JPKM) - Aphelion 5 (2): 429-436. [Indonesian]
- Suwardi AB, Navia ZI. 2023. Sustainable use and management of wild edible fruit plants: A case study in the Ulu Masen protected forest, West Aceh, Indonesia. J Sustain For 42 (8): 811-830. DOI: 10.1080/10549811.2022.2123355.
- Uzzaman S. 2020. Pharmacological activities of neem (*Azadirachta indica*): A review. Intl J Pharmacogn Life Sci 1: 38-41. DOI: 10.33545/27072827.2020.v1.i1a.8.
- Vivekananda IBL. 2023. Efektivitas daun jambu biji dalam mengatasi diare. J Sci Mandalika 4 (9): 173-178. DOI: 10.36312/10.36312/vol4iss9pp173-178. [Indonesian]
- Wang SY, Zhao H, Xu HT, Han XD, Wu YS, Xu FF, Yang XB, Göransson U, Liu B. 2021. *Kaempferia galanga* L.; Progresses in phytochemistry, pharmacology, toxicology and ethnomedicinal uses. Front Pharmacol 12: 675350. DOI: 10.3389/fphar.2021.675350.
- Yeung AWK, Heinrich M, Atanasov AG. 2018. Ethnopharmacology - A bibliometric analysis of a field of research meandering between medicine and food science? Front Pharmacol 9: 215. DOI: 10.3389/fphar.2018.00215.