

Ethnopharmacological study of medicinal plants used on *usadha rare* remedies in Bali Province, Indonesia

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Abstract. Widhiantara IG, Putra IMWA, Lestari NKD, Wiradana PA, Permatasari AAAP, Sari NKY, Windarista NPL, Elizabeth G, Sucipto TH. 2024. Ethnopharmacological study of medicinal plants used on *usadha rare* remedies in Bali Province, Indonesia. *Biodiversitas* 25: 4723-4736. *Lontar usadha rare* is an inventory of ancient manuscripts on traditional Balinese medicine, with a focus on the system of treating disorders in children. This manuscript presents various information about various types of medicinal plants, formulation methods, and application by the Balinese people for hundreds of years. However, most of the knowledge contained in the *lontar* is only known to traditional medical practitioners and includes behaviors that are typical of the usage of medicinal plants. This study aimed to examine and document the diversity of medicinal plants used in *usadha rare* in Bali Province, Indonesia. Data were collected through direct interviews conducted with traditional medical practitioners selected using a purposive sampling method. This study was conducted from May to September 2024, and data that was successfully collected included the type of plant, regional name, Latin name, parts used, method of application, and diseases treated. Data collected were analyzed subjectively and quantitatively using diagrams, graphs, and tables, and then the Use Value (UV) was used to assess the results. The results showed that there were 65 types of medicinal plants from 34 families successfully identified in *usadha rare* treatment. Plant families most frequently used by traditional medical practitioners include Zingiberaceae (12.31%), Asteraceae (7.69%), as well as Apiaceae, Apocynaceae, Euphorbiaceae, Menispermaceae, Piperaceae, and Rubiaceae, each with 4.62%. In most cases, leaves were more widely used, followed by fruits, bark, rhizomes, and flowers. Boiling and pounding were the basic methods in making preparations from medicinal plants, while topical external use was the most common way of administering medicine to infants and children. Medicinal plants were often used to treat fever, diarrhea, bloating, and body warming, relieve coughs and toothaches, and heal wounds in children.

Keywords: Ethnopharmacology, indigenous knowledge, medicinal plants, Traditional Balinese medicine, *usadha rare*

INTRODUCTION

The Indonesian government, through the Ministry of Health, Republic of Indonesia, is actively promoting the independence of medicines and products derived from natural sources by implementing a series of policies and initiatives, specifically the Research on Medicinal Plants and Jamu (RISTOJA) program (Widhiantara et al. 2023). Furthermore, to ensure that healthcare services are accessible to all segments of the population, it is essential to integrate traditional and conventional systems (integrative medicine) (Jadid et al. 2020; Febriyanti et al. 2024). Given the strong cultural and geographical context of Indonesia, which supports the enduring practice of traditional medicine using medicinal plants and ethnomedicine, this integration is particularly promising (Fadhilah et al. 2023; Suharmiati et al. 2023). The collaboration of traditional healing practices with modern medical approaches can lead to holistic healthcare services that are more affordable, efficient, effective, and associated with fewer side effects. This efficiency ensures that the quality of healthcare in Indonesia remains high, instilling confidence in both healthcare

professionals and patients (Yuan et al. 2016; Ampomah et al. 2023; Chaachouay and Zidane 2024).

The Balinese community has long used medicinal plants and remedies for treatment (Arozal et al. 2020; Wijana and Rahmawati 2020). This practice is documented in *lontar* manuscripts, which are integral to the local wisdom known as *usadha* (Widiastuti et al. 2023; Astuti et al. 2024). It comprises texts on traditional medicine detailing medicinal ingredients, formulations, types of herbal remedies, and applications (Andila et al. 2023). The objectives outlined in the *lontar usadha* Bali cover a comprehensive range of conventional treatments for various ailments, including infectious diseases, internal organ issues, reproductive health, poisoning, and common diseases affecting infants and children. However, despite the wealth of information regarding medicinal plants documented in these texts, scientific data on the efficacy and standardized formulations still needs to be improved across different regions of Bali.

A prominent medicinal system outlined in the *lontar usadha* Bali and still in practice is *usadha rare*, which focuses on using herbal remedies for treating childhood diseases (Warditiani et al. 2015). In the past, Balinese

people believed that supernatural or mystical things caused health problems in children, such as fever, abdominal pain, or stomachache. Previous literature reviews have only mentioned two species among more than 50 types of plants used in traditional Balinese medicine (Warditiani et al. 2015). A previous study confirmed several medicinal plants that are empirically used by the Balinese community. For example, *sembung* leaves (*Blumea balsamifera* (L.) DC.), used in a traditional Balinese beverage called *loloh*, have shown antioxidant and antihypercholesterolemic properties (Widhiantara and Jawi, 2021; Widhiantara et al. 2021, 2023). Additionally, *dadap serep* leaves (*Erythrina lithosperma* Miq.) are used for wound healing, *boreh*, and traditional ceremonial purposes (Widiastuti et al. 2023).

Several studies have documented ethnomedicinal results from various regions in Indonesia. For example, an ethnomedicinal study of medicinal plants used by the Dayak community in Sintang Village, West Kalimantan, identified 25 species from 9 families. The most commonly used part was the leaves, which were prepared by boiling and consuming the extracted juice. The plant with the highest Value Index was found to be taro (*Colocasia esculenta* L.) (Supiandi et al. 2019). Similarly, the Sundanese community primarily uses 65 species of local landrace plants as fresh salad vegetables and cooking spices (Iskandar et al. 2023). Previous studies on the types of plants used in *usadha rare* have primarily explained the pharmacological bioactivity of certain plants, focusing specifically on particular locations (Warditiani et al. 2015). However, similar studies on herbal plants used in *usadha rare*, which aims to treat diseases among children, are still lacking.

Therefore, to discover new formulas as alternative treatments for children rooted in local culture, an ethnopharmacological approach can be used to identify

plant species with high potential and use techniques based on the empirical knowledge held by communities in Bali Province, Indonesia. Ethnopharmacological studies are needed to preserve the traditional knowledge of the Balinese community regarding medicinal plants, as recorded in *usadha rare* manuscript, to ensure the sustainable sourcing of traditional medicinal materials.

MATERIALS AND METHODS

Study site and methods

This study was conducted from May to September 2024 and started with an ethnobotanical survey carried out across all districts and cities in Bali Province, Indonesia (Figure 1). The methods used include area study and ethnopharmacological investigation. The area study was prepared through observational surveys to assess the locations consisting of nine districts/cities, including Badung, Bangli, Buleleng, Gianyar, Jembrana, Klungkung, Karangasem, Tabanan, and Denpasar City. Plant species collected in the field were identified in the Laboratory of Plant Taxonomy, Program Study of Biology, Universitas Dhyana Pura, Bali, Indonesia.

Selection of the informants

The search for informants was conducted using purposive and snowball sampling methods. Informants were identified based on referrals from residents showing individuals who had substantial knowledge or experience in traditional medicine, specifically with *usadha rare*. Selection was also carried out based on recommendations from community leaders, village heads, and other credible sources.

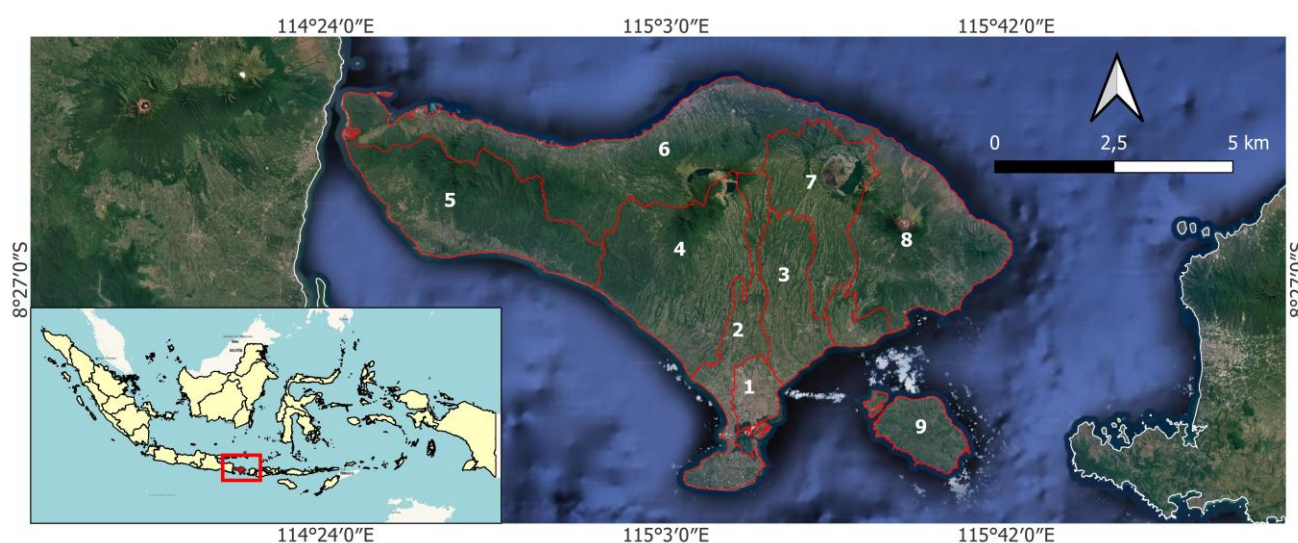


Figure 1. Research area in 9 districts/cities in Bali Province, Indonesia. 1. Denpasar City; 2. Badung; 3. Gianyar; 4. Tabanan; 5. Jembrana; 6. Buleleng; 7. Bangli; 8. Karangasem; 9. Klungkung, Bali, Indonesia

A total of 27 informants (3 informants in each district/city) with an age range of 60-69 years and education levels ranging from high school to college were used. All informants were male, and after interviews, additional individuals were requested for subsequent interviews when necessary (Taek et al. 2019).

Data collection

Data collection was conducted through observation, direct interviews, and focus group discussions. Interviews with informants were carried out using semi-structured questionnaires designed to complement data and knowledge regarding plants used for treating children, treatment methods, and preparation. Local names, plant parts, and families were also recorded to enhance the ethnopharmacological data in this study.

Data analysis

Data collected from interviews with each informant were tabulated using Microsoft Excel (Microsoft, USA) and subsequently analyzed through qualitative and quantitative descriptive methods. The efficacy and preparation methods of the herbal remedies were described in detail. Quantitative analyses were conducted on the Use Value (UV), plant family, parts used, types of diseases treated, and processing methods. The determination of scientific names for the collected plant species was carried out by cross-referencing with the PlantList.org database (www.scienceopen.com), while local names were documented based on informants' input (Chaachouay et al. 2019; Zenderland et al. 2019; Oza et al. 2021; Bibi et al. 2022). The UV equation is as follows:

$$UV = \sum U_i / N$$

Where:

UV : use value index

U_i : number of uses reported by informants for specific plant

N : total number of respondents

RESULTS AND DISCUSSION

Types of plants used as a *usadha rare* in Bali Province

The interviews conducted with several traditional medical practitioners in Bali identified the use of 34 plant families in the treatment of pediatric diseases as described in *usadha rare*. The distribution and percentages of each plant family are shown in Figure 2. A total of 65 medicinal plant species belonging to 34 different families were identified in this study. The Zingiberaceae family was the most represented, with 8 species accounting for 12.31% of medicinal plants identified followed by the Asteraceae family with 4 species, representing 7.69%. The families Apiaceae, Apocynaceae, Euphorbiaceae, Menispermaceae, Piperaceae, and Rubiaceae each contributed 3 species, with a family percentage of 4.62%. The total number of plant families identified was higher than those found in the ethnomedicinal study conducted in the Dayak Village, West Kalimantan, Indonesia, which recorded 16 families, with Aracaceae having the highest percentage at 20% (Supiandi et al. 2019). However, the number of plant families used in pediatric treatment based on *usadha rare* was lower compared to an ethnobotanical study conducted in Buleleng District, Bali, Indonesia which identified 37 families, with Zingiberaceae being the most prominent, consisting of 11 species (Andila et al. 2023). Medicinal plant parts used were categorized into leaves, bark, fruits, rhizomes, tubers, flowers, and seeds. In general, the treatment of pediatric diseases in Bali was predominantly based on the use of leaves (49%), followed by fruits (20%), bark (11%), flowers (8%), rhizomes (5%), seeds (4%), and tubers (3%) (Figure 3).

Leaves were identified as the most frequently used plant part in herbal medicine, likely due to their abundance and accessibility compared to other components (Cordero and Alejandro 2021). According to different studies, leaves can be harvested in large quantities (Mbuni et al. 2020) and regenerate faster than roots or stems (Fabie-Agapin 2019). The use is widespread across various regions, including China (Xiong et al. 2020), Japan (Arai 2021), South Korea (Kim et al. 2015), and many African countries (Evboumwan et al. 2023).

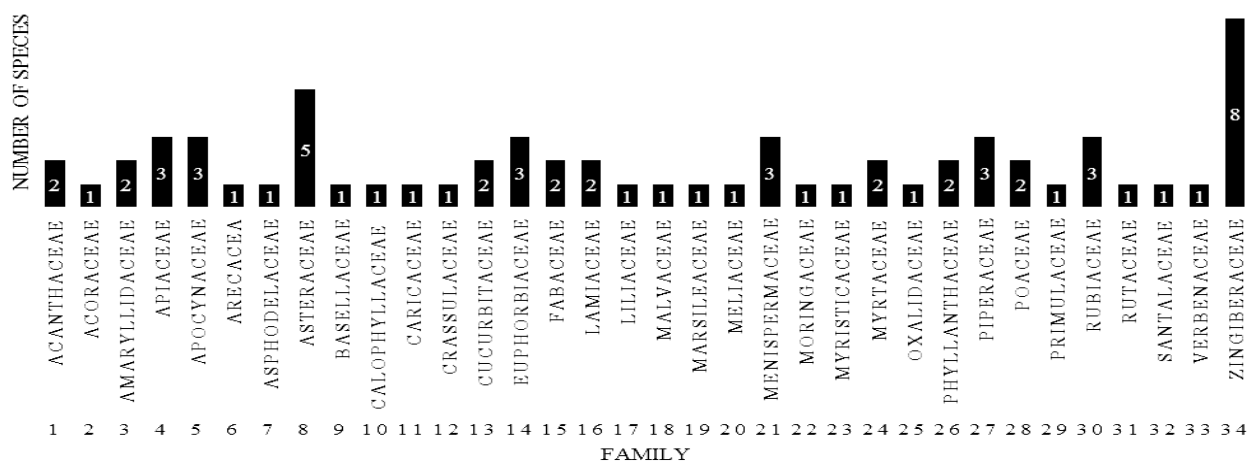


Figure 2. The families of medicinal plants used in *usadha rare* traditional medicine for pediatric treatment in Bali Province, Indonesia

In Indonesia, for example, Sundanese communities in rural West Java primarily use leaves for traditional dishes known as *lalab* (Iskandar et al. 2023). Similarly, ethnobotanical studies of the Akit Tribe in Karimun District, Kepulauan Riau, Indonesia, reported the dominant use of leaves, followed by fruits, rhizomes, stems, and whole plants (Dewi et al. 2024).

In Northwestern Ethiopia Lay District, 21.7% of medicinal plant use includes leaves, followed by seeds (8.4%) and bark (4.7%) (Yiblet 2024). The prominence of leaves is attributed to the presence of bioactive compounds such as flavonoids, alkaloids, and essential oils (Singh et al. 2023a; Singh et al. 2023b; Tourabi et al. 2023). The chemical potency, with characteristic aromas and textures,

drives leaves to be effective in traditional healing practices (Batiha et al. 2023). Additionally, fresh leaves often contain higher concentrations of active phytochemicals, further enhancing medicinal value (Ba et al. 2024).

Several types of diseases or health issues in children that can be treated with traditional plants, included in *usadha rare*, comprise fever, diarrhea, bloating, warming the body, wounds/sores, itching, cough, and thrush. The herbal plants in *usadha rare* are reported to effectively alleviate fever symptoms in children, accounting for 39% of treatments, followed by diarrhea (32%), relief from bloating and warming the body (24%), cough and thrush (2%), as well as itching and wound healing, each comprising 1% (Figure 4).

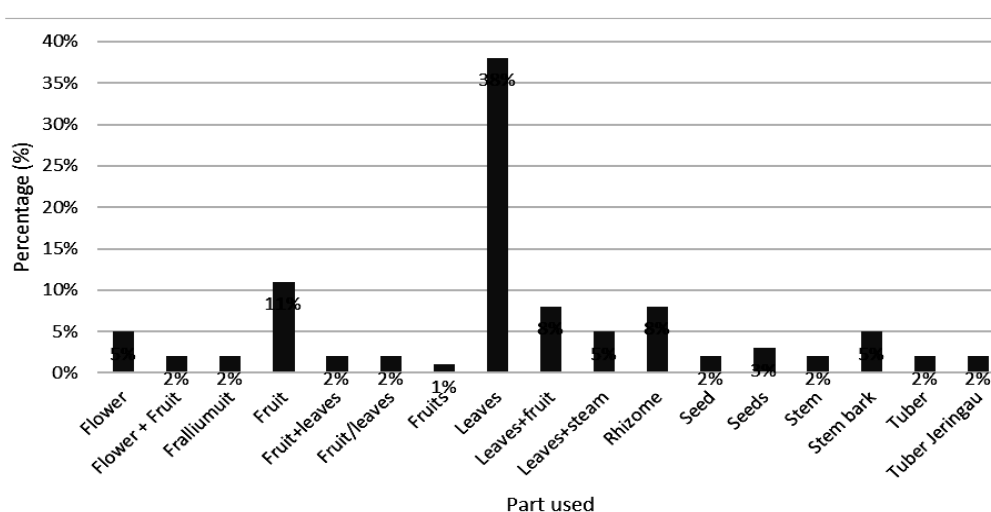


Figure 3. Plant parts used in *usadha rare* traditional medicine in Bali Province. Plants that have more than one part can be combined (+), or one type can be selected (/)

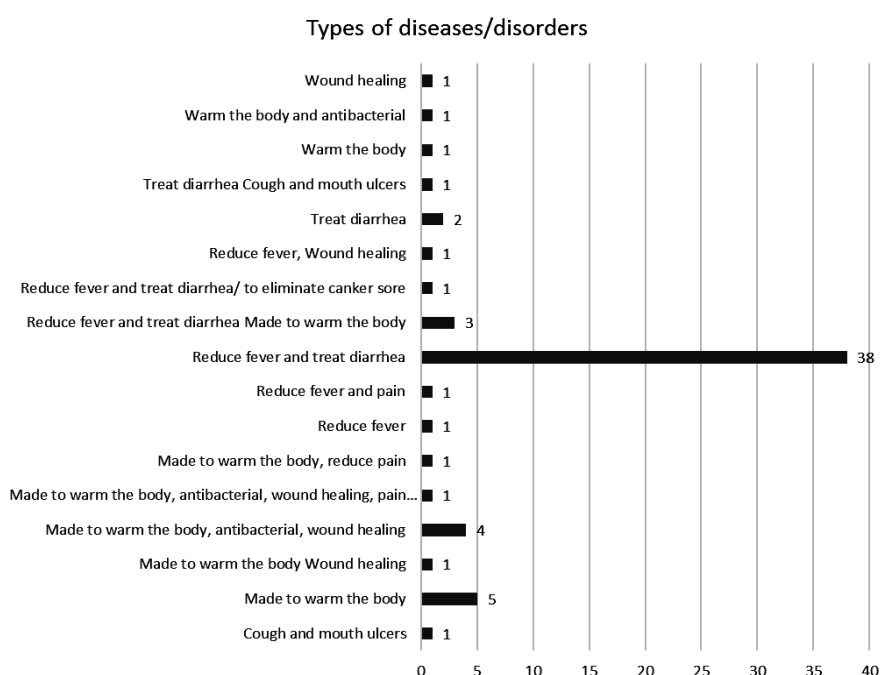


Figure 4. Types of diseases treatable with herbal plants in *usadha rare* medicine

Based on the results, fever and digestive diseases were reported as the most prevalent health conditions among children. This conclusion is corroborated by several related ethnomedicinal surveys that recognize the use of various plant species for treating or alleviating associated symptoms. Diarrhea is the most common digestive disease affecting both children and adults, caused by a variety of pathogens, including viruses, bacteria, fungi, and parasites. Typically, diarrhea refers to intestinal disturbances induced by microorganisms such as cholera, bacterial dysentery, amoebiasis, and infections causing typhoid and paratyphoid fever (Wang et al. 2022; X. Zhang et al. 2024).

In this study, 41% of herbal plants were reported to effectively treat fever, while 33% alleviated diarrhea in children. Traditional medicinal plants from *usadha rare* are identified as effective for treating fever and diarrhea, including guava leaves (*Psidium guajava*), shallots (*Allium cepa*), kencur (*Kaempferia galanga*), fennel (*Foeniculum vulgare*), and dadap serep (*Erythrina lithosperma*). A comprehensive list of herbal plants used by the Balinese community for addressing children's needs is presented in Table 1.

Based on interviews with traditional medical practitioners in various districtscities in Bali Province, Indonesia the length of treatment with *usadha rare* is a maximum of 3-4 days with fever caused by bacterial/virus infections. Herbal medicine includes the extraction and use of various plant components that possess numerous bioactive

compounds. The development of medicinal formulations, including *usadha rare*, presents an appealing alternative to traditional treatments, offering potential benefits with minimal side effects and ensuring safety, particularly for children (Kropi et al. 2024). The leaves of *P. guajava* have been used in ethnomedicine (Weli et al. 2019; Beidokhti et al. 2020) to treat ailments such as diarrhea, rheumatism, diabetes (Gutiérrez et al. 2008; Morais-Braga et al. 2016), digestive diseases, sore throat, gastric ulcers, malaria, cough, and bacterial infections (Ugbogu et al. 2022).

The bioactivity of guava leaves, potentially resulting from the action mechanisms of the bioactive compounds, is a fascinating area of research. These leaves, rich in phenolics as identified by HPLC-DAD, contain key compounds such as chlorogenic acid, rutin, vanillic acid, quercetin, p-hydroxybenzoic acid, syringic acid, kaempferol, myricetin, isoquercetin, and apigenin (Babatola and Oboh 2021). What's intriguing is that similar bioactive contributions have been noted in other plants, such as shallots (*A. cepa*) (Sari et al. 2024), kencur (*K. galanga*) (Wang et al. 2021), fennel (*F. vulgare*) (Kaveh et al. 2023), and dadap serep (*E. lithosperma*) (Rahman et al. 2019; Widiastuti et al. 2023). These plants have shown potential in addressing symptoms of diarrhea, typhoid, and fever and in providing warmth to children. Figure 5 shows the selection of medicinal plants used in *usadha rare* specifically for treating diarrhea and fever, adding to the intrigue of this research.

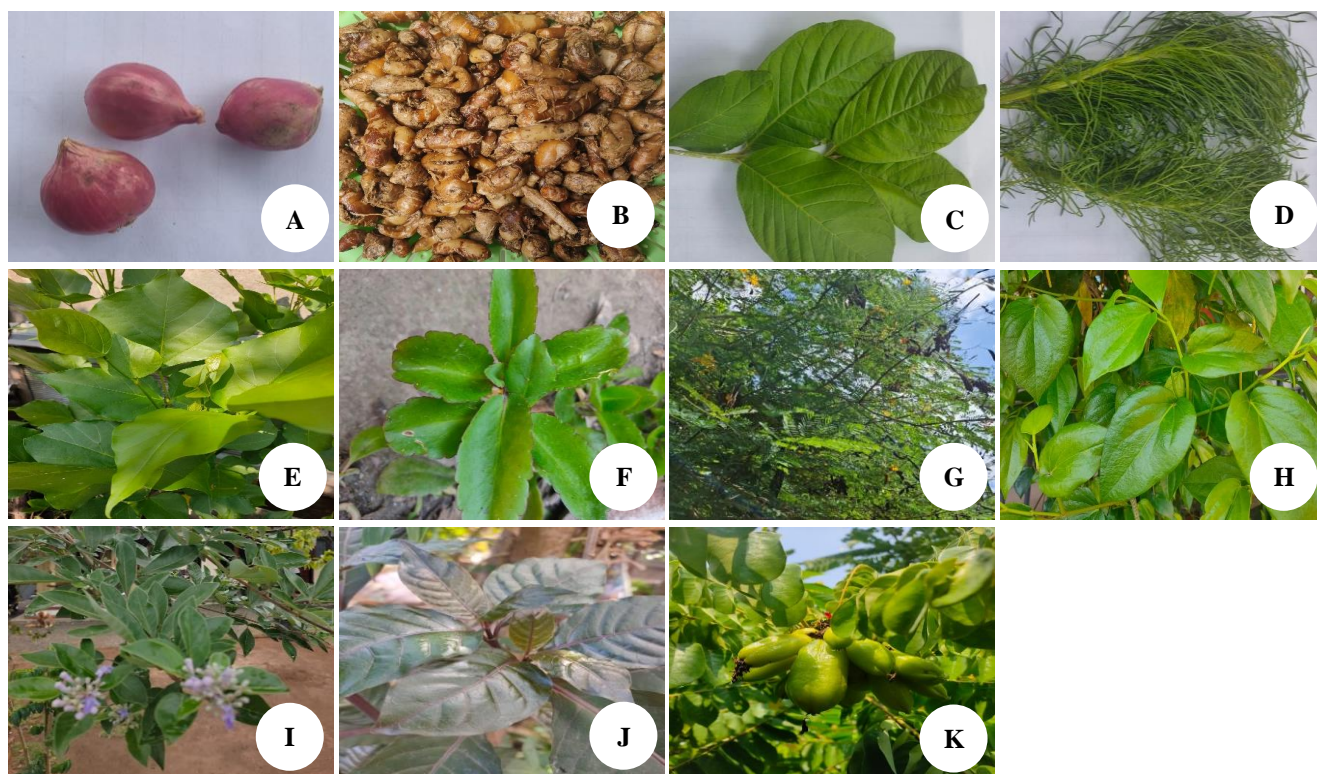


Figure 5. Several herbal plants used to treat diarrhea and fever in children as part of *usadha rare* in Bali, Indonesia include A. Shallots (*Allium cepa*); B. Kencur rhizome (*Kaempferia galanga*); C. Guava leaves (*Psidium guajava*); D. Fennel (*Foeniculum vulgare*); E. Dadap serep leaves (*Erythrina lithosperma*); F. Goethe plant (*Kalanchoe pinnata* Pers.); G. Secang (*Biancaea sappan*); H. Piper betle (*Piper betle*); I. Simpleleaf chastetree (*Vitex trifolia*); J. The caricature plant (*Graptophyllum pictum*); K. Tree sorrel (*Averrhoa bilimbi*)

Table 1. Medicinal plants used in *usadha rare* remedies in Bali Province, Indonesia

Family	Scientific name	Local name	Plant part	Preparation and administration	Prep.	Use in <i>usadha rare</i>	Use values
Acanthaceae	<i>Graptophyllum pictum</i> L. Griff.	<i>Daun wungu/daun punding hitam</i>	Leaves	Squeezed, drink	Squeeze	Reduce fever and treat diarrhea	0.37
Acanthaceae	<i>Strobilanthes crispa</i> Blume.	<i>Keji beling</i>	Leaves	Squeezed, drink	Squeeze	Reduce fever and treat diarrhea	0.37
Acoraceae	<i>Acorus calamus</i> L.	<i>Jeringau</i>	Rhizome	Boil in water, drink	Boiled	Reduce fever and treat diarrhea	0.07
Amaryllidaceae	<i>Allium cepa</i> L.	<i>Bawang merah</i>	Tuber	Squeezed, drink	Squeeze	Reduce fever and treat diarrhea	0.89
Amaryllidaceae	<i>Allium sativum</i> L.	<i>Bawang putih</i>	Tuber jeringau	Pound, topical/rub on the skin	Pounded	Warm the body and antibacterial	0.59
Apiaceae	<i>Centella asiatica</i> Linn.	<i>Pegagan</i>	Leaves	Squeezed, drink	Squeeze	Reduce fever and treat diarrhea	0.52
Apiaceae	<i>Coriandrum sativum</i> L.	<i>Ketumbar</i>	Seeds	Boil in water, drink	Boiled	Reduce fever and treat diarrhea	0.07
Apiaceae	<i>Foeniculum vulgare</i> Miller.	<i>Adas</i>	Leaves	Squeezed, drink	Squeeze	Reduce fever and treat diarrhea	0.56
Apocynaceae	<i>Alstonia scholaris</i> L. R. Br	<i>Pulai</i>	Stem bark	Mixture of several herbal ingredients, made by grinding plant parts, such as leaves, bark, flowers, seeds, and rhizome, with the addition of sufficient water.	Cooked	Made to warm the body, antibacterial, wound healing	0.04
Apocynaceae	<i>Kopsia arborea</i> Blume.	<i>Pronojiwo</i>	Leaves	Boil in water, drink	Boiled	Reduce fever and treat diarrhea	0.04
Apocynaceae	<i>Plumeria alba</i> L.	<i>Kamboja</i>	Flower	3 flowers, one spoonful of sticky rice, 3 segments of rhizome, 5 dried cloves mashed with enough water.	Smashed	Made to warm the body Wound healing	0.04
Arecacea	<i>Cocos nucifera</i> L.	<i>Kelapa</i>	Fruit	Cooked to make oil	Cooked	Warm the body	0.50
Asphodelaceae	<i>Aloe vera</i> Burm.f.	<i>Lidah buaya</i>	Leaves	Squeezed, drink	Squeeze	Reduce fever and treat diarrhea	0.15
Asteraceae	<i>Alocasia macrorrhizos</i> (L.) G. Don	<i>Talas sente</i>	Leaves	5 dried cloves mashed with enough water, topical	Cooked	Made to warm the body	0.04
Asteraceae	<i>Blumea balsamifera</i> (L.) DC.	<i>Sembung</i>	Leaves	Squeezed, drink	Squeeze	Reduce fever and treat diarrhea	0.19
Asteraceae	<i>Crassocephalum crepidioides</i> (Benth.) S. Moore.	<i>Sintrong</i>	Leaves	Boil in water, drink	Boiled	Reduce fever and treat diarrhea	0.11
Asteraceae	<i>Cyanthillium cinereum</i> (L.) H. Rob	<i>Sawilangit</i>	Leaves	Squeezed, drink	Squeeze	Reduce fever and treat diarrhea	0.04
Asteraceae	<i>Eclipta prostrata</i> L.	<i>Urang-aring</i>	Leaves	Boil in water, drink	Boiled	Reduce fever and treat diarrhea	0.41
Basellaceae	<i>Anredera cordifolia</i> (Ten.) Steenis.	<i>Binahong</i>	Leaves	Mixture of several herbal ingredients, made by grinding plant parts, such as leaves, bark, flowers, seeds, and rhizome, with the addition of sufficient water, topical	Cooked	Made to warm the body, antibacterial, wound healing	0.37
Calophyllaceae	<i>Mesua ferrea</i> L.	<i>Nagasari</i>	Flower	Boil in water, drink	Boiled	Treat diarrhea	0.10
Caricaceae	<i>Carica papaya</i> L.	<i>Pepaya</i>	Fruit/leaves	Pounded leaves, topical	Pounded	Reduce fever wound healing	0.04
Crassulaceae	<i>Kalanchoe pinnata</i> Pers.	<i>Cocor bebek</i>	Leaves	Mixture of several herbal ingredients, made by grinding plant parts, such as leaves, bark, flowers, seeds, and rhizome, with the addition of sufficient water. Binahong	Cooked	Made to warm the body, antibacterial, wound healing, relieve pain	0.04

Cucurbitaceae	<i>Citrullus lanatus</i> Tunb.	<i>Semangka</i>	Fruit	Ripe fruit blended, drink	Smashed	Reduce fever	0.19
Cucurbitaceae	<i>Momordica charantia</i> L.	<i>Pare</i>	Leaves	Squeezed, drink	Squeeze	Reduce fever and treat diarrhea	0.37
Euphorbiaceae	<i>Acalypha australis</i> L.	<i>Anting-anting</i>	Leaves, fruit	Boil in water, drink	Boiled	Reduce fever and treat diarrhea	0.56
Euphorbiaceae	<i>Aleurites moluccana</i> (L.) Willd	<i>Kemiri</i>	Fruit	Heated in 100 mL coconut oil, topical	Cooked	Made to warm the body	0.30
Euphorbiaceae	<i>Ricinus communis</i> L.	<i>Jarak kaliki</i>	Leaves, fruit	Boil in water, drink	Boiled	Reduce fever and treat diarrhea	0.30
Fabaceae	<i>Biancaea sappan</i> L.	<i>Secang</i>	Stem bark	Boil in water, drink	Boiled	Reduce fever and treat diarrhea	0.04
Fabaceae	<i>Erythrina lithosperma</i> Miq.	<i>Dadap serep</i>	Leaves	Squeezed, drink/3 leaves mashed with enough water, topical	Squeeze	Reduce fever and treat diarrhea. Made to warm the body	0.89
Lamiaceae	<i>Orthosiphon aristatus</i> Blume.	<i>Kumis kucing</i>	Leaves	Boil in water, drink	Boiled	Reduce fever and treat diarrhea	0.56
Lamiaceae	<i>Vitex trifolia</i> L.	<i>Legundi</i>	Leaves	Mixture of several herbal ingredients, made by grinding plant parts, such as leaves, bark, flowers, seeds, and rhizome, with the addition of sufficient water. Topical	Cooked	Made to warm the body, antibacterial, wound healing	0.04
Liliaceae	<i>Lilium longiflorum</i> Thunb.	<i>Bakung</i>	Flower	Squeezed, drink	Squeeze	Reduce fever and treat diarrhea	0.30
Malvaceae	<i>Sida rhombifolia</i> L.	<i>Sidaguri</i>	Leaves, stem bark, root	Boil in water, drink	Boiled	Reduce fever and treat diarrhea	0.30
Marsileaceae	<i>Marsilea crenata</i> Presl.	<i>Semanggi</i>	Leaves	Squeezed, drink	Squeeze	Reduce fever and treat diarrhea	0.20
Meliaceae	<i>Sandoricum koetjape</i> Merr.	<i>Kecapi</i>	Leaves	Boil in water, drink	Boiled	Reduce fever and treat diarrhea	0.10
Menispermaceae	<i>Cyclea barbata</i> Miers.	<i>Cincau hijau</i>	Leaves	Squeezed, drink	Squeeze	Reduce fever and pain	0.20
Menispermaceae	<i>Punica granatum</i> L.	<i>Delima</i>	Fruit, leaves	Eat, boil in water, drink	Boiled	Reduce fever and treat diarrhea	0.63
Menispermaceae	<i>Tinospora coriacea</i> Beumee.	<i>Panca sona</i>	Leaves	Boil in water, drink	Boiled	Reduce fever and treat diarrhea	0.19
Moringaceae	<i>Moringa oleifera</i> L.	<i>Kelor</i>	Leaves, stem bark	Boil in water, drink, stem bark mashed	Boiled	Reduce fever and pain	0.30
Myristicaceae	<i>Myristica fragrans</i> Houtt.	<i>Pala</i>	Flower, fruits	Boil in water, drink	Boiled	Reduce fever and treat diarrhea	0.15
Myrtaceae	<i>Psidium guajava</i> L.	<i>Jambu biji</i>	Leaves, fruit	Boil in water, drink	Boiled	Treat diarrhea	0.81
Myrtaceae	<i>Syzygium aromaticum</i> L.	<i>Cengkeh</i>	Fruit	Boil in water and drink, mashed with enough water, topical	Boiled	Made to warm the body	0.33
Oxalidaceae	<i>Averrhoa bilimbi</i> L.	<i>Belimbing wuluh</i>	Fruits	Boil in water, drink	Boiled	Cough and mouth ulcers	0.19
Phyllanthaceae	<i>Antidesma bunius</i> L.	<i>Buni</i>	Fruit	Ripe fruit blended, drink	Smashed	Treat diarrhea, cough, and mouth ulcers	0.04
Phyllanthaceae	<i>Sauropus androgynous</i> (L.) Merr.	<i>Katuk</i>	Leaves	Boil in water, drink	Boiled	Reduce fever and treat diarrhea	0.15
Piperaceae	<i>Piper betle</i> Linn.	<i>Sirih</i>	Leaves	Boil in water, drink	Boiled	Reduce fever and treat diarrhea	0.19
Piperaceae	<i>Piper retrofractum</i> Vahl.	<i>Cabai jawa</i>	Leaves, fruit	Squeezed, drink	Squeeze	Reduce fever and treat diarrhea	0.04
Piperaceae	<i>Piper nigrum</i> L.	<i>Merica</i>	Seeds	Boil in water, drink	Boiled	Reduce fever and treat diarrhea	0.04
Poaceae	<i>Cymbopogon citratus</i> DC.	<i>Serai</i>	Stem	<i>Serai</i> stalks heated in 100 ml coconut oil, topical	<i>Cooked</i>	Made to warm the body, reduce pain	0.04
Poaceae	<i>Oryza sativa</i> L. var. Glutinosa	<i>Ketan</i>	Seed	Pounded, topical	Pounded	Wound healing	0.37
Primulaceae	<i>Ardisia elliptica</i> Thunb.	<i>Lempeni</i>	Leaves, fruit	Squeezed, drink	Squeeze	Reduce fever and treat diarrhea	0.04
Rubiaceae	<i>Ixora javanica</i> (Blume). DC.	<i>Soka jawa</i>	Leaves	Mashed with enough water, topical	Smashed	Made to warm the body	0.15
Rubiaceae	<i>Morinda citrifolia</i> L.	<i>Mengkudu</i>	Fruit	Boil in water, drink	Boiled	Reduce fever and treat diarrhea/eliminate canker sore	0.19
Rubiaceae	<i>Paederia foetida</i> L.	<i>Sembukan</i>	Leaves	Boil in water, drink	Boiled	Reduce fever and treat diarrhea	0.63
Rutaceae	<i>Triphasia trifolia</i> Burm.f.	<i>Kingkit</i>	Fruit	Squeezed, drink	Squeeze	Reduce fever and treat diarrhea	0.04

Santalaceae	<i>Santalum album</i> L.	<i>Cendana</i>	Stem bark	Mixture of several herbal ingredients, made by grinding plant parts, such as leaves, bark, flowers, seeds, and rhizome, with the addition of sufficient water. Binahong	Cooked	Made to warm the body, antibacterial, wound healing	0.04
Verbenaceae	<i>Stachytarpheta jamaicensis</i> (L) Vahl.	<i>Pecut kuda</i>	Leaves, stem bark	Boil in water, drink	Boiled	Reduce fever and treat diarrhea	0.56
Zingiberaceae	<i>Alpinia galanga</i> (L.) Willd.	<i>Lengkuas</i>	Rhizome	Boil in water, drink	Boiled	Reduce fever and treat diarrhea	0.04
Zingiberaceae	<i>Amomum cardamomum</i> (L.) Maton.	<i>Kapulaga</i>	Fruit	Boil in water, drink	Boiled	Reduce fever and treat diarrhea	0.67
Zingiberaceae	<i>Curcuma longa</i> Linn.	<i>Kunyit</i>	Rhizome	Boil in water, drink	Boiled	Reduce fever and treat diarrhea	0.37
Zingiberaceae	<i>Curcuma zedoaria</i> Rocs.	<i>Temu putih</i>	Rhizome	Squeezed, drink	Squeeze	Reduce fever and treat diarrhea	0.70
Zingiberaceae	<i>Kaempferia galanga</i> L.	<i>Kencur</i>	Rhizome	Boil in water, drink 3 segments of rhizome mashed with enough water, topical.	Boiled	Reduce fever and treat diarrhea. Made to warm the body	0.81
Zingiberaceae	<i>Zingiber cassumunar</i> Roxb.	<i>Bangle</i>	Rhizome	3 segments of rhizome mashed with enough water, topical	Smashed	Made to warm the body	0.11
Zingiberaceae	<i>Zingiber officinale</i> Rosc.	<i>Jahe</i>	Rhizome	Boil in water, drink 3 segments of rhizome mashed with enough water, topical.	Boiled	Reduce fever and treat diarrhea. Made to warm the body	0.19
Zingiberaceae	<i>Zingiber zerumbet</i> Linn.	<i>Lempuyang gajah</i>	Rhizome	Boil in water, drink	Boiled	Reduce fever and treat diarrhea	0.37

The method of processing herbal plants for treating childhood diseases in Bali Province, Indonesia is mostly done by traditional medicine practitioners by boiling, which is 47.7%, followed by squeezing, cooking, and punching, which are 26.2%, 13.8%, and 4.6%, respectively (Figure 6). The choice of processing method is significantly influenced by the type of herbal plant used, including the method of application to the patient (Egea et al. 2015).

Generally, herbal preparations derived from leaves are initially processed by boiling until the water reaches a rolling boil, often supplemented with additional ingredients, including salt and honey. Boiling enhances the solubility of active phytochemical profiles in water (Zhu et al. 2019). The decoction of herbal plant parts is primarily administered orally in varying dosages, predominantly for treating typhoid fever and diarrhea in children. Determining the appropriate dosage remains essential to achieving the pharmacological effects necessary for the scientific application of *usadha rare*. For example, the compound gentiopiridin, a major secoiridoid (49.7-67.7 mg/g), and amarogentin (2.7-3.6 mg/g), a bitter phytoconstituent, are found in the roots of *Gentiana purpurea* and can be extracted using boiling water (Zhang et al. 2023).

Aside from boiling, herbal plants are also processed by squeezing and pounding. Traditional medical practitioners often extract the juice from the leaves of medicinal plants and mix it with water. This preparation is locally known as *loloh*, or herbal tonic, by the Balinese community. To reduce the bitterness of the extract, traditional medical practitioners commonly mix it with wild honey. Herbal plants that are processed by pounding are typically combined with other ingredients, including rhizomes, tubers, honey, and 250 mL of boiled water. In several regions, including China, the fruit *Lycium barbarum*, commonly known as wolfberry, is processed by pounding and consumed as a drink. This fruit has a sweet taste, provides warming effects, and is widely used in the functional food industry

across China, Korea, Japan, and several Southeast Asian countries (Zhou et al. 2022; Li et al. 2024).

Aside from being consumed orally by children, pounded herbal plants can be applied topically to the skin. Common components of these topical applications include *dadap serep* (*E. lithosperma*), sticky rice (*Oryza sativa*), *kencur* (*K. galanga*), *soka jawa* (*Ixora javanica*), coconut (*Cocos nucifera*), glutinous rice (*O. sativa* var. *glutinosa*), frangipani (*Plumeria alba*), red ginger (*Zingiber officinale*), and cloves (*Syzygium aromaticum*). Commonly known as *boreh* in the Balinese community, this preparation is prepared by grinding various plant parts such as leaves, bark, flowers, seeds, and rhizomes into a paste with water. *Boreh* serves as a warming balm, traditionally used to warm the bodies of infants and children. The herbal formulation for making *boreh* includes 3 leaves or flowers, 1 tablespoon of sticky rice, 3 pieces of rhizome, and 5 dried cloves; all ingredients are ground, and enough water is added. When formulated with these herbal ingredients, *boreh* is believed to possess a phytochemical profile that aids in preventing bacterial infections. It is also considered effective for alleviating bloating caused by colds in children. This is also reflected in Traditional Chinese Medicine (TCM) through a practice known as *qu feng*, which targets the expulsion of wind, a pathogenic factor believed to cause symptoms such as pain during movement, itching on the skin surface, and tremors (Zeng et al. 2024). The TCM formulations used for *qu feng* are similar to *boreh* in *usadha rare*, which alleviates skin-related conditions such as itching through antioxidant mechanisms (DiNicola et al. 2013). This herbal ointment is composed of medicinal plants, including common *Cnidium* fruit, *Coptis chinensis*, *Phellodendri chinensis* cortex, *Dictamnii* cortex, *Sophora flavescens* radix, giant knotweed rhizome, violae herba, kochiae fructus, herba *Polygoni avicularis*, herba *Artemisiae scopariae*, *Atractylodis* rhizome, *Zanthoxyli pericarpium*, and synthetic borneol, among others (Chen et al. 2020a).

Processing methods

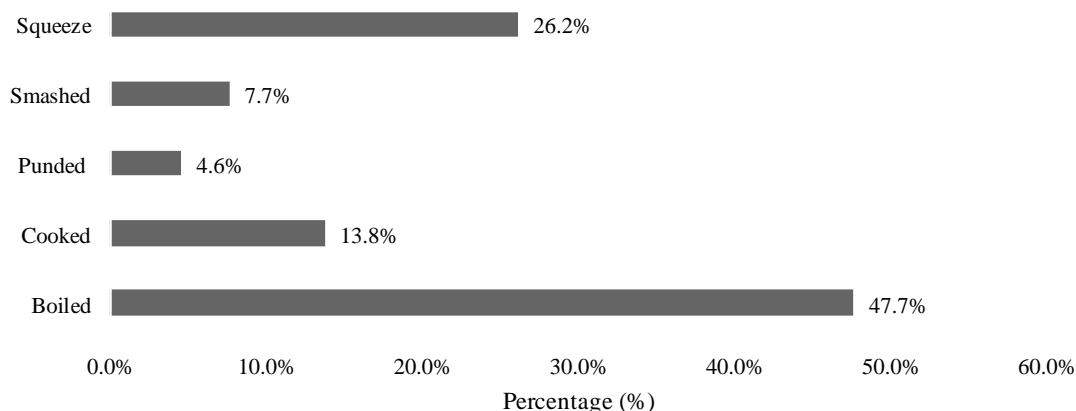


Figure 6. The processing method of medicinal plants which are included in *usadha rare*

Aside from *boreh*, another traditional herbal remedy in *usadha rare* is *pupuk*, a mixture made by grinding plant materials and applying the paste topically to the child's crown. Plant composition includes *kencur* (*K. galanga*), rice (*O. sativa*), and *dadap serep* (*E. lithosperma*). The formulation for making *pupuk* includes 1 segment of *kencur*, 1 tablespoon of rice, and 2 *dadap serep* leaves, ground without adding water. Additionally, *lengis* refers to a massage oil predominantly made from coconut oil through traditional processing methods, such as preparing coconut milk and heating. The production comprises the infusion and heating of other herbal ingredients in coconut oil. Plant components include candlenut (*Aleurites moluccanus*), coconut (*C. nucifera*), garlic (*A. sativum*), and lemongrass (*Cymbopogon citratus*). The formulation for making *lengis* includes 3 candlenuts, 3 cloves of garlic, and 2 stalks of lemongrass, then heated in 100 mL of pure coconut oil. *Lengis* is applied to the entire body of infants to prevent bacterial infections, warm the body, and improve circulation. Finally, *kemuh* is an herbal mouthwash prepared by boiling *kemukus* (*Piper cubeba*) leaves in water, often added with salt. Mud, a traditional natural remedy, is used for a variety of children's oral ailments, including mouth ulcers, toothaches, bleeding gums, and coughs. This traditional method, known as *kemuh* in *usadha rare*, involves the use of two medicinal plants-betel (*Piper betle*) and *mengkudu* (*Morinda citrifolia*). A mixture of three old *kemukus* and betel leaves, along with one *mengkudu* fruit, is boiled in 200 mL of water. The resulting water is then used for gargling. The herbal preparation from *usadha rare* lontar is detailed in Figure 7, while the interview activities with informants are presented in Figure 8.



Figure 7. Several formulations of medicinal plant preparations used in *usadha rare* in Bali Province. A. *Loloh* betel leaf; B. Grilled candlenut *lengis* mixed with grilled *kencur*; C. *Pupuk*; D. *Boreh* from *Kalanchoe pinnata* leaves mixed with shallots; E. *Boreh* from *Erythrina lithosperma* leaves mixed with shallots; F. *Loloh* from guava leaf

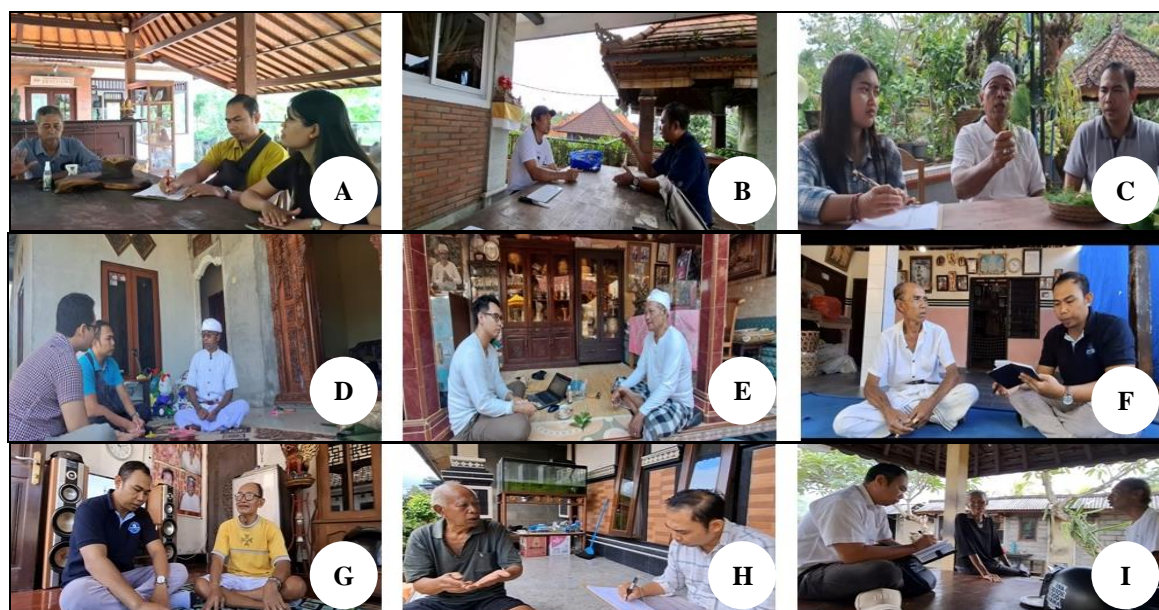


Figure 8. Some interview activities during the survey with informants who have careers as traditional medical practitioners of *usadha rare* in Bali Province, Indonesia. A. Gianyar District; B. Badung District; C. Tabanan District; D. Bangli District; E. Denpasar City; F. Karangasem District; G. Klungkung District; H. Buleleng District; I. Jembrana District

Lengis, commonly recognized as an essential oil, is well-known in traditional medicine practices. Medicinal plant components used in the form of essential oils have dual-action mechanisms, including enhancing wound healing and closure while simultaneously acting as antibacterial agents, which is a clinically significant feature in wound recovery (Lodhi et al. 2016). For example, the biennial herb *Smyrniololus atrum* contains essential oils (Sekkout et al. 2024) with prominent compounds, including furanosesquiterpenes making up the majority of the flower (59.1%), followed by monoterpene hydrocarbons, oxygenated sesquiterpenes, and sesquiterpene hydrocarbons, comprising 13.5%, 11.8%, and 8.6% respectively, from a total of 50 phytoconstituents (Quassinti et al. 2014; Petrelli et al. 2017). In *usadha rare*, *lengis* is also used to treat infected wounds in children. *Eremostachys hyoscyamoides*, a medicinal plant with an ethnobotanical heritage from the northeastern provinces of Iran, has been empirically proven to treat bacterial infections, instilling confidence in its effectiveness (Talebi et al. 2024); it also has antiparasitic (Asnaashari et al. 2017), antioxidant, and anti-inflammatory properties (Khan et al. 2010). Additionally, the mouthwash or *kemuh* is used by children to relieve mouth ulcers and bleeding gums. The mouthwash, consisting of betel leaves and *mengkudu* (*M. citrifolia*), is viewed as an alternative to antibiotics and traditional chemical agents due to the low side effects in preventing and treating oral diseases (El-Tarabily et al. 2021). The anti-plaque properties of these extracts help prevent pathogenic microbial recolonization and maintain mechanical plaque removal (Wongsariya et al. 2024).

Use Value (UV) analysis showed that the most frequently used medicinal plants in *usadha rare* practice in Bali, ranked accordingly, include red onion and *dadap serep* (0.89), fennel (0.56), *kencur* (0.81), and guava (*P. guajava*) (0.81) (Table 1). Traditional medical practitioner commonly uses these five medicinal plants to treat digestive issues, diarrhea, and fever, and as body warmers for infants and children. Based on the interview results, these plants are typically cultivated in home gardens or purchased directly from traditional markets. Red onion is a versatile vegetable that can be consumed fresh or cooked (Srivastava et al. 2022). It contains quercetin, a flavonoid known for its antiviral, antioxidant, anti-inflammatory, and antibacterial properties, making the plant safe for application on infant skin (Xue et al. 2023). *Dadap serep* leaves, with deep ties to the Balinese spiritual and cultural life, are frequently used in religious ceremonies and have significant health benefits, particularly for infants and children. Applying crushed leaves on the skin has antibacterial and anti-inflammatory effects (Widiastuti et al. 2023). Previous surveys have also shown that *dadap serep* leaves are used as herbal medicine by the Sundanese people in West Java, Indonesia (Roosita et al. 2008).

Fennel (*F. vulgare*), a medicinal plant from the family of Apiaceae, originates from the Mediterranean region and is commercially cultivated in China, India, Japan, and Russia. In Bali, as in TCM, fennel is used to alleviate flatulence and gastrointestinal problems. Liquid Chromatography-Mass Spectrometry (LCMS) analysis has

shown that fennel contains trans-anethole (88.28%) in the fruit (Chen et al. 2020b), as well as estragole (51.04%), limonene (11.45%), l-fenchone (8.19%), and trans-anethole (3.62%) in the essential oil (Ahmed et al. 2019). In *usadha rare* healing system, fennel leaves are prepared as a fresh herbal drink for children to relieve internal heat and fever. *K. galanga*, commonly known as kencur in Indonesia, has been traditionally used by over 109 ethnic groups. This plant is found across various regions, including Sumatra, Java, Kalimantan, East Nusa Tenggara, Sulawesi, and the Maluku Islands. In Bali, the application as part of traditional herbal medicine has been underreported. The rhizomes have long been used to treat wounds, reduce headaches, and alleviate flu, fever, cough, and skin abscesses in children (Ariani et al. 2024). Furthermore, guava (*P. guajava*) leaves and fruit contain compounds such as saponins, oleanolic acid, xylopyranoside, flavonoids, quercetin, arabinopyranoside, and guaijavarin (Naseer et al. 2018). As reported in previous studies, guava leaf extract, tested in vitro against dengue virus typeshowed that quercetin effectively inhibited DEN-2 virus activity, while other flavonoids had lower efficacy (Zandi et al. 2011).

In conclusion, this study identified 66 medicinal plant species from 36 families with therapeutic properties used to treat infants and children in the Province of Bali. The families of Zingiberaceae and Asteraceae represented the highest number of medicinal plants used in *usadha rare*. Leaves were the most frequently used plant part by traditional medical practitioners, followed by fruits, stem bark, flowers, rhizomes, seeds, and tubers. The most commonly treated ailments in infants and children included fever, diarrhea, cough, mouth ulcers, wounds, itching, and body warming. The primary method of preparation was boiling plant parts and topical applications mixed with coconut oil, often in the form of *boreh*. The results showed the significance of the documented medicinal plants in *usadha rare*, underscoring the importance of the development of standardized and formulated herbal medicines that need to be preserved. UV data shows that the five plants with the highest utility values include guava leaves, *dadap serep*, shallots, fennel, and *kencur*. Although this study has successfully documented the use of medicinal plants in traditional healing culture, further studies are required to fully understand the bioactivity in treating conditions such as diarrhea and fever. These medicinal plants hold the potential for development into standardized herbal medicines.

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