Tenggerese traditional medicine of Indonesia: Existing practices and the botanical identification of medicinal plants

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Research

Abstract

Background: The Indonesian health care system comprises both modern and traditional medical systems; while they are not integrated, they have co-existed for decades. Traditional medical treatments continue to enjoy popularity nationwide, especially for people living in rural areas.

Methods: We interviewed the traditional healers of the Tengger community (the last Hindu society in Java Island – Indonesia) and botanically identified their medicinal plants. The cross-sectional surveys were conducted based on an unstructured ethnopharmacology interview. Use Value (UV), Family Use Value (FUV), Infomart consensus factor (ICF) and Use-reports were derived as primary data.

Results: Nineteen *dukuns* were identified and interviewed. The *dukun* (local healer) practiced both spiritual and physical medication (using medicinal plants and animals). There were 41 medicinal plants from 23 different families used for treating 17 ailments. The study revealed that although Tengger culture evolved from the Southeast Asian dominant Hindu Kingdom - Majapahit, only less than half of the species identified were contained in the PROSEA and Ayurvedic databases. *Apium graveolens* L., *Causonis clematidea* (F.Muell.) Jackes, *Drymocallis arguta* (Pursh) Rydb., *Elaeocarpus longifolius* Blume, *Garcinia mangostana* L., *Rubus allegheniensis* Porter, *Tagetes tenuifolia* Cav. were the most cited species. The scientific approach revealed the uses of *A. gravelolens*. *G. mangostana*, *R. allegheniensis* and *T. tenuifolia.*

Conclusions: These findings revealed the medicinal potential of ethnopharmacology in the medicinal plants of Tengger however several medicinal plants required further scientific investigation.

Keywords: Ethnopharmacology, Indonesia, Hinduism, Tengger, Medicinal plants

Background

Indonesia is the largest archipelago in the world, with an estimated 17,504 islands, and is ranked fourth globally in population with 240 million inhabitants. This large population includes numerous ethnic, cultural and linguistic groups, speaking 724 distinct languages and dialects (Ekor 2014). The culture and traditions of the complex ethnic populations are shaped by their religious, spiritual, and belief alignment with their environment. Based on registered data in 2022, 87.02% of Indonesians identified themselves as Muslim, 7.43% Protestant, 3.06% Catholic, 1.69% Hindu, 0.73% Buddhist, 0.03% Confucianist, 0.04% others (Kementerian Agama Republik Indonesia 2022). This reveals Indonesia's great diversity of religious, cultural, and traditional practices. One such practice is the belief in traditional medicines and ethnopharmacological remedies, which are widespread across all islands of Indonesia. While modern or Western medicine remains the mainstream health care system, traditional medical treatments continue to enjoy considerable popularity and are practiced by numerous healers and practitioners over the entire country, especially in rural areas. In 2020, approximately 56% of the Indonesian population lived in urban areas with the remaining 44% in rural regions (Malamassam and Katherina 2023), exalting extant rural cultural practices. Different ethnic and cultural groups in remote and rural parts of the country have developed their own, distinct folklore health care systems.

The Indonesian constitution acknowledges health needs as part of the human right to seek and choose available health services, including modern and traditional medicines (The Office of the Registrar and the Secretariat General of the Constitutional Court of the Republic of Indonesia 2015; Purwadianto *et al.* 2017). The Indonesian health system has a mixture of public and private health care providers, but these two medical systems are not integrated. The Ministry of Health is responsible for managing central, provincial and district hospitals, providing strategic direction, setting standards and regulation, and ensuring the availability of financial and human resources. Since 2014, the Government of Indonesia has been planning to attach traditional medication to formal frontline health services (PUSKESMAS) in each sub-district throughout the archipelago (Kementerian Kesehatan Republik Indonesia 2017). This process is managed by the Directorate of Traditional Health Services, the Directorate General of Health Service, and the Ministry of Health of The Republic of Indonesia (Kementerian Kesehatan Republik Indonesia 2017). The profit-driven traditional medicines healthcare providers are required to have minimum standards and liable practices, including reliable sources of quality medicinal plants (Kementerian Kesehatan Republik Indonesia 2017). Recently, the majority of the cultivation of medicinal plants has been undertaken by some research institutions and non-governmental organisations (NGOs), as well as by some commercial jamu herbal companies that want reliable source materials. Moreover, the Ministry of Health launched a campaign to promote the development of community or family medicinal gardens to stimulate and popularise the use of traditional medicine for treating common ailments (Roosita *et al.* 2008).

The Indonesian Ministry of Health has also adopted a policy to improve the quality of traditional medicine while retaining its identity. The improvement encompasses multiple approaches, such as improving i) diagnosis through the use of modern techniques, ii) traditional treatment methods, and iii) production processes and quality control of traditional medicines (Roosita *et al.* 2008). The policy encourages scientific studies of traditional medicines, including botanical identification, taxonomical authentication, phytochemical and pharmacological screenings, clinical trials and documentation of their therapeutic effectiveness. Generating scientific data is important for making herbal products acceptable to the medical profession and facilitating the integration of traditional medical system with mainstream modern healthcare services. In alignment with these policies, a small number of studies to extract and document the sources of traditional medicine knowledge of the healers throughout the archipelago has been conducted by the Ministry of Health and the research institutions of Indonesia through explorative projects (Nugraha and others 2022). The databases and inventories of biological resources and traditional medicinal knowledge are scattered among different sectors, research institutions, and government organizations (Kementerian Kesehatan Republik Indonesia 2013). In this study, we documented the traditional medical knowledge and botanical identification of medicinal plants used by the Tenggerese community, including an analysis of the level of integration among different *Dukun* healers and other healthcare providers.

The Tengger tribal community resides in a Wonokerso village, located inside the Bromo Tengger Semeru National Parks (1600-2000 meters above sea level, masl) of East Java (Sutarto 2006). There were few ethnopharmacological studies carried out in the Bromo Tengger Semeru National Parks (Batoro and Siswanto 2017; Putri *et al.* 2016), *e.g.* 24 medicinal plant species were identified from the Wonokitri village (Azrianingsih and Kusumahati 2018). However, no comprehensive study on the ethnopharmacological knowledge of the people of the Tengger tribal community of Wonokerso village has been done (Rohman and others 2019). Wonokerso village is claimed to be the oldest village in the park region, and the residents still practice Hinduism. Due to tourism and modernization, the rich ethnopharmacological tradition and the practices of the Tengger local healers (*dukuns*) are disappearing fast. Therefore, this study aimed to comprehensively document the

ethnopharmacological knowledge of Wonokerso village healers and highlight the biodiscovery potential of Tenggerese medicinal plants.

Materials and Methods

Study area, population and time frame

The study site is within the administrative area of Probolinggo Regency, East Java Province, Indonesia (Figure 1) (BPS Probolinggo 2014). The regency (*kabupaten*) lies between 7.7764° S latitude and 113.2037° E longitude and covers 24 districts (*kecamatan*), one of which is Sumber district. This district is divided into nine villages and the present study was conducted in Wonokerso Village (*desa*). This village lies on the east side of the Bromo mountain area and is administratively divided into seven sub-villages (*dusun*), namely Ledoksari, Windon, Tugusari, Wonokitri, Wonosejo, Wonosasi, and Krajan (Figure 1B). Wonosasi is the most populous subvillage and was the base camp for this study as it is the oldest village of the Tengger people and one of the annual Hindu ceremonies, *Karo*, is traditionally required to start from here before proceeding onto other villages. Wonokerso occupies 9,126 km^2 and has a population of 2,337 residents in 621 households who predominantly work in the agricultural sector, with almost half living under the poverty line as defined by the Indonesian Government.

The preliminary study was initiated in May 2015 with an evaluation of the cultural history of Tengger based on reports authored by the scholars at the University of Jember (Sutarto 2006) to enable background knowledge prior to the ethnopharmacological survey. The survey began by finding the oldest village inhabited by the Indigenous people of Tengger, defining its geographical borders, and identifying the key informant (the spiritual leader, *dukun pandhita*). By the end of the survey, data documented on paper was collected and medicinal plant samples were identified by the authors at the University of Jember. In June 2016, voucher specimens of medicinal plants were deposited at Purwodadi Botanical Garden-National Research and Innovation Agency (formerly known as Indonesian Institute of Science) in Pasuruan, East Java, Indonesia.

Identification of the community healers (*dukuns*) and their networking analysis

Dukun is regarded as an informal occupation in the Tenggerese society. *Dukun* is a term that locally refers to community leaders with religious and traditional functions. In other places in Java, the term dukun refers to those with sacred powers and special abilities to whom people ask for help and ailment healing (Sutarto 2000). Among the Tenggerese such a role is performed especially by *dukun cilik*, while among the Balinese society by *pengusada* or *balian* (Arsana *et al.* 2020). *Dukun* assumes an important position in the Tenggerese society in the past and even today. It was reported that in 1920 there were 10 Tenggerese *dukuns* in Probolinggo, 9 *dukuns* in Pasuruan, 5 *dukuns* in Malang, and 12 *dukuns* in Lumajang (Jasper 1926). The number of Tenggerese *dukuns* declined during the independent era, with the decreasing size of the Tenggerese population as a consequence of the expanding Islamic influences. Unfortunately, there is no official dukun registry in government offices today. In order to reach as many as *dukun* in the selected area (Figure 1), a snowball sampling method was used, which ensured that a respondent was truly a *dukun*. Recognition of someone as *dukun* from other *dukuns* is important as this determines their position in society. This analysis created a map of the *dukun* network based on referrals from each respondent.

Plant specimen and data collection

Research ethics was granted with approval number of 072/058/426.302/2016. In addition, approval for research activities was also granted by the Vice Rector of the University of Jember, the Chief of Wonokerso Village and the Spiritual Leader of the People of Tengger. Before the main cross-sectional survey, a preliminary survey started with the first *dukun* (as introduced by the local leader - *Pak Tinggi*) as the main reference for snowball sampling. They were asked to inform other *dukuns* in Wonokerso that they would be interviewed with the process repeated with subsequent *dukun* asked the same questions. An unstructured ethnopharmacology interview was utilised as it is considered more effective in collecting data in a community where literacy is considered low (Gill and others 2008). The latest data from the regency's statistics office describes the adult literacy rate in 2013 as 88.44% and the mean years of schooling as 6.3 years (BPS Probolinggo 2014), which are less than the national averages (UNESCO 2016). Therefore, a conceptual framework of survey questions was constructed to improve the consistency of collected information. Personal data collected from respondents included age, sex, type of healer, and religion. Although religion is generally considered a sensitive issue amongst Indonesians, it is an important data point since the focus was on tracking back the practice of traditional medicine from Majapahit, the largest historical Hindu Kingdom in the country (Raffles and Raffles 1830). The interview also explored the local names and components of medicinal plants used. The data surveyors were accompanied by locals to find and collect the medicinal plants. The respondents were also asked about diseases and plants used, including the methods of preparation to treat them.

Medicinal plants specimen collection, preservation, and identification.

Modified ethnopharmacological evaluation methods were used, as previously described (Wangchuk *et al.* 2017). Medicinal plants were collected with the assistance of a healer and the specimens were dried using a herbarium press and labelled before transportation to Purwodadi Botanical Garden, the Indonesian Science Institute in Malang, East Java, Indonesia, for identification in which a specimen of each plant was assigned a voucher specimen code/number. Fresh specimens were transported directly to the Botanical Garden. Botanical names of the medicinal plants were confirmed using Plants of the World Online or World Flora Online database (POWO 2024; WFO 2024).

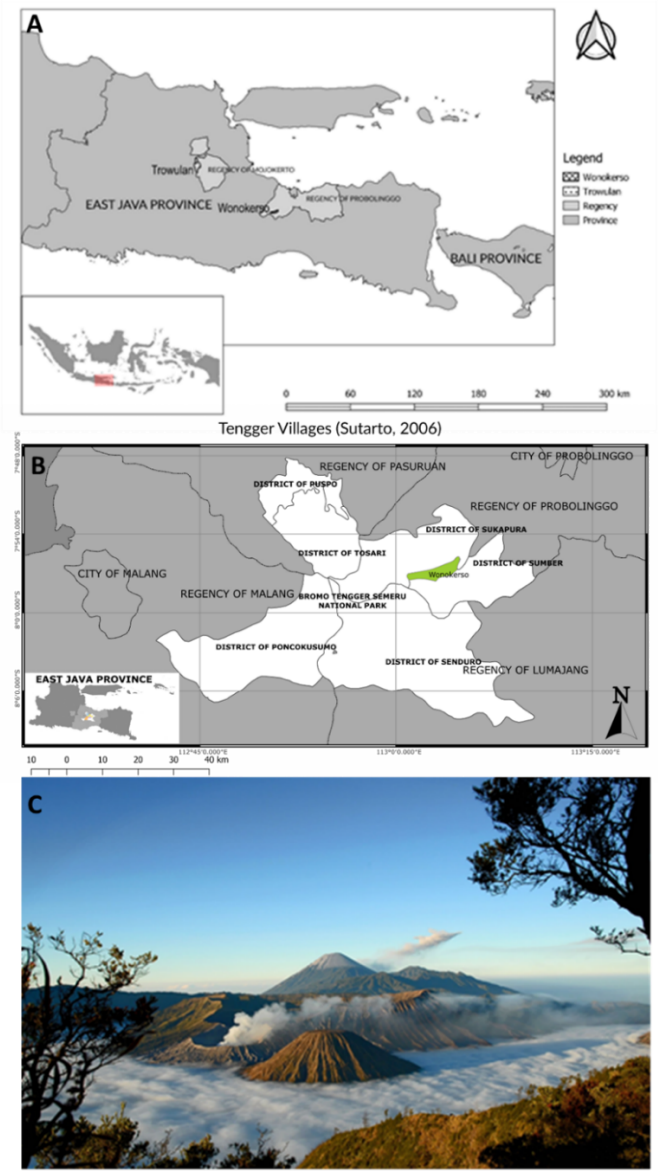

Figure 1. Map of Indonesia. (A) Location of Tengger community within a Java Island; (B) The location of Wonokerso village of Tengger (the oldest village in the Tenggerese community); (C) Bromo mountain range, where the Tenggerese community lives (Sutarto 2006).

The use value (UV), family use value (FUV), factor of informant's consensus (ICF), use-reports and crosschecking against medicinal plant databases

The Use Value (UV) represents the relative significance of species used locally and is calculated using equation 1 (Arrout *et al.* 2022), as:

$$UV = \frac{\sum UV}{N} \quad \text{..... Equation 1}$$

where use-value is the UV of a species, U is the number of mentions given by respondents for each species, and n is the number of respondents.
The Family Use Value (FUV) represent the significance of plant family whihc calculated using equation 2 (Arrout *et al.* 2022), as:

$$FUV = \frac{\sum UVs}{Ns} \text{..... Equation 2}$$

Where UVs is sum of UV of all plants within family and Ns is total number of plants within each family.

The factor of informant's consensus (ICF, equation 3) is calculated to determine intra-cultural consensus regarding the species used for a specific disease category (Awan *et al.* 2021), as:

$$ICF = \frac{n_{ur} - n_{spp.used}}{n_{ur} - 1} \text{..... Equation 3}$$

where n_{ur} is the number of use-reports per disease category and $n_{spp.used}$ is the number of species used to treat the disease.

In addition, data were kept as primary information in which the frequency of citation of a specific remedy represented the number of individual use-reports for a type of drug and therapeutic application (Weckerle *et al.* 2018). The number of species used to treat the disease was derived to evaluate the shared knowledge among the healers.

Hinduism was inherited from India and spread throughout Southeast Asia, resulting in a ruling Hindu Kingdom. Therefore, claims for the traditional uses of medicinal plants of Tengger were compared against claims from the broader ancestral community of the ruling Hindu Kingdom by comparison using the database of medicinal plants of Southeast Asia, PROSEA (PROSEA 2024), and the Ayurvedic Pharmacopoeia of India (Ministry of Health and Family Welfare-Government of India 2017) for their historical record and also through the Scifinder Scholar database for any published laboratory-based studies relating to these plants for evaluation of traditional claims against scientific evidence.

Sample size and the statistical analysis
This study included all the living *dukuns* in the study areas, which was identified through snowball sampling method. Using the Microsoft Excel program, descriptive statistics were analysed to present the sociodemographic data of the respondents. Continuous data were presented as a mean with standard deviation, while discrete data were presented as a percentage. Data for the exploratory social network analysis was prepared using the software txt2Pajek version 3 (Pfeffer 2013) and the analysis itself was performed using Pajek version 4.10 (Mrvar and Batagelj 2016).

Results

The sociodemography of the Tengger community study respondents
The indigenous people of Tengger inhabit four regencies, including Probolinggo, Malang, Pasuruan, and Lumajang. Interestingly, most of the community spiritual leaders reside in Ngadas Village, Sekarpura District, and Probolinggo Regency. The Tengger culture is still rich in traditional customs, from ceremony to medication, using medicinal (herbs, animal products, and minerals) and spiritual approaches. The Tengger people recognize three categories of *dukuns* (traditional leaders) with each having their own role in the society:

i) *dukun pandhita* (or *dukun adat*) who act mainly as priests for cultural ceremonies, although they have knowledge and skills in traditional healing;
ii) *dukun alit* (or *dukun cilik*), which has a major role as a traditional healer, commonly using medicinal plants in their practices. Some *dukun alit* only use water and myrrh as the healing medium and they are called *dukun tirta*; and
iii) *dukun bayi* helps pregnant women during labour and heal children using traditional massage techniques. *Dukun bayi's* knowledge and skills in relation to the use of medicinal plants are more limited than *dukun alit's*.

Based on preliminary/informal communication with the spiritual leaders from the Probolinggo Regency, the ethnopharmacological survey was directed to the oldest village and the most isolated community from where the sacred annual festival ceremony known as "*Karo*" begins in Tengger, Wonokerso Village, Sumber District, Probolinggo Regency. Due to high poverty in this area, people rely on 'natural sources' for their health care needs even to this day. Nevertheless, modernisation and religious assimilation of their surrounding villages, especially those nearby tourist sites such as Bromo Mountain Range, are changing their lives. From snowball sampling, 20 *dukun* names were gathered and the subjects were interviewed, with one subsequent exclusion due to death. Informants were predominantly male, with a mean age of 60 years (Table 1). Five (31%) informants did not admit their work as *dukun*, but as a farmer instead. This can be understood as part

of Javanese culture, which healers were unlikely to self-declare their capability, but the society legitimated their healing skills. Amongst different types of *dukuns*, *dukun tirta* comprised 32% of the study participants. The majority of *dukuns* embraced Hinduism, but surprisingly, one reported to have mixed faiths of Buddism, Hinduism, and Islam. The community represented the Hindu society of the people of Tengger.

Table 1. Sociodemographic characteristics of respondents

Characteristic	Value, n=19
Age, mean±SD	59.7±10.2
Gender, n (%)	
Male	18 (94.3%)
Female	1 (5.7%)
Self-reported occupation, n (%)	
dukun adat	1 (5.3%)
dukun alit	
dukun bayi	2 (10.5%)
dukun tirta	6 (31.6%)
dukun alit	2 (10.5%)
Farmer	8 (42.1%)
Self-reported faith, n (%)	
Hinduism	15 (83.3%)
Islam	2 (11.1%)
Mixed (Hinduism, Buddhism, Islam)	1 (5.6%)

Distribution and network of *dukun* healers within Sumber District, Probolinggo Regency

The Sumber district has many subvillages including Wonosejo, Windon, Wonokitri, Wonosari, Tugusari, Ledoksari and Krajan. The results of the social network analysis showed that each subvillage had at least one person with traditional healing knowledge and skills in which node size represents the number of nominations (Figure 2). Tugusari, in particular, had the largest number of healers (7 of 19), although this subvillage is located quite far from the village center. The size of nominations indicated four major healers (repondent number 101, 104, 105, 106), who acted as *dukun alit*, with two of them dwelling in Krajan, the village center. In addition, results of the analysis also confirmed the position of the *dukun adat* as described by the spiritual leader. The *dukun adat* may not have the biggest size of node as his main responsibility was religious ceremony.

Medicinal plants identification and their parts use

The ethnopharmacological study revealed that the *dukuns* of Tengger use as many as 41 medicinal plants derived from 23 families and 38 genera for the treatment of 17 diseases (Table 2). Table 2 shows the individual botanical plant name, its family, local name, parts used, method of preparation, diseases treated, use value, their recorded status in Ayurvedic medicine, and the voucher code number.

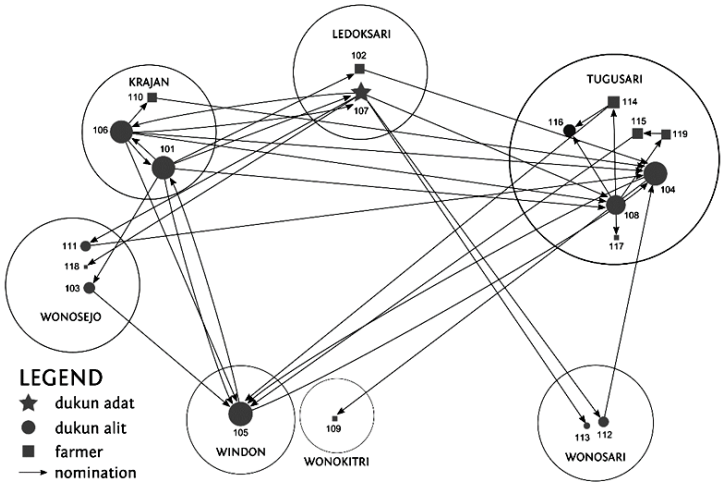

Figure 2. Distribution of healers in seven different subvillages, Wonosejo, Windon, Wonokitri, Wonosari, Tugusari, Ledoksari and Krajan. Healers' occupations were described in the legend and numbers of healers were written from 101 to 119. The size of the node represents the number of nominations.

Table 2. Medicinal plant used by the indigenous people of Tengger

No	Species	Family	Plant habit	Local name	Part of plants, preparation and application	Uses	VC	UV	PROSEA	Ayurveda
1	*Acorus calamus* L.	Acoraceae	Grasses	dringu	Leaves are poulticed and applied to forehead	Fever	Tu1	0.11	y	y
2	*Allium sativum* L.	Alliaceae	Grasses	bawang putih	Bulb was poulticed and applied to the wound or cut	Wound or cut	Tu2	0.11	y	y
3	*Alyxia reinwardtii* Blume	Apocynaceae	Shrubs	pulosari	Young leaves and stems are decocted and drunk three times a day	Fever	Le4	0.11	y	na
					Young leaves and stems are decocted and drunk three times a day	Rheumatism		0.11	y	na
4	*Anredera cordifolia* (Ten.) Steenis	Basellaceae	Vines	binahong	Young leaves are grilled and applied to area	Itchy	Le5	0.11	y	na
					Leaves are pounded and applied to wound	Wound		0.11	y	na
5	*Apium graveolens* L.	Apiaceae	Herbs	seledri	Leaves are eaten (fresh or cooked)	Hypertension	Le1	0.44	na	y
6	*Borreria laevis* (Lam.) Griseb.	Rubiaceae	Grasses	tepung otot	Leaves and stem are ground and mixed with water as drink or ointment	Rheumatism	Le6	0.11	y	na
7	*Brassica rapa* L.	Brassicaceae	Herbs	sawi	Yellow flower is soaked with water and drunk three times a day	Fever	Kr1	0.11	y	na
					Mature leaves are cooked and drunk 3 times a day	Hypertension		0.11	y	na
					Mature leaves are cooked and eaten	Nutrition		0.11	y	na
8	*Capsicum pubescens* Ruiz & Pav.	Solanaceae	Vines	lombok terong	Young leaves are boiled and drunk once a day	Labour	Kr2	0.11	na	y
9	*Causonis clematidea* (F.Muell.) Jackes	Vitaceae	Herbs	tirem	The whole plant is boiled and drunk three times a day	Stomach	Le7	0.22	y	na
10	*Cinnamomum burmannii* (Nees & T. Nees) Blume	Laruaceae	Trees	keningar	Leaves are boiled and drunk three times a day	Fever	Tu13	0.11	y	y
11	*Cocos nucifera* L.	Aracaceae	Trees	kelapa	Coconut water is drunk once a day	Foetus health	Kr3	0.11	na	y
12	*Cuminum cyminum* L.	Apiaceae	Herbs	jinten	Seed are fried and expressed oil used as an ointment	Fever	Tu8	0.11	na	na
13	*Curcuma longa* L.	Zingiberaceae	Herbs	kunyit	Rhizome is cut and applied to forehead	Fever	Le8	0.11	y	y
					Rhizome is peeled and applied to forehead	Headache		0.11	y	na
					Rhizome is pounded and applied to wound	Wound		0.11	y	na
14	*Datura metel* L.	Solanaceae	Shrubs	kecubung	Young stem is soaked in water and applied to forehead, neck, chest and hand twice a day	Fever	Tu15	0.11	na	y
15	*Daucus carota* L.	Apiaceae	Herbs	wortel	Fresh root is eaten	Eyesight	Kr4	0.11	na	na
16	*Drymocallis arguta* (Pursh) Rydb.	Rosaceae	Herbs	grunggung	Ripen fruit is eaten	Diarrhoea	Le9	0.44	na	na
					Ripen fruit is eaten	Anaemia		0.11	na	na
17	*Elaeocarpus longifolius* Blume	Elaeocarpaceae	Trees	jambu wer	Fresh young fruit is eaten	Diarrhoea	Kr5	0.33	na	na
18	*Erythrina variegata* L.	Leguminoseae	Trees	dadap serep	Leaves are pounded and applied onto skin	Fever	Tu20	0.11	y	na
19	*Foeniculum vulgare* Mill.	Apiaceae	Herbs	adas	Leaves and stem are boiled and drunk three times a day	Fever	Le10	0.11	y	y
					The whole plant is boiled and drunk three times a day or applied as an ointment	Rheumatism		0.11	na	y

20	*Garcinia mangostana* L.	Clusiaceae	Trees	manggis	Fruit skin is grilled, soaked in water and drunk three times a day	Stomach	Tu7	0.22	na	na
21	*Jatropha gossypiifolia* L.	Euphorbiaceae	Shrubs	jarak merah	Leaves are grilled and boiled in water, drunk two times a day or as an ointment	Rheumatism	Le11	0.11	y	na
22	*Kaempferia galanga* L.	Zingiberaceae	Herbs	kencur	Rhizome is juiced and drunk three times a day or applied as an ointment	Rheumatism	Tu3	0.11	na	na
					Rhizome is juiced and drunk three times a day	Vitalise		0.11	y	na
23	*Malus prunifolia* (Willd.) Borkh.	Rosaceae	Tress	apel	Young fruit is eaten twice a day	Diarrhoea	Tu17	0.11	na	na
24	*Manihot esculenta* Crantz	Euphorbiaceae	Shrubs	ketela pohon	Young root is boiled and drunk twice a day	Hypertension	Tu23	0.11	na	na
25	*Musa paradisiaca* L.	Musaceae	Herbs	pisang raja	Young and ripen fruit is grilled and eaten twice a day	Diarrhoea	Tu24	0.11	y	y
					Fruit skin is grilled, soaked in water and drunk two times a day	Stomach		0.11	y	na
26	*Musa sp.**	Musaceae	Herbs	pisang mas	Ripen fruit is eaten	Jaundice	Tu9	0.11	y	na
27	*Oryza sativa* L.	Poaceae	Grasses	padi	Seeds are soaked in water overnight and the water drunk two times a day	Vitalise	Le2	0.11	y	na
28	*Persea americana* Mill.	Lauraceae	Trees	alpukat	Leaves are pounded, juiced and drunk	Hypertension	Tu19	0.11	na	y
29	*Physalis lagascae* Roem. & Schult.	Solanaceae	Herbs	ciplukan	Ripen fruit is eaten	Diarrhoea	Kr6	0.11	y	y
					Ripen fruit is eaten	Stomach	Wi3	0.11	y	y
30	*Piper fluminense* Raddi	Piperaceae	Vines	merica	Seed is fried, ground, soaked with water and drunk	Rheumatism	Tu5	0.11	y	na
31	*Piper betle* L.	Piperaceae	Vines	daun sirih	Young leaves are pounded and applied into nostrils	Bleeding	Tu10	0.11	y	y
32	*Rosa tomentosa* Sm.	Rosaceae	Trees	mawar	Flower is soaked with water and drunk twice a day	Fever	Kr7	0.11	na	na
33	*Rubus allegheniensis* Porter	Rosaceae	Herbs	calingan	Ripen fruit is eaten	Diarrhoea	Kr8	0.22	y	na
34	*Saccharum officinarum* L.	Poaceae	Grasses	tebu hitam	Stem was grilled and eaten	Rheumatism	Tu9	0.11	na	na
35	*Sicyos edule* Jacq.	Cucurbitaceae	Vines	labu siam	Fruit is pounded and applied onto skin	Fever (kindern)	Le2	0.11	na	na
36	*Sesbania grandiflora* (L.) Poir.	Fabaceae	Trees	turi	Leaves are pounded and applied onto skin	Fever	Tu19	0.11	y	y
37	*Solanum lycopersicum* L.	Solanaceae	Vines	tomat	Ripen fruit is eaten	Nutrition	Kr6	0.11	y	na
38	*Solanum nigrum* L.	Solanaceae	Herbs	ranti	Young leaves are boiled and drunk twice a day	Hypertension	Wi3	0.11	y	na
					Leaves are boiled and drunk once a day	Tonic drink after labour	Tu5	0.11	na	na
39	*Tagetes tenuifolia* Cav.	Asteraceae	Herbs	ganjan	Young leaves are pounded and applied into nostrils	Nasal bleeding	Le3	0.22	na	na
40	*Tamarindus indica* L.	Fabaceae	Trees	asam jawa	Fruit is boiled and drunk	Nausea	Le12	0.11	na	y
41	*Zingiber officinale* Roscoe	Zingiberaceae	Herbs	jahe	Rhizome is pounded and applied onto forehead	Headache	Wi4	0.11	y	y

Note: VC: Voucher code; UV: Use-value; PROSEA: Plants of Southeast Asia database; y: recorded in PROSEA or Ayurveda, na: unrecorded in PROSEA or Ayurveda. *Reassessment requires a complete set of the plant to gain the correct species identification.

Medicinal plants are the bulk ingredients of dukuns' medications. We found that as many as 17 different types of diseases are treated by dukuns using 41 medicinal plants (Table 2). The majority of medicaments were related to infective disease therapies, diarrhoea, and fever followed by metabolic disorder, hypertension and rheumatism. Medicinal plants were also prescribed for health promotion including vitality, foetus health, and additional nutrition source (Table 3). Maximum number of plant species was used for treating fever (11 species), followed by diarrhoea (six species) and stomach problem (four species used) (Table 3). Fever was mitigated with internal or external medicaments with each Tengger healer ("dukun") proposing different medicinal species. Overall, sharing knowledge among "dukun" was reflected in plant used to treat diarrhoea, hypertension, nasal bleeding and stomach based on informant consensus factor (table 3).

Table 3. Informant consensus factor (ICF)

No	Disorder	n_{ur}	$n_{spp.used}$	ICF
1	Anaemia	1	1	0
2	Diarrhoea	12	6	0.55
3	Eyesight	1	1	0
4	Fever	11	11	0
5	Foetus health	1	1	0
6	Headache	2	2	0
7	Hypertension	8	5	0.43
8	Itchy	1	1	0
9	Jaundice	1	1	0
10	Labour	2	2	0
11	Bleeding (nasal)	3	2	0.50
12	Nausea	1	1	0
13	Nutrition	2	2	0
14	Rheumatism	7	7	0
15	Stomache	6	4	0.40
16	Vitality	2	2	0
17	Wound	3	3	0

Note: n_{ur}: number of use-reports per disease category; $n_{spp.used}$: number of species used to treat the disease.

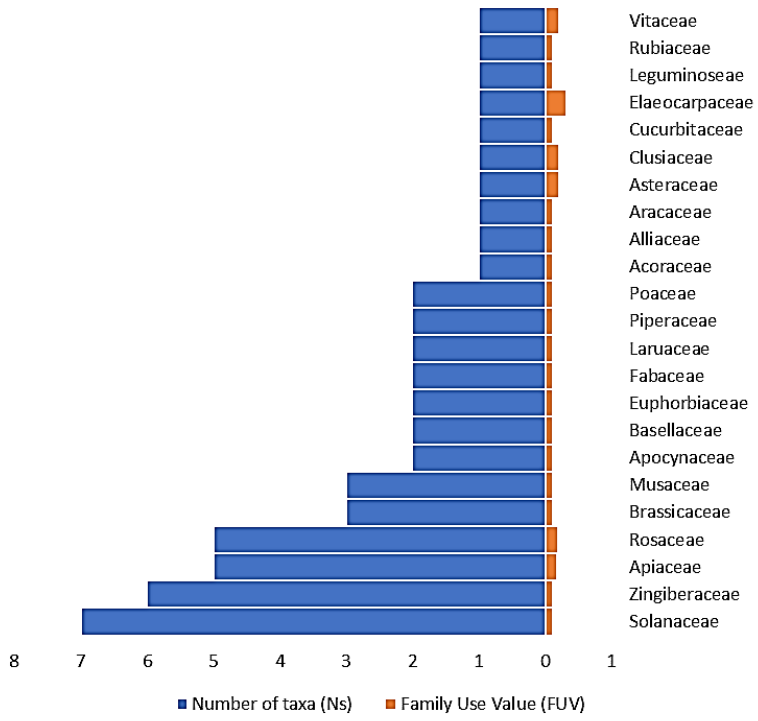

Figure 3. Number of species and significant of use in each family

Out of 23 families, the Solanaceae family ranked first with 5 species, closely followed by Apiaceae and Rosacease (Figure 3). Locally referred as "empon-empon", Zingeberaceae plants were previously reported to be the most commonly used plant in Indonesian traditional medicine called "Jamu" (Beers 2012; Eisai Indonesia 1986). However, this was not true with Tengger *dukuns* medicine, which rated Solanaceae, Apiaceae, and Rosaceae as the most common plants, not Zingeberaceae (Figure 3). The *dukuns* also used local crops in their recipes, including capsicum, tomatoes, ground berries, carrot, wild collard, apple, wild rose apple, celery, wild eggplant, and wild banana (Table 2).

A review of the literature and database searches revealed that of the 41 medicinal plants identified from Tengger region, 32 were recorded in the PROSEA database and 18 were recorded in the Ayurvedic medicines (Table 2), suggesting twenty-three medicinal plants species were native and unique to the indigenous knowledge of Tengger communities.

Medicinal plants habit or life forms, part of plants, preparation and application

The listed medicinal plants of Tengger are classified into grasses (12%), herbs (38%), vines (15%), shrubs (10%) and trees (25%) (Figure 4A). Leaves and fruit were the major components of medicinal trees used by the *dukuns* while the roots were only taken from medicinal herbs. In Indonesian culture, the doctrine of signature is a common practice in providing clues for medicinal uses of certain plants. The people of Tengger used the grass *Borreria laevis* (Lam.) Griseb to treat muscle related ailments, including rheumatism. This traditional knowledge was based on the similarity in appearance of grass to human muscle, even resulting in grass being named as *tepung otot* (a direct English translation, muscle powder). Among the plant parts used in Tengger ethnopharmacological medicine, 38% were leaves followed by fruit (28%), rhizomes (11%) and seeds (5%) (Figure 4B). Although the majority of these medicinal plants are consumed raw without processing, the indigenous people of Tengger have also developed different extraction methods including soaking, boiling, and decoction (Figure 4C). The Tengger *dukuns* carry out wound healing practices by preparing medicament from *Allium sativum* L., *Anredera cordifolia* (Ten.) Steenis, and *Curcuma longa* L.

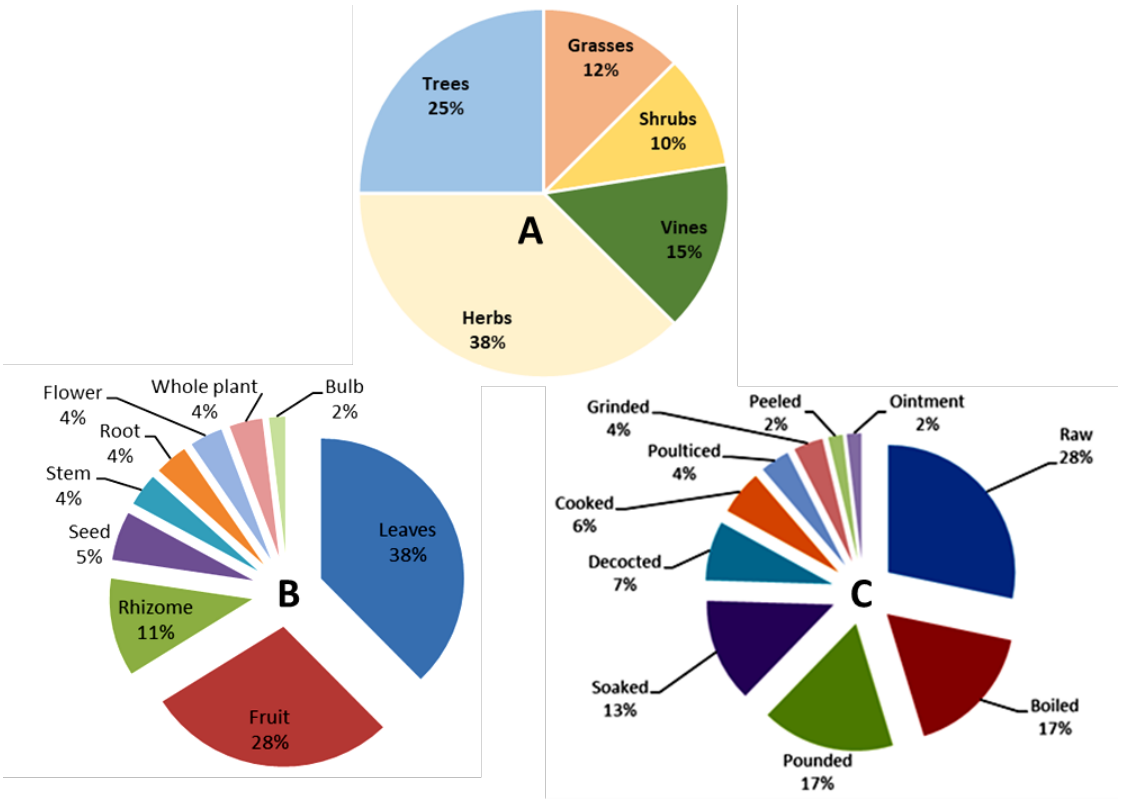

Figure 4. Plant habit/life form of medicinal plants of the indigenous people of Tengger (A); Diversity of plant parts used by dukuns (B); method preparation of medicinal plants (C).

Diseases treated by *dukuns* using different medicinal plants

This study found that the *dukuns* of Tengger use two main medication practices: the medicaments based on medicinal plants and animal products, while the spiritual medication is mediated by water and incantation of prayers. This spiritual treatment was conducted by a special healer referred to *dukun tirta*. *Tirta* is a Sanskrit name (an ancient Javanese language) for water.

Allolobophora caliginosa Savigny is the only animal-originated medicine (a worm obtained from inside the banana pseudostem or corm - *Musa paradisiaca* L.) used by *dukuns* for treating fever with abdominal complaints related to *Salmonella typhi* infection.

Medicinal plants are the bulk ingredients of *dukuns*' medications. As many as 17 different types of diseases are treated by *dukuns* using 41 medicinal plants (Table 3). The majority of medicaments were related to infective disease therapies, diarrhoea, and fever, followed by metabolic disorder, hypertension and rheumatism. Medicinal plants were also prescribed for health promotion, including vitality, foetus health, and as an additional nutrition source (Table 3). Six medicinal plant species were used by 12 healers to treat fever (Table 4, Figure 5). Fever was mitigated with internal or external medicaments with each Tengger healer proposing different medicinal species. Six medicinal plants including *Acorus calamus* L., *Alyxia reinwardtii* Blume, *Brassica rapa* L., *Cinnamomum burmannii* (Nees & T. Nees) Blume, *Foeniculum vulgare*, *Rosa tomentosa* Sm were prepared as decoctions to be consumed orally.

Table 4. Use-reports based on indication

No	Indication	Number of use-reports per disease category	Number of species used to treat the diseases
1	Anaemia	1	1
2	Diarrhoea	12	6
3	Eyesight	1	1
4	Fever	11	11
5	Foetus health	1	1
6	Headache	2	2
7	Hypertension	8	5
8	Itchy	1	1
9	Jaundice	1	1
10	Labour	2	2
11	Bleeding (nasal)	3	2
12	Nausea	1	1
13	Nutrition	2	2
14	Rheumatism	7	7
15	Stomachache	6	4
16	Vitality	2	2
17	Wound	3	3

A further six species including *Cuminum cyminum* L.*, Curcuma longa* L.*, Datura metel* L.*, Erythrina variegata* L.*, Sicyos edule* Jacq.*, Sesbania grandiflora* (L.) Por. are applied topically to reduce fever. Fever associated with malaria is treated with the decoction of the root of *Sesbania grandiflora* (L.) Por. (Fabaceae). Living in a tropical region with poor water supply and sanitation has made the Tengger people more prone to diarrhea, which spikes during the monsoon season. Of the six medicinal plants used for treating diarrhea (Table 3), *Drymocallis arguta* (Pursh) Rydb., *Elaeocarpus longifolius* Blume and *Rubus allegheniensis* Porter were the most used species.

For rheumatism pain, the healers prescribe *Saccharum officinarum* L., *Kaempferia galanga* L., *Foeniculum vulgare, Jatropha gossypiifolia* L., *Alyxia reinwardtii* Blume, *Borreria laevis* (Lam.) Griseb. or *Piper fluminense* Raddi. Five medicinal plants, *Apium graveolens* L., *Persea americana* Mill., *Manihot esculenta* Crantz, *Solanum nigrum* L. and *Brassica rapa* L., are used to treat hypertension. Eight *dukuns* were found to use these same species for treating hypertension in Tengger.

Overall, the correlation of medicinal plants species and their uses were summarised in a Sankey diagram below which clearly indicated fever was the most common ailment treated with vary medicinal plants (Figure 5).

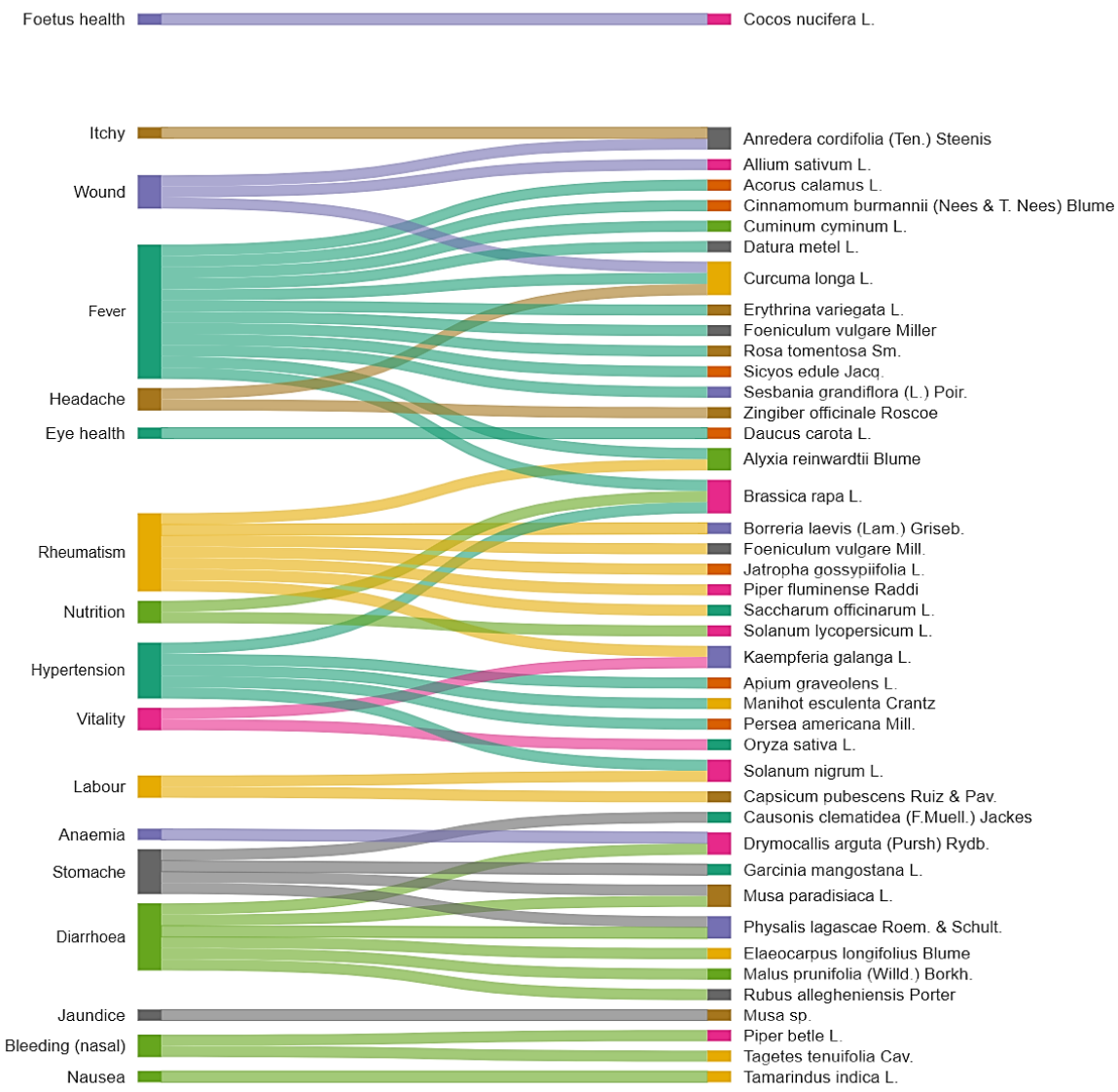

Figure 5. Shankey diagram indicating medicinal plant species distribution according to their indications.

Consensus amongst *dukuns* and the relationship of their medicinal plants with the Southeast Asian medicine

It was found that sharing knowledge among healers occurred only in diarrhoea, nasal bleeding, hypertension and stomach ache therapy with 6, 2, 5 and 4 different species, shared by 12, 3, 8 and 6 healers, respectively (Table 3). To draw relationships of *dukuns*' medicinal plants with other Southeast Asian medical system, the PROSEA database was reviewed and compared against the Indian Ayurvedics medical system. Although Hinduism spread into Southeast Asia through expansion of Hindu kingdom and trading (Leur 1967), less than 50% of Tengger knowledge of medicinal plants was listed in the medicinal database of Southeast Asia, PROSEA, a result duplicated with comparison against the Indian Ayurvedic pharmacopoeia. The comparison result could indicate that Tengger society was dynamic in developing medicinal plant knowledge.

Discussion

The historical and cultural perspective of Tengger community of Indonesia

The Tengger tribal people still practice Hinduism from the old Majapahit Hindu Kingdom (1300-1500 AD) (Hefner and 1985), which arrived in Indonesia in the first century through Indian traders with Brahmin passengers as direct agents in transmitting the religion. Hinduism was accepted by the locals by acquiescence and not by force as there is no evidence of the region ever having received an Indian king or being conquered by an Indian kingdom. Hinduism reached its peak civilization in the Indonesian archipelago during the Majapahit Kingdom, with its tributaries stretching from present Thailand to New Guinea (Figure 6). The Majapahit capital, Trowulan, was in the present Trowulan (Mojokerto, East Java) 70 km northwest of Tengger

(Vlekke 1959). Cultural influences grew with the erection of temples and the infusion of Javanese language with elements from the Sanskrit lexicon (Krom 1954; Vlekke 1959). The loss of the Hindu kingdom, the rise of the Islamic Kingdom in India, and the political and economic chaos in the Indonesian Hindu kingdoms led Muslim traders to dominate Indonesia, taking control of economic development. Interestingly, Islam did not intervene with the Javanese culture, and it was allowed to remain essentially Hinduistic-Javanese until recent times (Nasution and Arum 2024). Nevertheless, the Hindu faith in Indonesia is fading and is being practiced by less than 2% of the total Indonesian population, including the people of Tengger.

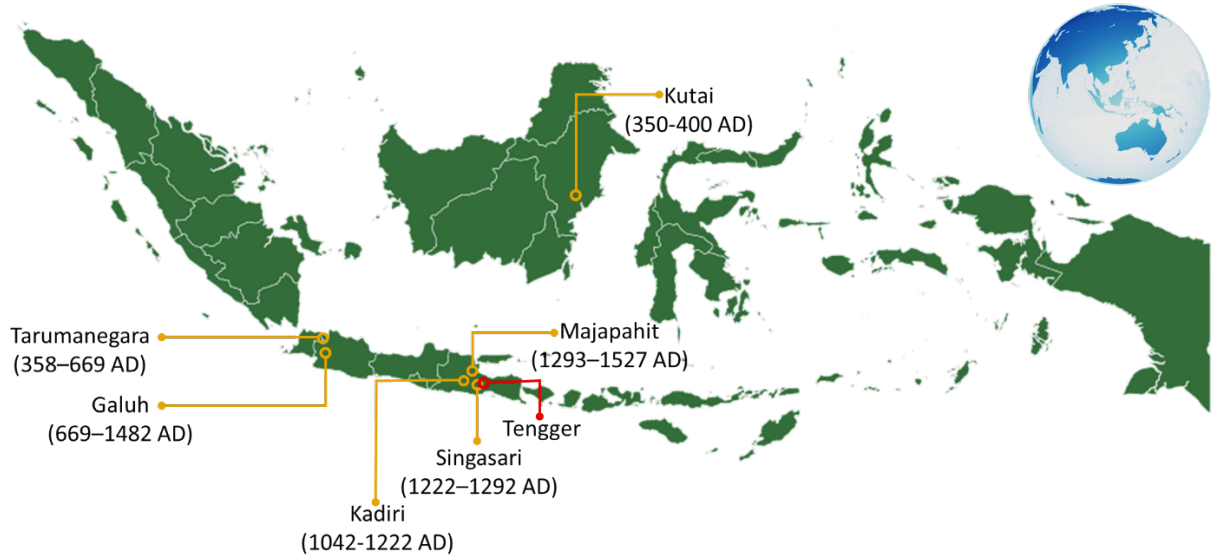

Figure 6. Capital of Hindu Kingdoms in Indonesia and Tengger location.

Hinduism practiced by the people of Tengger is unique, though officially, it is the same with Hinduism adopted by the Balinese. The uniqueness of Tenggerese Hinduism can be seen in the form of *Karo* dan *Kasada* rites. The two rites were not performed by Balinese society. Karo rite is held on Karo month, the second month of the Tengger calendar. Karo rite is devoted to the guardian spirits of the mountain and villages and consists of communal and individual performances. Important elements of the Karo rite are ritual activities done in the dukun's house, followed by the collection of contributions in the form of food and money. It culminates with festivities and *tandhak* dance performance held in the village head's house. By performing the rite, the Tenggerese believe that the year to come will be prosperous and all wishes will come into reality. Individually, each house present offerings in the form of *tumpeng* (volcano-like rice cone), equipped with fruits and *takirs* (banana leaf box) filled with traditional foods. Meawhile, *Kasada* is a ritual activity performed by offering sacrifices in the form of agricultural products and livestock thrown into the crater lake of Bromo volcano. It is held during Kasada, the month of the Tengger calendar, and is devoted to Bromo mountain's supreme divine beings and ancestral guardian spirits. The Tenggerese often describe themselves as *wong gunung* (mountain people) who are different from *wong ngare* (lowland people) (Sutarto 2000).

It can be said that Hinduism and pre-Hindu native beliefs have influenced the evolution of Tengger cultural and traditional practices through centuries of cultural exchanges, assimilation and adaptation. For example, the advent of Hinduism may have also ushered the Hindu-based Indian Ayurvedic medicine practices in Tengger regions. However, the historical record is scant and it is unknown whether the present-day people of Tengger are practicing the mainstream scholarly Indian Ayurvedic medicine. Their culture was documented by scholars from the Mataram Islamic Kingdom in Java (1778 AD) and described in the ancient manuscript, "*Centhini*" (Santoso *et al.* 2006). In the 1817 book "*The History of Java*", Sir Thomas Stamford Raffles described the indigenous people of Tengger as a warm, hard-working society (Raffles 1830). However, only limited information on their ethnopharmacological practices can be found in these historical documents.

The Tenggerese people believe that ailments can be caused either by mystical or physical causes. Mystical-linked ailments usually refer to diseases and bad luck, which are regarded as being caused by evil spirits' disturbances. To contain this kind of ailment, the Tenggerese perform *ritus tirta tolak-bala* (counter-plague water rites) led by *dukun pandhita.* The rite is usually held at road intersections where all villagers are asked to participate. Not all ailments, however, are believed to have mystical causes. There is also a belief among the Tenggerese that the cause of the ailments could be linked to something physical that requires medical responses to cure. The healing method usually involves using some equipment and applying

herbal medicine obtained from the surrounding environment (Putro 2020). To some extent, such practices are not exclusive to the Tenggerese people but also observable elsewhere in Java, including among the Madurese, the Javanese, the Usingese, and the Sundanese (Jordaan 1985; Mahony 2002; Nawiyanto 2017; Slamet-Vesink 1996; Wessing 2010).

Scientific approach on bioprospecting potential of Tenggerese medicinal plants

More than 50,000 plant species are used in these traditional medicines worldwide with the majority in Asian practices including that of Indonesia (Wangchuk and Tobgay 2015). Most of these medicinal plants have given rise to numerous modern drugs, including anticancer (taxol), antimalarial (artemisinin), analgesic (morphine) and many others. It has been estimated that Indonesia's natural wealth includes more than 10% of the world's plants, thousands of which are used for the treatment of diseases and 900 have been investigated for medicinal properties (Roosita *et al.* 2008). Only a few isolated works have provided evidence for the use of limited Indonesian medicinal plants.

Indonesia has 22,500 recorded higher plant species but of these species, only a miniscule number have been recorded as being used as medicinal plants and even less have been subjected to biodiscovery studies (Gewali and Awale 2008). For example, of the 41 medicinal plants identified here from Tengger, only a few species have been studied chemically and pharmacologically. Given that Indonesia is rich in biodiversity and traditional medicine knowledge and that many of the medicinal plants are less explored pharmacologically, there is enormous potential for biodiscoveries and bioprospecting in Indonesia (Nugraha *et al.* 2022; Rani *et al.* 2023). There is an urgent need to integrate the existing medicinal plants inventories in a single database with controlled accessibility to all parties (notably health care providers, researchers and communities) and sufficient protection for the knowledge holders. The Ministry of Health in Indonesia foresees to establish an information and documentation network on traditional medicine by involving relevant stakeholders. In addition, "Saintifikasi Jamu", a straight program under the Ministry of Health in Indonesia on evidence based traditional medicine, has significantly promoted traditional medicine into a formal health service. This program is being enforced through a Ministry of Health of Indonesia regulation No. 3, 2010 (Kementerian Kesehatan Republik Indonesia 2010). The purpose is to develop a comprehensive traditional medicine database covering methods of treatment and traditional drugs in order to strengthen the development and use of traditional medicine.

The evaluation of the use value (UV) revealed six medicinal plants which commonly used by the *dukuns* of Tengger including *Apium graveolens* L., *Causonis clematidea* (F.Muell.) Jackes, *Drymocallis arguta* (Pursh) Rydb., *Elaeocarpus longifolius* Blume, *Garcinia mangostana* L., *Rubus allegheniensis* Porter, *Tagetes tenuifolia* Cav. (Figure 7).

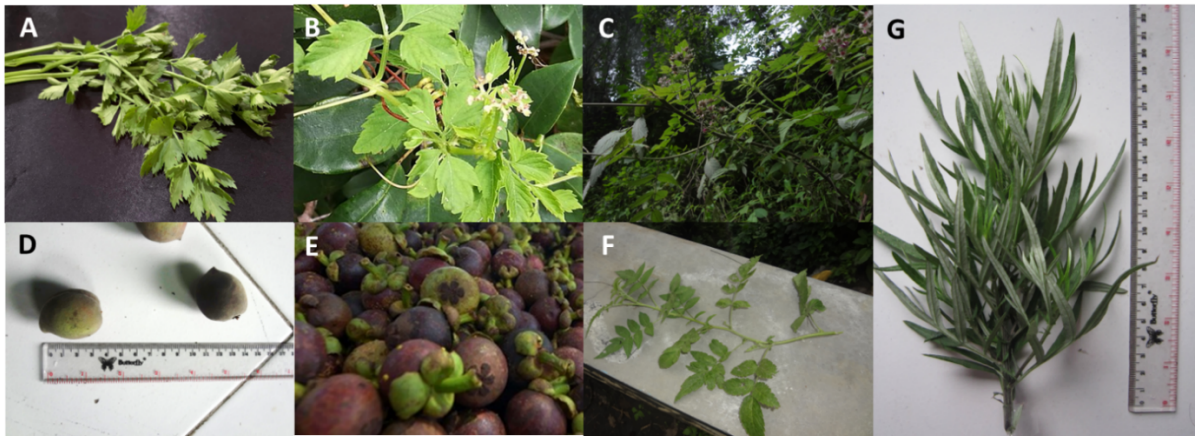

Figure 7. Seven most cited medicinal plants by the dukuns of Tengger. (A). *Seledri* (*Apium graveolens* L.). (B). Tirem (*Causonis clematidea* (F.Muell.) Jackes). (C). *Grunggung* (*Drymocallis arguta* (Pursh) Rydb.). (D). *Jambu wer* (*Elaeocarpus longifolius* Blume). (E). *Manggis* (*Garcinia mangostana* L.). (F). *Calingan* (*Rubus allegheniensis* Porter). (G). *Ganjan* (*Tagetes tenuifolia* Cav.)

Locally called as *Seledri*, *A. graveolens* has been prepared by *dukuns* to treat hypertension. This herb is well distributed in the whole of the Java and Sumatra Islands and well known for not only its distinct flavour as a food garnish but also for its capability in reducing blood pressure (Hutapea 2001). Phytochemical studies suggested sedanolide **1**, *n*-butylphthalide **2**, and sedanenolide **3** were responsible for the unique aroma and taste (Figure 10) (Dianat *et al.* 2015). Reported studies on antihypertensive bioprospecting of *A. graveolens* involved arrays of studies from *in vitro, in vivo* and clinical experiments. Crude hexane, methanol, and aqueous-ethanolic extracts of *A. graveolens* possessed hypotensive activity on rat models by

reducing systolic blood pressure by 38, 24, 23 mmHg at a dosage form of 300 mg/kg (Moghadam *et al.* 2013). Further studies revealed high concentration of *n*-butylphthalide **2** in the hexane extract which might be attributed to hypotensive activity through a vasodilatation mechanism (Moghadam *et al.* 2013). A quasi experiment using the form of pretest and post-test control group design based on 24 of 40-50 years old respondents resulted in a significant blood systolic and diastolic decrease by 17.58 and 7.08 mmHg respectively, after *A. graveolens* juice treatment (Azizah *et al.* 2020). A crossover placebo-controlled experiment on *A. graveolens* seed extract indicated female patients exhibiting a higher therapeutic response in blood pressure reduction (Gautam 2023). Bioactive discovery of *A. alveolens* successfully isolated nine compounds (Figure 8); junipediol A 8-*O*-*β*-D-glucoside (1-*β*-D-glucosyloxy-2-(3-methoxy-4-hydroxyphenyl)-propane-1,3-diol) **4**, isofraxidin-*β*-D-glucoside **5**, roseoside **6**, apigenin-7-*O*-*β*-D-glucoside **7**, luteolin-7-*O*-*β*-D-glucoside **8**, icariside D2 **9**, apiin **10**, chrysoeriol-7-*O*-*β*-D-apiosylglucoside **11**, and 11,21-dioxo-3-*β*,15*α*,24-trihydroxyurs-12-ene-24-*O*-*β*-D-glucopyranoside **12** in which junipediol A 8-*O*-*β*-D-glucoside **4** possessed good angiotensin-converting enzyme (ACE) inhibitory activity with an IC_{50} value of 76 µg/mL (Simaratanamongkol *et al.* 2014). *A. graveolens* crude extract also indicated concentration-dependent vasodilatory effect based on isolated rat aorta by reducing calcium influx into vascular smooth muscle cells (Sohrabi *et al.* 2021).

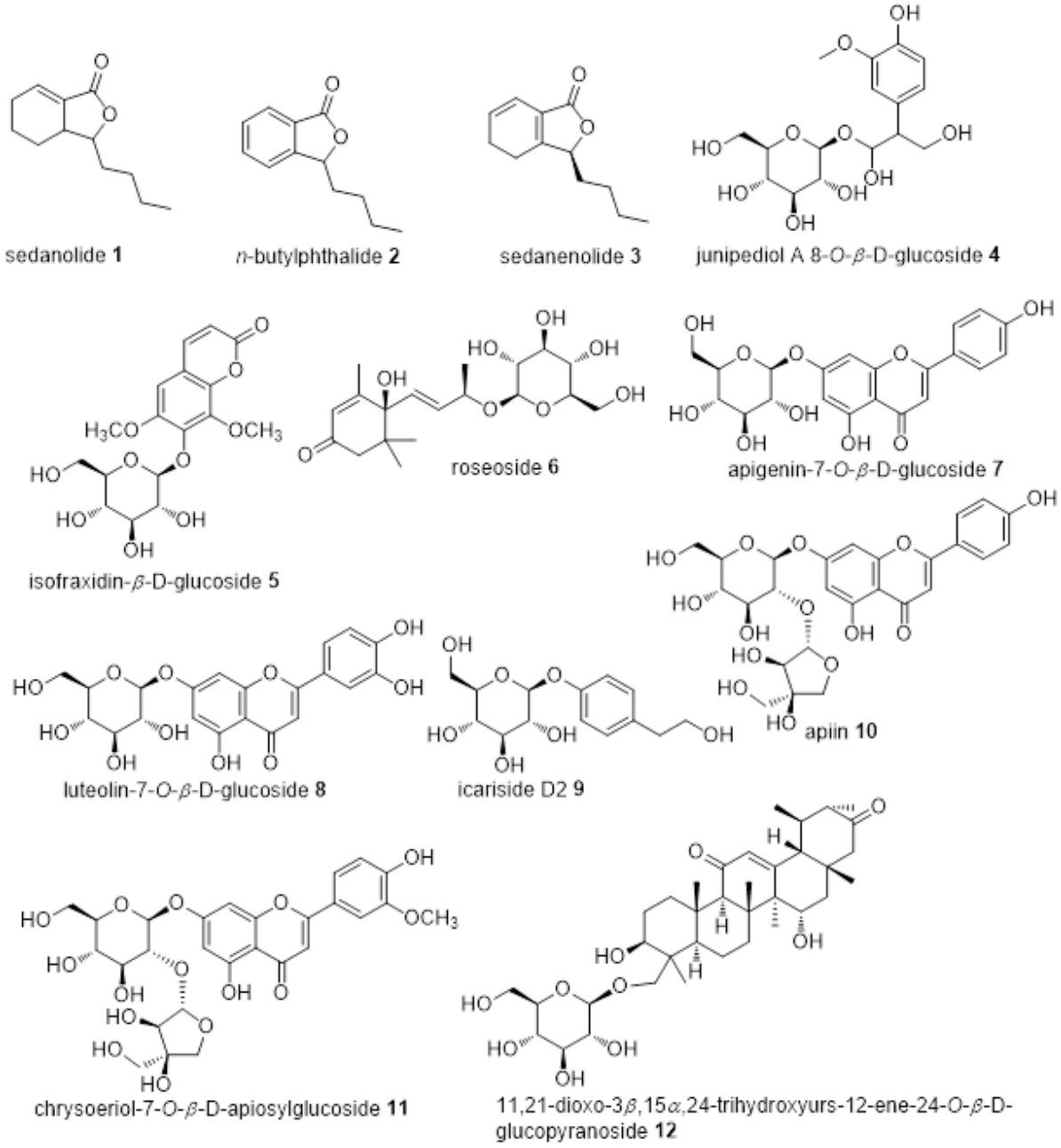

Figure 8. Molecular structure of bioactive constituents of A. graveolens.

Rippen fruit of *R. allegheniensis* shrub was commonly prepared by *dukun* in Tengger to treat diarrhea. Nevertheless, this plant was distributed in Sumatra, Jawa and Madura Islands and is called by different names, *e.g.* Arbe, kecalingan and Gharunggung, in which the leaves were used to treat stomach complaints, cough, ulcers and used as antinociceptive agent (Djumidi 1997). Previous phytochemical investigations on the fruit of *R. allegheniensis* successfully isolated two terpenes, rubusside A **13** and niga-ichigoside F1 **14** (Figure 9) (Ono *et al.* 2003). A study reported niga-ichigoside F1 isolated from *R. imperalis* to possess an antinociceptive activity based on acetic acid-induced abdominal constrictions and formalin test model in mice with respected ID_{50} values of 3.1 and 2.6 mg/kg (positive control, aspirin, ID_{50} value of 24 mg/kg and inactive) (Niero and others 1999). The antinociceptive treatment is necessary in diarrhoea-predominant irritable bowel syndrome (Paragomi *et al.* 2014).

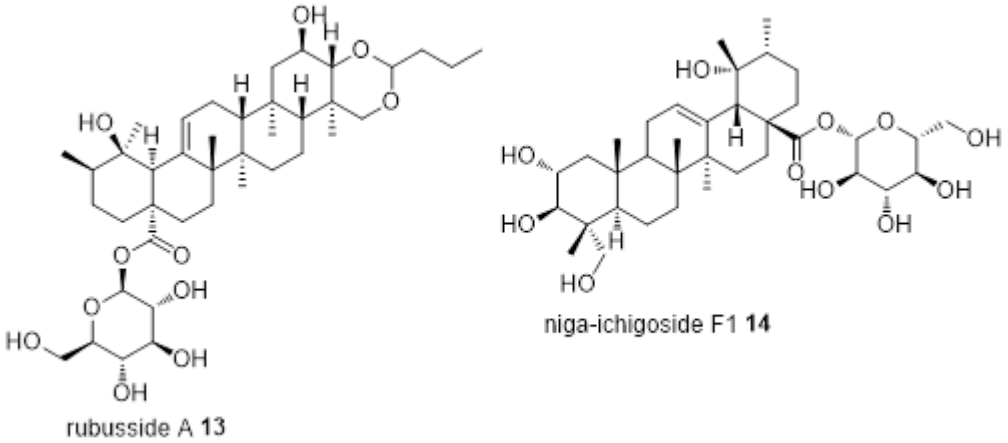

Figure 9. Molecular structures of bioactive terpenoids from *R. allegheniensis.*

The use of *T. tenuifolia* to treat nasal bleeding is unique to *dukuns* in the Tengger community as the other ethnics in Java Island use other species in the same genus, *Tagetes erecta* L as insect repellent (Hutapea 2001). Nevertheless, previous phytochemical investigation on the essential oils from the aerial part of *T. tenuifolia* successfully detected *α*-thujene **15**, tagetone **16**, dihydro-tagetone **17**, *cis*-ocimenone **18**, *trans*-ocimenone **19**, *β*-caryophyllene **20** (Figure 12) (Héthelyi *et al.* 2012). These components were also found in the flowers along with camphor **21** (Figure 10) (Gupta and Vasudeva 2014). In a case of epistaxis or nasal bleeding, several treatments involved antibiotic use along with nasal packing and a nasal vasoconstrictor agent (Graf *et al.* 2024). Essential oils have also gained interest in different applications due to their antibacterial activities (Meenu *et al.* 2023). Several essential oils sourced from Tagetes species indicated significant activities against pathogenic microbes such as *Staphylococcus aureus, Staphylococcus epidermidis,* and *Candida albicans* (Salehi *et al.* 2018). This suggests the benefits of using *T. tenuifolia* in nasal bleeding treatment.

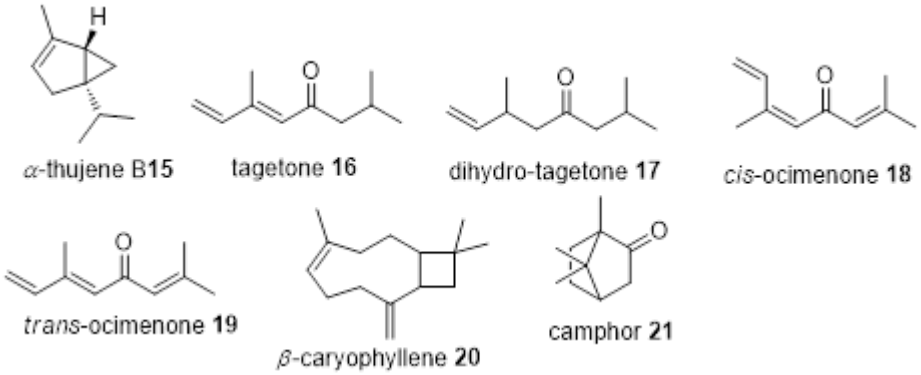

Figure 10. Molecular structures of essential oils constituents of *T. tenuifolia.*

The dukuns in Tengger used infused water from the grilled fruit skin of *G. mangostana* to treat abdominal complaints. This fruit is well-known among different communities in Sumatra, Jawa, Bali, Sulawesi and Maluku Islands where the roots have been used to treat dysentery and irregular periods (Hutapea 1994). The fruit was prepared to alleviate dysentery, stomach ulcer, leucorrhea, and tooth ache. Stem bark and its exudate were used to treat constipation and other abdomen discomfort (Eisai Indonesia 1986). The *G. mangostana* pericarp was previously reported to possess several bioactivities including antioxidant, anti-bacterial, anti-fungal, anti-tumour, and anti-inflammation (Thilagavathi *et al.* 2023), despite traditional pathology being unable to clearly define the cause for abdominal complaints. A symptomatic approach could be used to

understand the diseases such as abdominal discomfort due to liver cirrhosis or infection. Use of an ethanolic pericarp extract indicated significant hepatoprotective activity in an *in vivo* experiment using a rat model with liver cirrhosis induced by thioacetamide (TAA). Further experiments indicated the extract in downregulation of PCNA, *α*-SMA, and TGF-*β*1 antibodies in hepatocyte proliferation and based on serum profile the crude extract showed comparable potency to a standard drug, silymarin **22** (Figure 11) (Abood *et al.* 2020). Another experiment on hepatic injury using a mice model suggested *γ*-mangostin **23** as a new candidate for cholestatic patients (Figure 11) (Khayat *et al.* 2023).

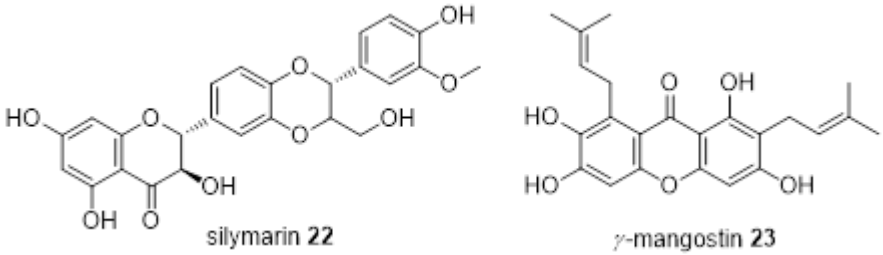

Figure 11. Molecular structures of a standard hepatoprotective agent, silymarin **22** and xanthon from *G. mangostana*, *γ*-mangostin **23.**

Despite *C. clematidea* herbs being commonly prescribed by the Dukuns to treat stomach discomfort, there are no reports regarding its phytochemistry and pharmacological activity. In fact, the species is unique to the Tengger community with no reports of the species being used in other communities in the archipelago of Indonesia. No previous studies were reported on *D. arguta* in which its fruit was prepared to treat diarrhea. Interestingly, medicinal knowledge of *E. longifolius* in treating diarrhoea was also unique to the dukuns in Tengger. Nevertheless, other species in the same genus such as *Elaeocarpus ganitrus* Roxb., *Elaeocarpus grandiflora* J. E. Smith, and *Elaeocarpus floribunda* Blume were reported in Sumatra and Java Islands with arrays of traditional uses including toothache, syphilis, helminthiasis and fever (Eisai Indonesia 1986). However, previous investigations on the pharmacological evaluation related to diarrhea alleviation are unavailable. These gaps suggest the need for further research on *C. clematidea, D. arguta,* and *E. longifolius* are necessary.

Conclusion

The practice of blessings plays an important role in the health care of the investigated communities, even in the…

The Indonesian healthcare system is complex and evolving. While modern healthcare services have made significant progress in the quality of care and distribution of healthcare facilities, traditional medicine is also gaining popularity. The government has put policy in place to improve the quality of traditional medicines in order to pave ways for its integration with the mainstream modern health system. However, there is a need to first improve the quality, safety and efficacy of traditional medicines and the best way to achieve this is to document their traditional knowledge and botanically identify medicinal plants. Our botanical identification survey revealed the Tengger *dukuns* practiced both spiritual and physical medication using medicinal plants and animals. This study documented 41 medicinal plants representing 23 families to treat 17 ailments. There were seven most cited medicinal plants, including *A. graveolens, C. clematidea, D. arguta., E. longifolius, G. mangostana, R. allegheniensis, T. tenuifolia*. Tengger knowledge on *Apium graveolens* as an anti-hypertension medicament, *T. tenuifolia* as nasal bleeding pack, *R. allegheniensis* as antinociceptive in severe diarrhoea and *G. mangostana* as hepatoproptective agent in abdominal complaints were scientifically justified. However, *D. arguta*, *C. clematidea* and *E. longifolius* were unique to Tengger with no previous reports on its phytochemical and biological activities. Although Tengger culture evolved from the Southeast Asian dominant Hindu Kingdom, the medicinal plants of Tengger are unlikely to be a direct derivation from Indian Ayurvedic medicine. Overall, we found that Tengger is rich in medicinal plants diversity with some scientifically investigated but many are not. Future work should focus on providing scientific justification for current practices especially medicinal plants that were never explored for phytochemical contents and pharmacological properties.

Declarations

List of Tengger terms: dukun adat or dukun pandhita: spiritual leaders, dukun alit: healers (usually use medicinal plants, animal products, or minerals), dukun tirta: healers (usually use chanting and water as media), dukun bayi: healers whose tasks are related to maternal and child health, especially in helping labour, Brahma: the creator God in Hinduism, Karo: A Hindu ceremony held by the people of Tengger to thank God for blessing food

Ethics approval and consent to participate: See under Methods. All participants provided oral prior informed consent.

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