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Alstonia boonei De Wild. photo by Sylvain Piry

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The usage of "et al." in long author lists will also be accepted:

Smith J, Jones M Jr, Houghton L et al. 1999. Future of health insurance. N Engl J Med 965: 325-329. DOI: 10.10007/s002149800025.

Book:

Rai MK, Carpinella C. 2006. Naturally Occurring Bioactive Compounds. Elsevier, Amsterdam.

Chapter in the book:

Webb CO, Cannon CH, Davies SJ. 2008. Ecological organization, biogeography, and the phylogenetic structure of rainforest tree communities. In: Carson W, Schnitzer S (eds.). Tropical Forest Community Ecology. Wiley-Blackwell, New York.

Abstract:

Assaeed AM. 2007. Seed production and dispersal of *Rhazya stricta*. 50th annual symposium of the International Association for Vegetation Science, Swansea, UK, 23-27 July 2007.

Proceeding:

Alikodra HS. 2000. Biodiversity for development of local autonomous government. In: Setyawan AD, Sutarno (eds.). Toward Mount Lawu National Park; Proceeding of National Seminary and Workshop on Biodiversity Conservation to Protect and Save Germplasm in Java Island. Universitas Sebelas Maret, Surakarta, 17-20 July 2000. [Indonesian]

Thesis, Dissertation:

Sugiyarto. 2004. Soil Macro-invertebrates Diversity and Inter-Cropping Plants Productivity in Agroforestry System based on Sengon. [Dissertation]. Universitas Brawijaya, Malang. [Indonesian]

Information from the internet:

Balagadde FK, Song H, Ozaki J, Collins CH, Barnet M, Arnold FH, Quake SR, You L. 2008. A synthetic *Escherichia coli* predator-prey ecosystem. Mol Syst Biol 4: 187. DOI: 10.1038/msb.2008.24. www.molecularsystembiology.com.

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Perception of malaria and cultural diversity of antimalarial plants in three sympatric communities: Agni, Akyé and Gwa in the District of Alépé, Côte d'Ivoire

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Abstract. *Diop AL, Malan DF, Kougbo MD. 2022. Perception of malaria and cultural diversity of antimalarial plants in three sympatric communities: Agni, Akyé and Gwa in the District of Alépé, Côte d'Ivoire. Asian J Ethnobiol 5: 1-11.* Each ethnic group has developed its culture expressed through traditional healthcare systems. This study aimed to determine how the communities with different histories perceive and manage malaria, a disease with a high prevalence rate in the Sub-Saharan region. An ethnobotanical survey was carried out in 10 Agni, Akyé, and Gwa communities villages. Two surveys were conducted: a house-to-house survey based on free lists interviews and an individual walk-in-the-woods interview. Frequency of quotation and Smith's index was used to assess antimalarial plants' knowledge level. The Venn diagram, hierarchical clustering, and Spearman correlation test compared malaria perception and the antimalarial plants among the three communities. Six forms of malaria were recognized in the studied communities with various symptoms. Seventy-seven antimalarial plants were used to cure these forms. The proportion of antimalarial plants specific to each community was quite low. This study has revealed the differences and similarities between the antimalarial plants used by communities in the same geographical area. This study has also highlighted new plants in the study area that could treat malaria. Finally, awareness must be made in the studied communities on different forms of malaria for a better understanding of this disease.

Keywords: Alépé, *Alstonia boonei*, *Annickia polycarpa*, Côte d'Ivoire, malaria, medicinal plants

INTRODUCTION

Medicinal plants are one of the most well-known of traditional knowledge. They provide primary health care (De Boer et al. 2012; Mazengia et al. 2019; Nahdi and Kurniawan 2019; Rianawati and Siswadi 2020; Assefa et al. 2021). In addition, traditional medicine is an important source of health care in rural or tribal areas (Maroyi 2013; Farooq et al. 2019; Az-Zahra et al. 2021; Novriyanti et al. 2021). In Sub-Saharan countries such as Côte d'Ivoire (Bla et al. 2015; Kipré et al. 2017), Mali (Diarra et al. 2015), and Guinea (Traoré et al. 2013), rural communities depend basically on medicinal plants. Sometimes, they are combined with modern drugs to cure many diseases like malaria and typhoid fever (Asafo-Agyeitey et al. 2019).

Malaria is among the major vector-borne diseases that kill many communities in Sub-Saharan Africa (Youmsi et al. 2017). Over 300 million acute malaria cases are estimated to occur worldwide yearly, with about 1 million deaths (Asafo-Agyeitey et al. 2019). Approximately 90% of these deaths occur in Sub-Saharan Africa, and most victims are children less than five years old and pregnant women (GHO 2020). This disease constitutes a real public health issue. Malaria is the cause of many consultations and hospitalizations in health centers, hospitals, and clinics (Yetein et al. 2013). However, the high costs of sanitary care lead many rural areas to use traditional medicine as an alternative solution to curing malaria (Ngarivhume et al. 2015; Syahdar et al. 2019; Tamalene et al. 2021).

The perception of malaria is the mode of apprehending this disease according to empiric acquisitions of people. This perception is specific to a given ethnic group (Yaya et al. 2017). Culture is a shared system of knowledge and competence among humans (Gaoue et al. 2017). Thus, cultural diversity refers to the richness and relative abundance of species used in a particular group according to their cultural context and the disease (Jamera et al. 2020). Unfortunately, in West Africa, people transmitted their medicinal knowledge orally from one generation to another (Soelberg et al. 2015). Yet, the knowledge holders die before passing on their knowledge to the younger generations (Asafo-Agyeitey et al. 2019). Therefore, it is necessary to determine the importance of the antimalarial plants to provide new data.

Measuring the knowledge provides information about the level of consensus and the variation in medicinal plants used by the different communities through the same geographical area and distant but culturally similar communities (De Boer et al. 2012; Bhandary 2021). On the other hand, the differences and similarities in traditional knowledge among different cultural communities living in the same area can explain how cultural reflection evolved (Amjad et al. 2020). Unfortunately, comparative ethnobotanical studies among communities within the same area are rare. Nevertheless, such studies help find which

species are shared through communities and for which reasons (Hilgert and Gil 2007). Moreover, these studies analyze whether cultural diversity is reflected in folk phytotherapy knowledge (Kujawska et al. 2017).

The targeted study area communities have been in close contact for many centuries. The Agni and the Akyé communities belong to the great Akan ethnic group (Kossonou and Assanvo 2016). In comparison, the Gwa communities were adopted in the great Akan ethnic group (Goly 2010; Aka 2011). Moreover, these communities live in the endemic zone of malaria. For instance, more than 300 confirmed cases per 1,000 inhabitants annually were observed (GHO 2020). In this context, there is a need to have a database to complete the existing antimalarial plants and to determine the perception of malaria in the local medicinal system for better awareness of this disease. To our knowledge, no study has been conducted on botanical knowledge about malaria in these communities. Based on the principle that any plant usage is a cultural expression, we assume that the communities of different origins living in the same geographical area would have different perceptions of malaria and use different plants to cure it. However, we assume that their long proximity allows them to share knowledge about this disease. Therefore, this study aims to determine (i) the perception of malaria through the communities and (ii) the similarity of antimalarial plants and the knowledge surrounding them.

MATERIALS AND METHODS

Study area

An explorative study was conducted in the Southeastern part of Côte d'Ivoire (West Africa), in the Region of La Mé. This region was subdivided into four districts, i.e., Adzopé, Akoupé, Alépé, and Yakassé-Attobrou. The district of Alépé where this research took place is located between 5°13'04.49"-5°55'22.06" N and 3°25'25.25"-3°57'46.64" W (Figure 1). The district's climate is equatorial and humid, characterized by four alternative seasons (two rainy and two dry seasons). The annual rainfall ranges from 1,200 to 1,600 mm, and the annual temperature is 26.4°C. The vegetation of the study area is a Guinean rainforest characterized by *Eremospatha macrocarpa* (G.Mann and Wendl) Wendl and *Diospyros mannii* Hiern (Guillaumet and Adjanohoun 1971).

The study area harbors three sympatric communities: Agni, Akyé, and Gwa. They are unequally spread within five sub-prefectures, i.e., Aboisso-Comoé, Alépé, Allosso, Danguira, and Oghlwapo. These three communities have been settled in their present territory since the beginning of the 18th century, the Agni and the Akyé from actual Ghana (Allou and Gonnin 2006; Diabaté 2013), and the Gwa from Liberia (Goly 2010; Aka 2011). These communities conquer their current geographical area (Bamba et al. 1989). All three communities are essentially farmers.

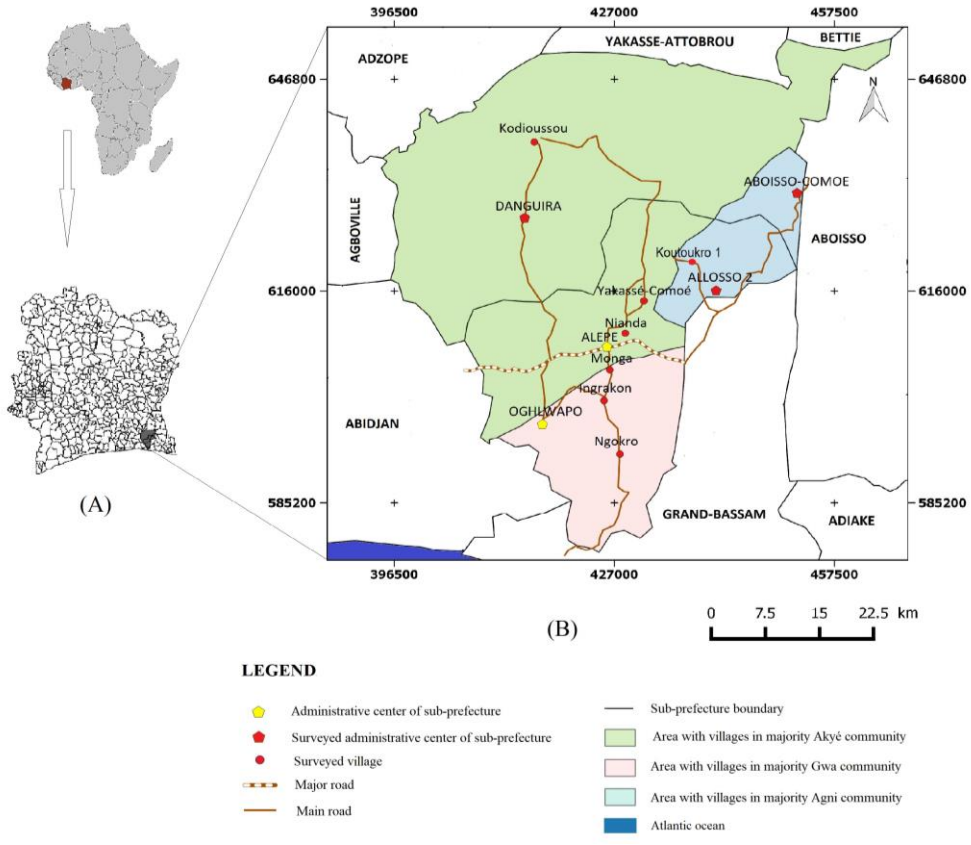

Figure 1. Location of the studied communities: A. Location of the study area in Côte d'Ivoire; B. Location of villages sampled in the study area

Data collection

Ten villages were surveyed (three villages in the Agni community, four in the Akyé community, and three in the Gwa community). The ten villages were visited in 13 trips from September 2017 to August 2019. The survey was carried out in two steps. First, during the survey, we followed the recommendations of the international codes of ethics (ISE 2006).

Step 1. During the house-to-house approach, men and women were interviewed randomly, individually, or collectively (Quinlan 2005). Questions were asked to collect information on the forms, symptoms, and plants to cure malaria. At the end of the interview, we asked for demographic information, including the spouse's marital status and ethnic group.

Step 2. From the previous list of interviewees, eight key knowledge holders were selected (two in the Agni community, two in the Akyé community, and four in the Gwa community) based on the high number of antimalarial plants they mentioned. For this step, knowledge holders were interviewed during a walk-in-the-wood approach in the surrounding bushes (Phillips and Gentry 1993). During these walks, herbarium vouchers of listed plants were collected for identification at the laboratory of Botany of NANGUI ABROGOUA University and were confirmed in the Herbarium of the Floristic National Center.

Data analysis

Distribution of the forms of malaria through the communities

Hierarchical clustering (Weller 2005) was performed using different packages, including *FactoMineR* for data analysis and *factoextra* to visualize the analysis. Hierarchical clustering shows the distribution of the forms of malaria and the antimalarial plants used through the targeted communities.

Similarity of plants used to heal malaria

Jaccard similarity Index (Jaccard 1908) was performed to determine the similarity of antimalarial plants used by the three studied communities. It ranges from 0% to 100% (maximum similarity). In addition, a Venn diagram was plotted to show shared and different species across studied communities. This diagram was obtained using the *Venn diagram* package (Chen and Boutros 2011).

Knowledge level of antimalarial plant and distribution of knowledge in the studied communities

Smith's index (Sutrop 2001) was performed using Anthropac 4.0 to obtain the knowledge level of each antimalarial plant. It is based on cognitive salience (Sa) and the frequency of quotation (Fq). The cognitive salience ranges from 0 (low cognitive salience) to 1 (high cognitive salience). In comparison, the frequency of quotations ranges from 0% to 100%.

Then, the Kruskal-Wallis test was used to compare the antimalarial plants shared through the three studied communities (Kruskal and Wallis 1952). This test determines the intercultural convergence about the antimalarial plants, which are shared through the targeted communities. Finally, the Spearman coefficient was used to test the correlation between gender and the knowledge of antimalarial plants. All statistical analyses were performed with R Studio software (version 4.0.3).

Finally, the fidelity level (FL) index (Friedman et al. 1986) was performed to identify the preferred plants to heal various forms of malaria and to show the proportion of interviewees reporting the usage of specific plants.

RESULTS AND DISCUSSION

Demographic profile of informants

A total of 290 knowledge holders were surveyed. They were distributed among 97 knowledge holders in the Agni community (40 men and 57 women), 97 in the Akyé community (35 men and 62 women), and 96 in the Gwa community (40 men and 56 women). Of the knowledge holders surveyed, 60 (20.7%) were between 18 and 39 years, 161 (55.52%) knowledge holders were between 40 and 62 years, and 69 (23.79%) knowledge holders were between 63 and 87 years. Of the 290 people surveyed, 134 (46.21%) were single, 120 (41.38%) people were married in the same ethnic group, and 36 (12.41%) people were married in other ethnic groups (Table 1).

Perception of malaria according to studied communities

The three communities recognized different forms of malaria: six in each of the Akyé and the Gwa communities and five in the Agni community (Table 2). However, those forms' descriptions differed from one community to another (Table 3), even if Akyé and Gwa were the closest in terms of convergence of symptoms (Figure 2).

Abundance and intercultural relationship of the antimalarial plants

The survey revealed that there are antimalarial plants unique to each community. It also revealed that two communities shared the antimalarial plants. Finally, the survey indicated that the targeted communities shared the same antimalarial plants. 20 (25.97%) were shared with the three communities among the collected plants. Twelve plants were used respectively by the Agni and the Akyé communities, and 15 by the Gwa community (Figure 3). In total, the Agni community mentioned 43 antimalarial plants. In comparison, the Akyé community indicated 44 plants used for malaria care. Finally, the Gwa community identified 48 antimalarial plants.

Knowledge level of the antimalarial plants within each community

Seventy-seven plants used to cure malaria were collected and distributed in 71 genera and 38 families (Table 4). The most represented families were Lamiaceae, Asteraceae, and Fabaceae, with five plants per family. These antimalarial plants comprised 67 trees and shrubs, nine herbaceous plants, and one liana.

Of the 77 antimalarial plants used to heal malaria, only seven (9.09%) have high knowledge levels, including

Annickia polycarpa (DC.) Setten & Maas ex I.M.Turner [Agni (Sa=0.23; Fq=44.33%), Akyé (Sa=0.35; Fq=49.48%), Gwa (Sa=0.19; Fq=28.13%] (Figure 4A), *Gymnanthemum amygdalinum* (Delile) Sch.Bip [Agni (Sa=0.16; Fq=26.8%), Gwa (Sa=0.25; Fq=35.42%)], *Alstonia boonei* De Wild. [Agni (Sa=0.27; Fq=38.14%), Akyé (Sa=0.26; Fq=35.05%)] (Figure 4B), *Nauclea latifolia* Sm. [Agni (Sa=0.16; Fq=21.65%), Gwa (Sa=0.27; Fq=32.29%)], *Harungana madagascariensis* Lam. Ex. Poir. [Agni (Sa=0.17; Fq=28.87%)], *Ocimum gratissimum* L. [Agni (Sa=0.15; Fq=22.68%)], and *Senna occidentalis* (L.) Link [Agni (Sa=0.15; Fq=21.65%)]. In addition, this knowledge level differs from one community to another.

Table 1. Demographic profile of informants

		Age group				
Ethnic group	**Gender**	**[18;39]**	**[40;62]**	**[63;87]**	**No. of informant [n (%)]**	**Total number [n (%)]**
Agni	Men	10	28	2	40 (41.24)	97 (33.45)
	Women	10	37	10	57 (58.76)	
Akyé	Men	12	16	7	35 (12.07)	97 (33.45)
	Women	19	30	13	62 (21.38)	
Gwa	Men	4	19	17	40 (13.79)	96 (33.1)
	Women	5	31	20	56 (19.31)	
		60 (20.7)	161 (55.52)	69 (23.79)	290	

	Matrimonial status					
	Item	**No. of informant [n (%)]**	**Item**	**No. of informant [n (%)]**	**Item**	**Number of informant [n (%)]**
	Single Agni	45 (46.39)	single Akyé	49 (50.52)	single Gwa	40 (41.67)
	Agni married to Agni	48 (49.48)	Akyé married to Akyé	43 (44.33)	Gwa married to Gwa	29 (30.21)
	Agni married to Akyé	3 (3.09)	Akyé married to Agni	4 (4.12)	Gwa married to Agni	1 (1.04)
	Agni married to Gwa	1 (1.03)	Akyé married to Gwa	1 (1.03)	Gwa married to Akyé	26 (27.08)

Note: no: number

Table 1. The local name of malaria and its meanings according to the studied communities

Studied community	**Local name**	**Local perception**	**Literal meaning**
Agni	*Ebunu*	*Ebunu fufue, ebunu kokole, ebunu bile, ebunu ewengo, enwulo*	White malaria, yellow malaria, black malaria, red malaria, bird malaria
Akyé	*Shilo*	*Shilo fi, shilo nin, shilo bi, shilo poin, n'kaka, kpun shilo*	White malaria, yellow malaria, black malaria, red malaria, bird malaria, mystical malaria
Gwa	*Djakoadjo*	*Djakoadjo popon, djakoadjo heni, djakoadjo mlu, djakoadjo nuin, zoku, djakoadjo montinin*	White malaria, yellow malaria, black malaria, red malaria, bird malaria, mystical malaria

Table 3. Forms of malaria and related symptoms according to the studied communities

Form of malaria	**Symptoms of malaria according to community**	**Community (number of the quotation of the symptom)**
Yellow malaria	Yellowish eyes	Akyé (18), Gwa (18)
	Yellowish urine	Agni (3), Akyé (18), Gwa (18)
	Fever	Agni (2), Akyé (2)
White malaria	Pale skin	Agni (2), Akyé (10), Gwa (13)
	Edema	Agni (10), Akyé (9), Gwa (4)
Red malaria	Fever	Akyé (1), Gwa (11)
	Reddish eyes	Akyé (8), Gwa (20)
Black malaria	Fever	Agni (1), Akyé (1), Gwa (4)
	Dark skin	Agni (3), Akyé (3), Gwa (9)
Birds malaria	Disjointed movement	Agni (2), Akyé (2), Gwa (5)
	Fever	Agni (2)
	Pale skin	Agni (1), Gwa (1)
Mystical malaria	Unnatural weight loss, madness, sorcery	Akyé (2), Gwa (4)

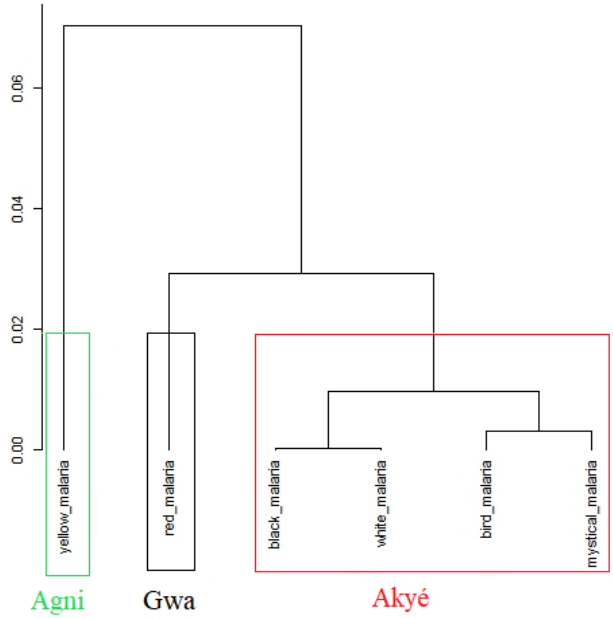

Figure 1. Distribution of the forms of malaria through studied communities

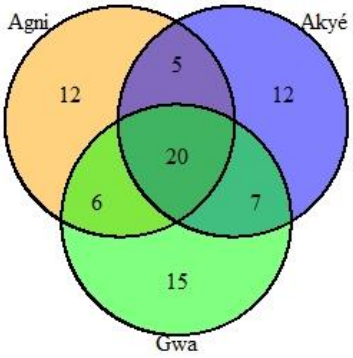

Figure 2. Number of exclusive and shared antimalarial plants among the studied communities

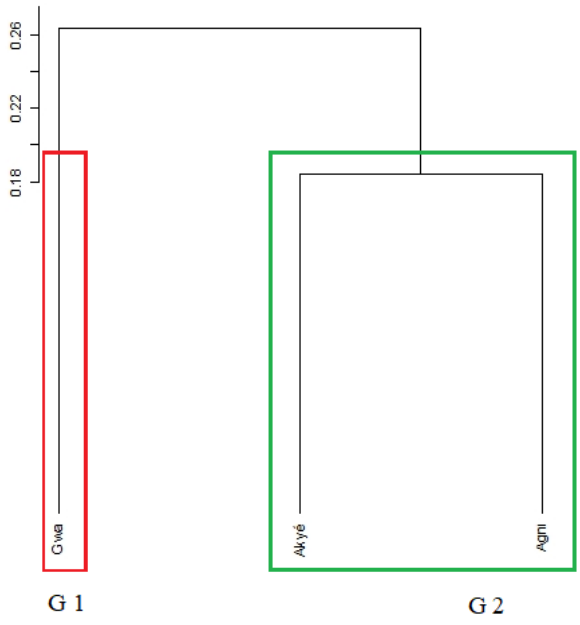

Figure 3. Hierarchical clustering of studied communities based on antimalarial plants

Distribution of knowledge

The distribution of the antimalarial plants subdivided the studied communities into two groups (Figure 5). The first (G1) is characterized by antimalarial plants used by the Gwa community. In addition, the second group (G2) includes antimalarial plants used by the Agni and the Akyé communities.

Similarity of antimalarial plants used in studied communities

The values of the Jaccard similarity index of the antimalarial plants were low in the three communities (Table 5).

Figure 4. Two antimalarial plants well-known by the studied communities: A. Bark pieces of *Annickia polycarpa* (DC.) Setten & Maas ex I.M.Turner collected by a key knowledge holder; B. Tree of *Alstonia boonei* De Wild.

Table 4. Knowledge level of antimalarial plants used by the studied communities

Family	Species	Agni		Akyé		Gwa		Local name (Agni, Akyé, Gwa)
		Fq (%)	Sa	Fq (%)	Sa	Fq (%)	Sa	
Acanthaceae	*Justicia tenella* (Nees) T.Anderson	-	-	-	-	1.04	0.01	-, nvêtza, nglonmpi
	Phaulopsis ciliata (Wild.) Hepper	-	-	2.08	0.02	-	-	-, ntobi, -
Alliaceae	*Allium sativum* L.	1.03	0.01	-	-	-	-	ail, -, -
Anacardiaceae	*Mangifera indica* L.	1.03	0.01	6.25	0.03	3.13	0.02	amango, mangoté, mongodé
	Spondias mombin L.	-	-	2.08	0.02	4.17	0.04	troman, mgba, maga
	Trichoscypha arborea (A.Chev.) A.Chev.	-	-	6.25	0.05	1.04	0.01	-, ndabo, namouhokoyé
Annonaceae	*Annickia polycarpa* (DC.) Setten & Maas ex I.M.Turner	44.33	0.23	49.48	0.35	28.13	0.19	essoubo-kokolè, tsin, poudin
	Monodora myristica (Gaertn.) Dunal	-	-	-	-	1.04	0.00	-, -, m'min
	Xylopia aethiopica (Dunal) A.Rich.	-	-	1.04	0.01	1.04	0.00	-, foutsan, nouébiho
Apocynaceae	*Alstonia boonei* De Wild.	38.14	0.27	35.05	0.26	17.71	0.10	émian, kokpè, obiayé
	Hunteria umbellata (K. Schum.) Hallier f.	2.06	0.01	-	-	-	-	kaklan, -, -
	Picralima nitida (Stapf) T.Durand and H. Durand	-	-	1.03	0.05	1.04	0.00	-, ndémouin, bichi
	Rauvolfia vomitoria Afzel.	14.43	0.09	10.42	0.09	7.29	0.05	bakakpégbé, nguéchébi, ngobiayé
Arecaceae	*Cocos nucifera* L.	-	-	-	-	7.29	0.03	-, -, ochibouo
Asteraceae	*Ageratum conyzoides* L.	-	-	-	-	11.46	0.01	-, -, mpi-souin
	Chromolaena odorata (L.) R.M.King and H. Rob.	5.21	0.05	1.04	0.01	-	-	independenci, poukèkè, -
	Gymnanthemum amygdalinum (Delile) Sch.Bip	26.80	0.16	19.79	0.11	35.42	0.25	aboyoui, tozo, mlipo
	Microglossa pyrifolia (Lam.) Kuntze	-	-	-	-	1.04	0.01	-, -, djon-nounou
	Struchium sparganophorum (L.) Kuntze	-	-	-	-	4.17	0.02	-, -, otchouon
Bignoniaceae	*Newbouldia laevis* (P.Beauv.) Seem. ex Bureau	-	-	-	-	2.08	0.02	-, -, ogoato
Bromeliaceae	*Ananas comosus* (L.) Merr.	-	-	1.04	0.00	2.08	0.01	-, akodin, ndrachi
Cannabaceae	*Trema orientalis* (L.) Blume	2.06	0.01	2.06	0.01	-	-	assia, anacha, -
Cannaceae	*Canna indica* L.	10.31	0.07	-	-	-	-	acounougbou, -, -
Caricaceae	*Carica papaya* L.	18.56	0.09	14.43	0.08	19.79	0.08	blèflè, mbomou, ablè
Combretaceae	*Terminalia catappa* L.	3.09	0.01	-	-	1.04	0.01	cocoma, -, cocoma
	Terminalia ivorensis A.Chev.	-	-	2.08	0.02	-	-	-, gnambi, -
	Terminalia superba Engl. and Diels	1.03	0.01	-	-	-	-	flamlé, -, -
Crassulaceae	*Kalanchoe crenata* (Andrews) Haw.	-	-	1.04	0.01	-	-	-, togbo, -
Cucurbitaceae	*Momordica charantia* L.	7.22	0.05	9.38	0.07	25	0.13	awossongo, atomomou, obiépon
Ebenaceae	*Diospyros sanza-minika* A.Chev.	-	-	-	-	1.04	0.01	-, -, bibliqué
Euphorbiaceae	*Alchornea cordifolia* (Schumach and Thonn.) Müll.Arg.	15.46	0.06	13.54	0.07	11.46	0.07	diéca, nzè, adjèguè
	Macaranga barteri Müll.Arg.	-	-	1.03	0.01	-	-	-, aboh, -
	Manihot esculenta Crantz	6.19	0.05	6.19	0.04	-	-	bèdè, mèdè, -
	Ricinodendron heudelotii (Baill.) Pierre ex Heckel	-	-	-	-	1.04	0.00	-, -, bobochi
Fabaceae	*Distemonanthus benthamianus* Baill.	2.06	0.01	5.15	0.03	-	-	éwrovia, -, adouanga
	Parkia bicolor A.Chev.	4.12	0.02	-	-	-	-	tominda, -, -
	Piliostigma thonningii (Schumach.) Milne-Redh.	-	-	1.03	0.01	-	-	-, kéoukégba, -
	Senna alata (L.) Roxb	-	-	-	-	4.17	0.04	-, -, mgbégbou
	Senna occidentalis (L.) Link	21.65	0.15	16.49	0.11	20.83	0.13	èkendébalouba, kangamonin, gongondjronmié

Hypericaceae	*Harungana madagascariensis* Lam. ex Poir.	28.87	0.17	14.43	0.10	6.25	0.05	cossoua, mgbouana, mgbamlin
	Vismia guineensis (L.) Choisy	6.19	0.04	-	-	-	-	babagamano, -, -
Irvingiaceae	*Irvingia gabonensis* (Aubry-Lecomte ex O'Rorke) Baill.	-	-	3.09	0.02	-	-	-, bé, -
Lamiaceae	*Hoslundia opposita* Vahl.	11.34	0.06	2.06	0.02	3.13	0.02	anoumaliè, anoumaliè, doupa-nounou
	Ocimum gratissimum L.	22.68	0.15	11.34	0.05	14.58	0.09	amagniné, pèhin, nounou
	Plectranthus monostachyus (P.Beauv.) B.J.Pollard	1.03	0.00	-	-	1.04	0.01	nzissiwololo, -, gbrolo
	Tectona grandis L.f.	11.34	0.05	1.03	0.01	3.13	0.02	teckgna, -, teck
	Vitex grandifolia Gürke	-	-	1.03	0.01	-	-	-, leubunh, -
Loganiaceae	*Anthocleista nobilis* G.Don	3.09	0.02	7.22	0.06	-	-	gblogblo, anougbé, -
Malvaceae	*Cola nitida* (Vent.) Schott and Endl.	-	-	-	-	4.17	0.03	-, -, opo
	Sida acuta Burm.f.	-	-	3.09	0.01	-	-	-, dzeugbontchou, -
	Tarrietia utilis (Sprague) Sprague	-	-	3.09	0.03	-	-	-, kpanda, -
	Theobroma cacao L.	2.06	0.01	-	-	-	-	coco, -, -
Meliaceae	*Azadirachta indica* A.Juss.	-	-	-	-	8.33	0.07	-, -, neem
	Khaya ivorensis A.Chev.	-	-	15.46	0.10	4.17	0.03	-, tzapeuchi, noucoumlin
Moringaceae	*Moringa oleifera* Lam.	-	-	-	-	2.08	0.00	-, -, moringa
Musaceae	*Musa x paradisiaca* L.	15.46	0.09	14.43	0.07	5.21	0.02	banan, domou, ngogo
Myrtaceae	*Psidium guajava* L.	-	-	3.09	0.03	1.04	0.01	-, adjama, alama
Ochnaceae	*Lophira alata* Banks ex C.F.Gaertn.	17.53	0.11	10.31	0.04	2.08	0.01	essolè, nonkpè, odoyé
Pandaceae	*Microdesmis keayana* J.Léonard	1.03	0.01	-	-	4.17	0.01	friman, -, adipion
Piperaceae	*Piper guineense* Schumach. and Thonn.	1.03	0.01	-	-	-	-	assian-sian, -, -
Poaceae	*Bambusa vulgaris* Schrad. ex J.C. Wendl.	5.15	0.03	-	-	14.58	0.11	camponi, -, bomblo
	Cymbopogon citratus (DC.) Stapf	2.06	0.02	1.03	0.01	1.04	0.01	tigna, nti,
	Saccharum officinarum L.	-	-	-	-	2.08	0.02	ahanlan, -, nglah
Rhizophoraceae	*Anopyxis klaineana* (Pierre) Engl.	-	-	-	-	1.04	0.00	-, -, ahoubin
Rubiaceae	*Mitragyna ledermannii* (K.Krause) Ridsdale	18.56	0.1	16.49	0.10	13.54	0.10	bèya, -, ogoayé
	Nauclea diderrichii (De Wild. and T.Durand) Merr.	22.68	0.11	-	-	1.04	0.01	bèdou, -, olémlédassin
	Nauclea latifolia Sm.	21.65	0.16	3.09	0.02	32.29	0.27	essoubo, mouleu, odoukwè
Rutaceae	*Citrus aurantiifolia* (Christm.) Swingle	5.15	0.04	3.09	0.02	18.75	0.09	doumouan, ndédé-tintin, mgbébié sacoba
	Citrus aurantium L.	8.25	0.07	4.12	0.01	1.04	0.01	ébolo-domouan, ndékichi, gué-gué
	Zanthoxylum gilletii (De Wild.) P.G.Waterman	1.03	0.01	-	-	-	-	édimoulalè, -, -
Sapindaceae	*Blighia unijugata* Baker	-	-	3.09	0.02	-	-	-, inkaka, -
	Paullinia pinnata L.	4.12	0.04	-	-	-	-	trondi,-,-
Solanaceae	*Physalis angulata* L.	-	-	1.03	0.01	-	-	-, ntototé, -
	Solanum nigrum L.	-	-	3.09	0.02	-	-	-, foué, -
Urticaceae	*Musanga cecropioides* R.Br.	3.09	0.02	-	-	6.25	0.03	édjui, -, m'moyé
	Myrianthus arboreus P.Beauv.	4.12	0.03	-	-	-	-	niangama, -, -
Zingiberaceae	*Aframomum melegueta* (Roscoe) K.Schum.	1.03	0.01	-	-	-	-	essa, -, -

Table 2. Matrix of the similarity of the antimalarial plants

	Agni	Akyé
Akyé	40.3	x
Gwa	40.00	41.5

Note: x: no value

Indeed, the Gwa community was close to the Akyé community geographically, and they married each other. The Kruskal-Wallis test revealed no significant difference (Chi squared= 3.27; p-value= 0.2) in the antimalarial plants shared by the studied communities. However, the Spearman test indicates women's better knowledge of antimalarial plants (S= 24774; p-value= 3.4 10-10; rho= 0.64).

Fidelity level of the antimalarial plants

The fidelity level values were less than 40%, suggesting that none of the antimalarial plants is specific to a particular form of malaria (Table 6). However, the mystical form of malaria is treated only by an animist priest with incantations and substances made with plants which the composition is secretly kept.

Discussion

Perception of malaria according to the studied communities

Different local names were used to refer to the forms of malaria. This difference in perception of malaria is generally transmitted orally in our study area. In Africa, several studies have also shown that the communities distinguished different forms of malaria according to the cultural context. For instance, in Mali, the communities of Sélingué sub-districts recognized five forms of malaria (Diarra et al. 2015), while in Zimbabwe, only two forms were distinguished by traditional healers in the Chipinge District (Ngarivhume et al. 2015). Generally, traditional medicine is a part of people's culture and closely linked to their beliefs which often go beyond explicable realities. Thus, two communities in our study area mentioned a mystical form of malaria with no clear symptoms, such as unnatural weight loss, madness, or sorcery. Indeed, people combine religion, sorcery, and interpersonal conflict into a single form of belief and practice (Gessler et al. 1995). For example, the Amazonian communities of Upper Rio Negro of Brazil associated malaria with spiritual beings and used it to cure the incantations of shamans (Kffuri et al. 2016). However, there are differences among the studied communities regarding forms of malaria and antimalarial plants. That may indicate each community has its way of including the forms of malaria. Furthermore, each community also has a specific inclusion of antimalarial plants. These results could be explained by the fact that the communities have independently explored the environment in search of plants and remedies, as observed in Argentina (Hilgert and Gil 2007).

Abundance and intercultural relationship of the antimalarial plants

Traditional knowledge of the antimalarial plants was widespread in the communities, probably due to the high malaria incidence in our study area. Also, the high costs of sanitary care were noted in some Brazilian rural communities (Kffuri et al. 2016). However, despite this widespread knowledge, the Jaccard similarity index values on antimalarial plants were under 50%. That suggests the knowledge about antimalarial plants is not strongly shared among the communities. Concerning medicinal plants in general, ancestral knowledge is transmitted secretly and vertically from one generation to another or horizontally by sharing knowledge through friendship (Yetein et al. 2013).

Thus, the studied communities share only a few antimalarial plants. This result could be explained by the availability of antimalarial plants in their environment. This result could also be explained by the fact that the community could ignore the antimalarial plants, even though plants are available in their environment. In contrast, Kujawska et al. (2017) observed a high variation in the medicinal plants used by Subtropics communities in Argentina. According to Kujawska et al. (2017), the Guarani, Criollos, and Polish communities have different knowledge of the number of plants per community and plants culturally important. This difference could be explained because the variation of knowledge in communities sharing the same environment depends on cultural background. It can be assumed from the present study that most of the knowledge about malaria is passed down from ancestors.

Table 3. Fidelity level of the antimalarial plants preferred in the study area

Species	FL (%)				
	White Malaria	**Yellow Malaria**	**Black Malaria**	**Bird Malaria**	**Red Malaria**
Alstonia boonei De Wild.	30.14	30.82	26.42	-	23.89
Annickia polycarpa (DC.) Setten and Maas	30.82	38.99	22.64	-	29.2
Carica papaya L.	23.29	16.98	26.42	-	-
Distemonanthus benthamianus Baill.	-	-	-	37.5	-
Gymnanthemum amygdalinum (Delile) Sch.Bip	36.3	21.38	32.08	25	30.97
Momordica charantia L.	19.86	10.69	22.64	-	12.39
Musa x paradisiaca L.	-	-	-	37.5	-
Nauclea latifolia Sm.	-	18.87	-	-	22.12

Note: FL: fidelity level of the antimalarial plant; -: species not mentioned

In addition, the geographical proximity of ethnic groups can influence the local culture in the usage of antimalarial plants. That is also through intercultural marriage and friendship (Teka et al. 2020). For example, in our study, interethnic marriages between the Akyé and the Gwa communities could explain the proximity of knowledge on antimalarial plants. In a similar case, in Pakistan, the communities of Dhirkot, Azad Jammu, and Kashmir, which share the same vegetation, have shared the same knowledge of medicinal plants (Amjad et al. 2020).

In our study, the intercultural relationship between the best-known antimalarial plants was not significantly different. The plants were usually shared and strongly used in the daily life of the studied communities. However, the extent of the knowledge about the antimalarial plants according to the fidelity level was heterogeneous. That indicated no consensus about antimalarial plants used to treat a particular form of malaria. On the contrary, in Benin, different rural communities on the plateau of the Allada use the same plants to treat malaria (Yetein et al. 2013). Also, according to Yetein et al. (2013), many species had the highest fidelity level (FL= 100%) and constituted the most favorite in treating malaria. This difference could be explained by the fact that there is no knowledge sharing on malaria among the studied communities.

Knowledge level of the antimalarial plants and distribution of knowledge

The results highlighted the unequal importance of antimalarial plant species within the studied communities. As mentioned by some authors (Maffi 2005; Menendez-Baceta et al. 2015), the usage of plants depends on the culture. In addition, the doctrine of signatures (Gaoue et al. 2017) has been used to understand the medicinal plant selection process in traditional cultures. Moreover, the organoleptic properties (bitter taste of bark stems and leaves or yellow color of the bark stems and the shape of plant organs) indicate that a given plant has medicinal potential and a therapeutic application (Leonti et al. 2002; Malan et al. 2015). Most salient antimalarial plants had already been mentioned in literature for their antiplasmodial activities (Zihiri et al. 2005; Atindehou et al. 2007; Iwalena et al. 2008; Omoregie et al. 2011; Kayembe et al. 2012). Nevertheless, the antimalarial activities of some plants quoted by the studied communities, including *Blighia unijugata*, *Diospyros sanza-minika*, *Cola nitida*, *Macaranga barteri*, *Parkia bicolor*, *Plectranthus monostachyus*, *Tarrietia utilis*, and *Vitex grandifolia*, are known to cure pains, fever, and anemia (Bouquet and Debray 1974). These plants are frequently associated with the symptoms of malaria.

African traditional medicine has gained renewed interest in health care services throughout the continent. That could probably be due to the increasing awareness of alternative medicine's potential and curative abilities, especially from the usage of antimalarial plants (Lifongo et al. 2014), as well as the difficult access to western medicine and the high cost of modern drugs. However, the distribution of knowledge about antimalarial plants varies considerably between men and women. Indeed, women have a better knowledge of antimalarial plants than men. This result could be explained by the fact that in the study area, women have the charge of the medicinal side of the household, using knowledge about malaria acquired from their parents. Furthermore, Deressa and Ali (2009), in the south-central district of Ethiopia, reported that women have a higher general knowledge of malaria, such as symptoms and treatment, than men. In addition, understanding the influence of gender in the management of malaria depends on several factors, including perception and gender (Lifongo et al. 2014). Therefore, considering the perception and gender in evaluating the knowledge level of malaria could enable a better response to malaria prevention.

In conclusion, this study has highlighted new findings in the area: *B. unijugata*, *D. sanza-minika*, *C. nitida*, *M. barteri*, *P. bicolor*, *P. monostachyus*, *T. utilis*, and *V. grandifolia*, which could be used to treat malaria. However, an awareness of local communities about the perception of malaria must be done to understand malaria symptoms and its treatment better. Furthermore, despite their different migratory histories, this study has revealed the differences and similarities between the antimalarial plants used by communities in the same geographical area.

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Perception and application of zootherapy for the management of cattle diseases occurred in northern laterite region of West Bengal, India

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Abstract. *Mandal SK, Rahaman CH. 2022. Perception and application of zootherapy for the management of cattle diseases occurred in the northern laterite region of West Bengal, India. Asian J Ethnobiol 5: 12-19.* The present study aims to invent the glory of traditional knowledge about zootherapy for livestock diseases in the northern laterite region of West Bengal, India. Semi-structured and open interviews were taken for data collection. Data were analyzed with statistical indices like use mention factor (UM) and use value index (UV). A total of 21 zoological specimens have been recorded. Mammals are the most common species (8) used in this region for livestock health care. In 57% of cases, endo & exoskeletal structures like bone, feather, horn, scale, shell, beak, teeth, etc., are used as ethnoveterinary medicine. Four species have been identified as the most frequently used species in the region *Coracias benghalensis* (Linnaeus, 1758) (UM=16; UV=0.12), *Herpestes javanicus palustris* (Ghose, 1965) (UM=12; UV=0.09), *Varanus bengalensis* (Daudin, 1802) (UM=11; UV=0.08) and *Lamellidens marginalis* (Lamarck, 1819) (UM=11; UV=0.08). Among the recorded species, more than 50% are enlisted in the IUCN Red List. The present study provides baseline information regarding the depth of ethnozoological knowledge and its current status in the studied area. It will further help frame conservation strategies for the medicinally important and threatened animal species.

Keywords: Conservation facets, livestock disease, new observations, quantitative ethnozoology, zootherapy

INTRODUCTION

The uses of animals as alternative therapeutic agents are ancient practices and have been considered an important constituent of traditional medicine (Alves and Souto 2015). In searching for alternative therapeutic resources, studies on ethnozoology contribute a lot worldwide. It also helps in decision-making regarding the exploitation and management of the local fauna. Numbers of wild and domesticated animals, their different body parts, and byproducts have been used as effective ingredients in another system of traditional medicine and Ethnomedicine (Still 2003; Mahawar and Jaroli 2008; Khan 2012). Indigenous tribes reside in different parts of the world with enormous knowledge about edible and medicinal animals (Alves et al. 2007; Lohani 2011; Martinez 2013; Belay 2015; Hussain and Tynsong 2020). For the treatment of veterinary diseases, the use of zootherapy has been chiefly recorded from Brazil (South America) and a few from Nigeria (Africa), Spain, and Italy (Europe) (Antoine-Moussiaux et al. 2007; Barboza et al. 2007; Confessor et al. 2009; Souto et al. 2011a; Souto et al. 2012; Piluzza et al. 2015; González et al. 2016).

Ethnozoological studies in India were first initiated in 1982 with the formation of AICRPE (All India Coordinated Research Project on Ethnobiology). Later on, many ethnobiologist showed interest in documenting the zootherapeutic knowledge of different ethnic groups in India (Jaroli et al. 2010; Chakravorty et al. 2011; Chellappandian et al. 2014; Chaudhury et al. 2016; Pongener et al. 2019).

Most of the ethnoveterinary survey in India focuses on the documentation of medicinal plants, and zootherapy remains neglected except in a few where animal-derived ethnomedicines are also documented along with the plant remedies (Galav et al. 2013; Mandal and Rahaman 2014).

As per our knowledge, from India, no such publication has been made exclusively on zootherapy for livestock diseases. In this context, the present study has been designed to invent the glory of traditional knowledge about zootherapy for livestock diseases practiced in India.

MATERIALS AND METHODS

Data collection

Regular field surveys were conducted from 2014-2018 in 21 blocks of the Birbhum and Burdwan districts which mainly constitute the northern laterite region of West Bengal, one of the culturally enriched states in eastern India (Figure 1).

A total of 132 informants were interviewed for data collection after visiting the remote and tribal-dominated villages. Before collecting the data, Prior Informed Consent (PIC) was taken verbally from each informant as the PIC safeguards the knowledge providers' Intellectual Property Rights (IPR). Then, interviews of the informants were performed with the help of semi-structured and open-ended questionnaires (Martin 1995; Thomas et al. 2007). Information on the animals' local and/or tribal names, their parts used, mode of remedy preparation, administration, etc., was recorded in detail.

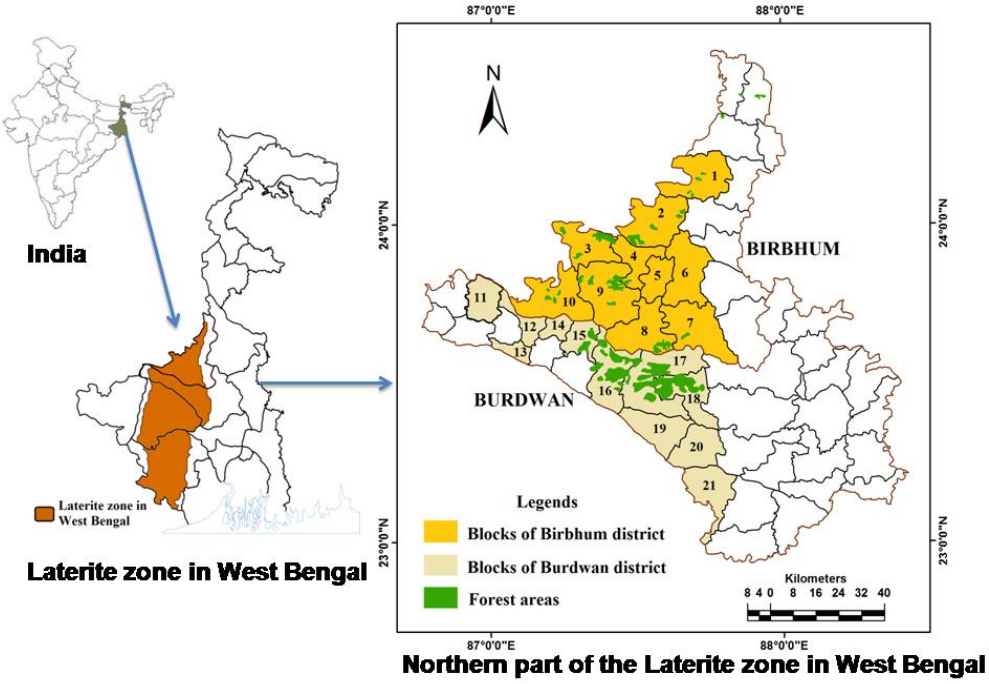

Figure 1. The study area covers 21 blocks of the northern laterite zone (West Bengal, India)

Identification of the zoological specimen

Collected zoological specimens were identified with the help of standard literature and specialists through examination of voucher specimens and photographs of the animal species or their parts taken during interviews (Tikader 1983; Ali 1996; Prater 1996). Whenever necessary, these procedures were supplemented by checking vernacular names provided by the healers against the scientific names.

Data analysis

Qualitative analysis

Recorded information on the local/ tribal name of the animals, updated scientific name and family, their parts used, mode of preparation of the remedies, and administration were tabulated scientifically.

Quantitative analysis

Two suitable statistical indices were employed to quantify the recorded zootherapeutic knowledge regarding their value, reliability, and importance to the ethnic communities in the study area.

Use value (UV). This index is a popular quantitative tool that helps measure a species' usefulness. The formula is -UV= ΣU/n**,** where U is the number of use-reports cited by each informant for a given species and n refers to the total number of informants. Use values are high when there are many useful reports for a species, implying that the animal is important. Conversely, the value approaches zero when there are few reports of uses of a particular species (Phillips et al. 1994).

The use mentions factor (UM). The UM is defined as the number of mentions for one species given by all informants for a specific health condition (Andrade-Cetto and Heinrich 2011).

RESULTS AND DISCUSSION

In the present investigation, 21 zoological specimens have been recorded as ethnoveterinary medicine in West Bengal, India's northern part of the laterite zone. That is the first report from West Bengal in India exclusively on zootherapy employed for livestock disease management. All the recorded species are listed alphabetically, providing their scientific name, common English name, local/tribal name, parts used, disease treated, and status in the International Union for Conservation of Nature (IUCN) Red List (Table 1).

In 21 cases, local people of the study area use recorded species singly or in combination with medicinal herbs as therapeutic agents (Table 2). So, using animal species along with medicinal plants is a good example of combined therapy for livestock diseases (Bullitta et al. 2018). Such knowledge in the studied area highlights the richness of knowledge diversity regarding using local flora and fauna, which may substitute one ingredient with another when certain medicinal resources are unavailable.

Most of the 21 recorded animal species belong to the vertebrate group (17 species). Only four species are of the invertebrate group (Figure 2). Mammals are the most common species (8) used in this region for livestock health care. In some other ethnozoological explorations in India, it has been found that mammals are the most commonly used species (Kakati et al. 2006; Mahawar and Jaroli 2008).

In most cases, it has been found that remedies are applied topically (9 times) in the form of poultice, massage oil, etc. In 5 cases, an oral application has been recorded. Moreover, quite a large number of animals (7 cases) are attached to magico-religious beliefs.

Generally, to prepare animal-based medicine, animal use as a whole, its parts, metabolic byproducts, and sometimes ingredients like building materials of nests, the soil of burrowing animals' holes, etc., are very common (Costa-Neto 2005). Here it has been found that in 57% of cases, endo- & exoskeletal structures like bone, feather, horn, scale, shell, beak, teeth, etc., are used as ethnoveterinary medicine followed by body fat (19%), fecal matter (5%), honey (5%), naval chord (5%) and whole-body (5%) (Figures 3 and 4).

Table 1. Ethnomedicinally import animal species recorded from the laterite region of West Bengal, India (n=21)

Common English name, (local name)	Scientific name of the recorded animal species	Parts used	Disease/illness treated	UM & (UV)	IUCN status
Indian hive bee (*Mou-machhi, Dumur*)	*Apis cerana indica* (Fabricius, 1798)	Honey	Foot and mouth disease (FMD)	4 (0.03)	-
Spotted deer (*Harin, Jil*)	*Axis axis* (Erxleben, 1777)	Horn/ Antlers	Headache	5 (0.04)	LC
Cow (*Garu, Dangra*)	*Bos Taurus indicus* (Linnaeus, 1758)	Fecal matter	Body sore due to poisoning	2 (0.02)	-
Crab (*Behula Kankra, Dhiri Katkom*)	*Cancer pagurus* (Linnaeus, 1758)	Front appendage	Sore between hooves	3 (0.02)	-
Dog (*Kukur, Sita*)	*Canis familiaris* (Linnaeus, 1758)	Skull	Retention of milk due to evil effect	4 (0.03)	LC
Goat (*Chhagol, Merom*)	*Capra hircus* (Linnaeus, 1758)	Fecal matter	Rheumatic pain	3 (0.02)	-
Clown knife fish (*Chital haku*)	*Chitala chitala* (Hamilton, 1822)	Scale	Loosened teeth	2 (0.02)	NT
Blue jay (*Nilkantha*)	*Coracias benghalensis* (Linnaeus, 1758)	Feather	Diarrhoea	16 (0.12)	LC
Short-nosed fruit bat (*Chamchiki, Bhaulo*)	*Cynopterus sphinx* (Vahl, 1797)	Skull & wing bone	Illness due to evil effect	7 (0.05)	LC
Russell's viper (*Chandrabora, Bing*)	*Daboia russelii* (Shaw and Nodder, 1797)	Body fat	Stiffness of shoulder	9 (0.07)	-
Indian green frog (*Jar-Baang, Badhe*)	*Euphlyctis hexadactylus* (Lesson, 1834)	Body fat	Stiffness of vein	9 (0.07)	LC
Vulture (*Shakun, Gidi*)	*Gyps bengalensis* (Gmelin, 1788)	Bone	Fever	6 (0.05)	CR
White-breasted kingfisher (*Machh-ranga, Kikir*)	*Halcyon smyrnensis* (Linnaeus, 1758)	Skull & beak	Breathing trouble	5 (0.04)	LC
Bengal mongoose (*Beji, Chemench*)	*Herpestes javanicus palustris* (Ghose, 1965)	Naval chord	Spleen enlargement	12 (0.09)	LC
Freshwater mussel (*Jhinuk*)	*Lamellidens marginalis* (Lamarck, 1819)	Shell	Fresh wound	11 (0.08)	LC
Turtle (*Kachhop, Kachhim, Hara*)	*Lissemys punctata punctata* (Bonnaterre, 1789)	Shell	To combat evil spirit	4 (0.03)	-
Bear (*Bhaluk, Bana*)	*Melursus ursinus* (Shaw, 1791)	Teeth	Fever	4 (0.03)	VU
Indian earth-worm (*Kencho, Lendet*)	*Metaphire posthuma* (Vaillant, 1868)	Whole body	Fever	5 (0.04)	-
Long-whiskered catfish (*Aar machh*)	*Sperata aor* (Hamilton, 1822)	Parietal bone	Body ache	2 (0.02)	LC
Pig (*Shukar, Shukri*)	*Sus scrofa domesticus* (Erxleben, 1777)	Body fat	Stiffness of shoulder	9 (0.07)	-
Bengal monitor (*Gosap, Sonagoda*)	*Varanus bengalensis* (Daudin, 1802)	Body fat	Rheumatic pain	11 (0.08)	LC

Note: UM & (UV): Use Mention & (Use Value), LC: Least Concern, NT: Near Threatened, VU: Vulnerable, CR: Critically Endangered

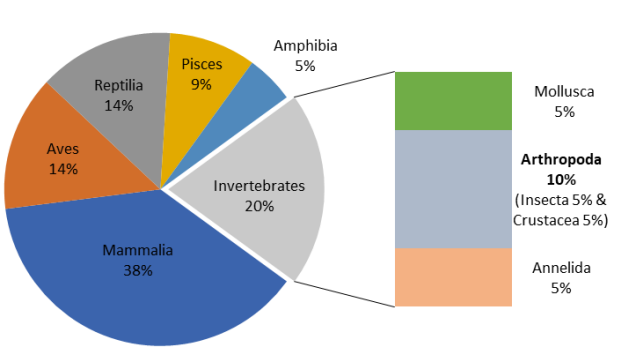

Figure 2. Distribution proportion of the recorded specie in the different animal classes

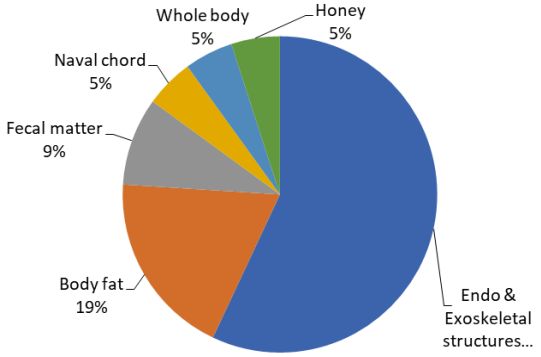

Figure 3. Percentage composition of animal body parts used in zootherapy

Figure 4. The zoological specimen used in/as ethnoveterinary medicine: A. Hunted Blue jay (*Coracias bengalensis*), B. Skull & beak of Kingfisher (*Halcyon smyrnensis*), C. Bone of vulture (*Gyps bengalensis*), D. Skull & wing bone of Fruit bat (*Cynopterus sphinx*), E. Antler of Spotted deer (*Axis axis*), F. Indian green frog (*Euphlyctis hexadactylus*), G. Nail of Fruit bat, H. Parietal bone of Long-whiskered catfish (*Sperata aor*), I. Naval chord of Bengal mongoose (*Herpestes javanicus palustris*), J. Teeth of Bear (*Melursus ursinus*), K. Front appendage of Crab (*Cancer pagurus*), L. Body fat of Bengal monitor (*Varanus bengalensis*), M. Body fat of Pig (*Sus scrofa domesticus*), N. Body fat of Russell's viper (*Daboia russelii*), O. Honey

Moreover, using the body fat of 4 animals like *Euphlyctis hexadactylus* (Lesson, 1834), *Daboia russelii* (Shaw and Nodder, 1797), *Sus scrofa domesticus* (Erxleben, 1777) and *Varanus bengalensis* (Daudin, 1802) were recorded from the study area. Those methods are administered to treat skeleton-muscular disorders such as stiffness of the shoulder, lameness of hind leg, rheumatoid arthritis, and body ache. Here, the fat of the same therapeutic value is derived from four animals, indicating its alternative sources. Thus, therapeutic practices associated with it would not be hampered when any of those four animals are unavailable. Using animal fat for various therapeutic purposes is a very common practice in ethnic communities worldwide (Souto et al. 2011b). The therapeutic use of animal fat for skeleton-muscular disorders has been scientifically proven through several studies for its anti-inflammatory potentiality (Yoganathan et al. 2003; Falodun et al. 2008; Ferreira et al. 2010; Buthelezi et al. 2012; Ferreira et al. 2014). In a recent study, Green-anaconda fat (*Eunectes murinus* Linnaeus, 1758) showed significant anti-inflammatory efficacy (Abrão et al. 2021). So, folk use of body fat of four animal species recorded here for the skeleton-muscular problems is very much justified as most of the disorders related to the skeleton-muscular system of veterinary animals are the pathophysiological manifestations of different inflammatory conditions. Animal fats sourced from the four species need further research for their chemical and biological activity studies.

Foot and mouth disease (FMD) is a contagious viral disease that seriously affects livestock health throughout the country. Here for the treatment of FMD, at least ten years old honey is given along with a medicinal herb *Andrographis paniculata* (Burm.fil.) Nees. The earlier investigations show that both components have antiviral potential (Pongtuluran and Rofaani 2015; Shahzad and Cohrs 2012). In addition, the traditional use of honey in medicine provides extra benefits as it acts as '*Yogavahi*' or helps absorb active molecules in the body system (Singh et al. 2016).

Multiple uses of antlers of deer have already proved their effectiveness. Here in this study, the use of deer antlers in the severe headache of bullock supports the earlier report of using it in case of the dizzy head (Kawtikwar et al. 2010).

There is a long tradition of using the fecal matter of domesticated animals to treat arthritis, which supports the use of cow and black goat fecal matter in treating rheumatoid arthritis or paralyzed leg in the studied area (Hatfield 2004).

Here scale ash of Chital fish is used to treat loosened teeth. The pharmacological relevance of using the fish scale in tissue formation has already been understood after observing the efficacy of gelatin extracted from the fish scale, which enhanced cell adhesion, cell growth, and wound healing (Huang et al. 2018).

For treating cattle fever use of earthworms is a fact now a day. The earthworm is popular in treating fever throughout the world (Cooper et al. 2012; Grdisa 2013). That is because earthworms' antipyretic and anti-inflammatory activity has been scientifically established (Balamurugan et al. 2009). Furthermore, powdered mollusk shells' wound-healing properties have recently been examined (Andrade et al. 2015). So the use of shell ash for treating the wound is very much acceptable.

Some new findings

Uses of two animal species like *E. hexadactylus* and *Sperata aor* (Hamilton, 1822) in ethnoveterinary medicine are exclusively new reports from India as they were not recorded in the earlier literature published so far (Gupta et al. 2003; Kakati et al. 2006; Mahawar and Jaroli 2008; Galav et al. 2013; Pushpangadan et al. 2014).

Colorful feathers of *Coracias bengalensis* (Linnaeus, 1758) were reported earlier for its ornamental uses (Altaf et al. 2017) and body fat as medicine (Pushpangadan et al. 2014). Still, there is no report on its medicinal efficacy against the loose motion of cattle. So this is a new report regarding the use of feathers of *C. bengalensis* in loose motion, which should be pharmacologically validated in the future.

Feathers of kingfisher have been globally used for ornamental purposes (Altaf et al. 2017), but there is no report on its beak and skull bone for breathing trouble of large ruminants.

Magico-religious belief

Indigenous people of the study area strongly believe in the magical power of certain animal species employed for healing certain diseases of their domesticated animals, which are supposed to be caused by the bad effects of some evil spirits. Different parts of the animals are first made sacred by holy chanting and then activate their magical healing power through certain religious rituals. Traditional people, in many cases, believe in the existence of supernatural power and evil spirit. Attachment of 7 out of 21 species (Table 3) with magico-religious cures reflects their strong belief in the magical healing power of the animal parts as found in many other traditional societies worldwide (Moazami 2005; Alves et al. 2012).

Quantitative ethnozoology

To estimate the relative importance of the recorded animal species, the data related to zootherapy are analyzed with the help of statistical indices like use mention factor (UM) and use value index (UV) and provided their value in Table 1.

The value of UM varies from 2 to 16, and UV values range from 0.02 to 0.12. The highest UM value assigned to *C. bengalensis* (UM=16), followed by *Herpestes javanicus palustris* (Ghose, 1965) (UM=12), *Lamellidens marginalis* (Lamarck, 1819) (UM=11) and *V. bengalensis* (UM=11) which indicate their wide acceptance regarding disease curing ability. Animals mentioned maximum numbers of times (UM) obtained greater UV values, reflecting their linear correlation. For example, the informants have mentioned the feathers of C. bengalensis a maximum number of times (UM- 16) for the treatment of cattle diarrhea and thus produce the highest UV score of 0.12 among all the documented taxa. Similarly, for treating body aches, the parietal bone of *S. aor* has been mentioned only

two times (UM=2), and a very minimum UV value has been calculated for that species (UV=0.02). So, all four ethnoveterinary medicinally important animals with higher UV and UM values can be considered promising sources of bioprospection, and an attempt should be prioritized for their conservation.

Table 2. Zootherapeutic remedies used for various ill-health conditions of cattle in the northern laterite region of West Bengal, India

Disease/ illness treated	Mode of remedy preparation and its applications
Foot and mouth disease (FMD)	Dried aerial part of *Andrographis paniculata* is made into a paste with honey (produced by *Apis cerana indica*) and given orally once a day for seven days.
Severe headache of a bullock	Mature root of *Datura stramonium* is made into a paste along with the roots of *Chrysopogon zizanioides* and *Cyperus rotundus* (2:1:1); a small amount of horn dust of spotted deer (*Axis axis*) is added to this preparation and applied as a poultice on the head twice a day for 2-3 days.
Rheumatoid arthritis /Paralyzed leg	• 14-15 pieces of mature leaves of *Calotropis gigantea* are made into a paste and mixed with 5 gm powder of Ammonium chloride ("*Nishadal"*), fecal matter (500 gm) of a heifer (*Bos Taurus indicus*), and the required amount of soil from the mouth of crab-hole. All the ingredients are taken into an earthen pot, heated for a few minutes, and applied to the paralyzed leg twice a day until the cure. • Lukewarm body fat of Bengal monitor (*Varanus bengalensis*) is applied to the affected body parts as a massage
Rheumatic pain	The whole plant of *Cleome gynandra* is made into a paste with common salt and fecal matter of black goat (*Capra hircus*) in a 4:1:2 ratio; applied topically to the affected area once a day for 9-10 days
Loosened teeth	Freshly collected rhizome of *Curcuma longa* is made into a paste and mixed with scale-ash of the "Chital machh" (*Chitala chitala*) and rock salt in a 2:2:1 ratio. The mixture is stirred well in mustard oil and applied at the base of the loosened teeth, wrapped with a piece of cotton, and then a red hot Ion rod is put on it for a few seconds. This practice is done once a day for three successive days
Diarrhoea	A mixture is prepared from the small amount of feather of the "*Nilkantha*" bird (*Coracias bengalensis*), 4-5 pieces of *Abrus precatorius* seeds, and 100 gm of bamboo leaves; given orally once a day for three days.
Stiffness of shoulder	• Body fat of Russell's viper (*Daboia russelii*) is slightly heated and applied to the affected area twice a day till the cure. • Body fat of the pig (*Sus scrofa domesticus*) is melted by slight heating and applied on the shoulder twice a day for at least 5-7 days.
Lameness in the hind leg	Body fat of an Indian green frog (*Euphlyctis hexadactylus*) is used as an effective massage.
Breathing trouble	A very small amount of paste is prepared by rubbing the beak and skull bone of a kingfisher (*Halcyon smyrnensis*) against a rough stone surface and given orally once on Tuesday and Saturday mornings for three consecutive weeks.
Spleen enlargement	A hot extract is prepared from 5 gm dust of Bengal mongoose spleen (*Herpestes javanicus palustris*) and given orally in the early morning, once a day, for 15 days.
Fresh wound	Shell ash powder of freshwater mussel (*Lamellidens marginalis*) is applied on the fresh cut to stop bleeding.
Fever	One piece of earthworm (*Metaphire posthuma*) is made into a paste, fed, and wrapped with bamboo leaves once a day for 3-5 days.

Table 3. Magico-religious myths attached to the healing of livestock diseases in the northern laterite region of West Bengal, India

Disease/ illness cured	Magico-religious practices/myths
Sore between the hooves	Sometimes, a piece of the front appendage of a crab (*Cancer pagurus*) is tied to the neck of the affected animal to protect it from evil spirits.
Poor lactation due to evil effect	If more than one animal shows the same symptom, a dog's skull (*Canis familiaris*) is hung from the southeastern roof corner of a cowshed.
Weakness due to evil effect	A talisman is prepared with the dust of the skull and wing bone of a short-nosed fruit bat (*Cynopterus sphinx*) and tied around the neck of an affected cow with a piece of black thread to combat the evil spirit.
Fever due to evil effect	Black magic is performed with the bone of a vulture (*Gyps bengalensis*) to relieve the situation.
Drowsiness due to evil effect	A dried shell of a freshwater turtle (*Lissemys punctata punctata*) is hung just above the front door of a cowshed.
Fever due to evil effect	One tooth of a Bear (*Melursus ursinus*) is used to protect against the evil spirit.
Body aches due to evil effect	Black magic is performed with the parietal bone of Long-whiskered catfish (*Sperata aor*) to eliminate the evil effect.

Conservation facets of threatened species

Among the recorded 21 species, more than 50% of species are already enlisted in the IUCN Red List of Threatened species (IUCN Red List 2021). Furthermore, it has been found that species like *Gyps bengalensis* (Gmelin, 1788) as 'Critically Endangered,' *Melursus ursinus* (Shaw, 1791) as 'Vulnerable' *Chitala chitala* (Hamilton, 1822) has been recorded as 'Near Threatened,' and eight other species as 'Least Concern.' In the global scenario, species categorized under the 'Least Concern' are not the focus of species conservation. In the studied area, the status of *V. bengalensis, S. aor, H. javanicus palustris, E. hexadactylus,* and *C. bengalensis* is gradually declining due to habitat destruction and other anthropogenic pressure.

An interesting observation has been made that there is a tendency to frequently use the 'locally rare' and 'Least Concern' recorded species like *C. bengalensis* (UM=16) and *H. javanicus palustris* (UM=12). This utilization pattern may indicate the anthropogenic Allee effect, which predicts the increasing tendency to exploit the gradually becoming rarer species. That can force a species to annihilate (Holden and McDonald-Madden 2017).

The local people have many superstitions and folklore associated with the local fauna. Sometimes it might help protect the local fauna from overexploitation or might cause harm to animal life due to their inadequate knowledge (Alves et al. 2012). So it is high time to make people aware of the rare and threatened animal species and their value as a component of biodiversity. Furthermore, to protect them, local inhabitants should be encouraged to use the available substitutes instead of rare and endangered species (Luo et al. 2011). Funds from Government and Non-Government organizations should be raised to investigate the local faunal resources thoroughly, evaluate their economic value, estimate their current status, and identify the needed threats. An arrangement should be provided for captive breeding and reintroduction of the endangered species. Concurrently, the socio-ecological conditions must be reinforced through sustainable utilization and conservation of the local biodiversity.

In conclusion, using 21 zoological specimens in ethnoveterinary medicine preparation highlights local zoo resources' exploitation as therapeutic agents, a wide knowledge base in zoo therapy in the surveyed area. All those 21 animal species used as medicine were found first time recorded from the state of West Bengal for ethnoveterinary medicinal purposes. This finding also indicates exploring more new recipes of zoo therapy practiced in the northern portion of the state laterite region and West Bengal as a whole. Some of the recorded species' medicinal effects have already been pharmacologically validated. There is a scope for further investigation to confirm the newer uses reported and the statistically justified information provided here. In addition, this study offers new mitigation and conservation strategies for restoring and preserving wildlife in the lateritic belt of West Bengal.

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Review: Local wisdom of the Tengger Tribe, East Java, Indonesia in environmental conservation

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Abstract. *Putri FK, Noven HJ, Nurcahyati M, Irfan AN, Septiasari A, Batoro J, Setyawan AD. 2022. Review: Local wisdom of the Tengger Tribe, East Java, Indonesia in environmental conservation. Asian J Ethnobiol 5: 20-34.* Indonesia is a multicultural country that is rich in ethnic diversity, including their local wisdom. Tengger Tribe is known for their environmental conservation local wisdom. This review aims to determine the environmental conservation and the influence of the Tengger Tribe's beliefs on environmental conservation. The results show that the Tengger Tribe is a tribe in Mount Bromo with the main livelihood as traditional farmers and the majority of the people are Hinduism. The Tengger Tribe has several traditions or ceremonies that are still held, including *kasada, karo, entas-entas, unan-unan, ojung*, galungan, *mulenan, pujan mubeng, leliwet*, and others. There are three values of local wisdom of the Tenggerese, namely, the value of compliance (*setuhu*), mutual cooperation (*sayan*), and honesty (*prasaja*). In addition, the Tenggerese are known as *Wong Tengger* with values called *welas asih pepitu* (seven love). Tengger Tribe has been living side by side for generations and utilizing natural resources. The Tengger Tribe also has efforts in environmental conservation which are closely related to their beliefs. The conservation is carried out through traditions that are still preserved by the Tengger Tribe. Tengger Tribe community's beliefs in the teachings of *karmaphala* are important and have a good effect on environmental conservation.

Keywords: Environmental conservation, important, local wisdom, Tengger Tribe

INTRODUCTION

The regional factor is one of the pillars of realizing an essential existence for a country (Soemarmi et al. 2019). Indonesia is located in Southeast Asia, consisting of thousands of islands and an archipelago country. According to Evers (2006), the concept of '*Nusantara'* has great meanings that have been attached throughout Southeast Asian history. The *Nusantara* concept is derived from two Sanskrit words: *nusa*, which means 'island', and *antara*, which means 'in between' or 'including'. Meliono (2011) states that the regions or geo-cultures formed by ethnic groups in the archipelago display unique features, characteristics, languages, values, and symbols that originate from the culture of the people. Ancient Indonesian culture has undergone many changes through various processes and understandings from local, indigenous, and mixed-race communities. As we know, the current Indonesian culture has gone through a dynamic process since a long time ago. Indonesia is a pluralistic nation, where this diversity is mainly found because of the diversity of ethnic groups in the society. Each ethnic group produces its own culture, and it can show the uniqueness in terms of race, religion, class, language, customs, and so on (Herimanto and Winarno 2008). Even though we know that Indonesia consists of various kinds of ethnic groups and other diversity, it is still considered a whole one consisting of unity of the Indonesian nation. Indonesia strongly holds tight to the legacy of ancestral motto, called *Bhineka Tunggal Ika*, which means *unity in diversity* (Suparlan 2003; Khaelan 2016; Huda and Khasanah 2019).

All religions and certain beliefs generally try to explain the beginning and development of the universe and the role of humans in the whole world. However, the relationship between religion and the environment is also related to the scope of personal behavior (Chuvieco 2012). As an archipelagic country, Indonesia encourages the development of various indigenous views, in which the indigenous tribal understanding of the environment reacts better than modern thinking (Lowe 2006). Indigenous beliefs are still attached in various regions, including Java, the most populated islands, and several tribes, such as Betawi, Baduy, Sundanese, Java, Madura, Tengger, Using, and others (Gunawan and Rante 2011).

The Tengger Tribe is one of the tribes in Indonesia, precisely located in East Java, which still maintains its cultures and traditions very well until now. This tribe is located in four districts, namely Probolinggo, Pasuruan, Lumajang, and Malang. Geographically, the Tengger Tribe, located in Lumajang and Malang districts, is located far

from the cultural ritual center of the Tengger people, which are generally located around the crater of Mount Bromo. Therefore, the Tengger Tribe in that location tends to be more rapidly modernized by the entry of foreign cultures (Ningsih 2016). The Tenggerese are considered the people who are very obedient to the cultural customs passed on by their ancestors, have noble social relationships, and have brotherly ties in daily life (Batoro 2017). The customary law that has been agreed upon regulates the order of life in harmony between humans and their environment. Rahayu et al. (2019) stated that the Tengger Tribe is known to be attached to a culture of compassion for the poor, giving help to difficult people, do not have a sense of comparing who is the right, clever, or rich, and must admit that everything belongs to God. Batoro et al. (2020) state that East Java has several tribes that have developed since the past, including Javanese, Madurese, Tenggerese, Samins, Osingese, and Chinese ethnicities. They are rich in cultural diversity, customs, languages, religions, beliefs, and rituals. As a result, the existence of traditional rituals and beliefs is a form of creativity, initiative, and work by utilizing the biodiversity in the environment. People's understanding of nature is related to its function in the belief system, and religion is related to environmental management. In the framework of their belief, the Tengger Tribe community carries out several traditional ceremonies, both mass and individual ceremonies, including the *kasada*, *unan-unan*, *pujan*, *barikan*, *nglukat* and *entas-entas* ceremonies which are all carried out according to a predetermined time traditionally (Hidayah 2015).

The environment is everything around us, providing mutual support functions for the sustainability of life (Sodiq 2014). The environment includes three components, including abiotic, biotic, and culture. Taufiq (2014) states that humans and the environment form many interactions. Basically, humans need the environment to fulfill their needs, on the other hand, the environment needs humans so that its sustainability is well maintained. Humans as the one who can be called owners of the world, have the power to use living things and the environment to fulfill their lives (Panjaitan et al. 2014). The relationship between humans and the environment is dynamic, both short-term and long-term. The relationship between humans and the environment is based on instrumental functions and symbolic values built from human views and behavior towards nature (Abdoellah 2017). Technological developments increasingly influence environmental dynamics. The development of science and technology certainly impacts life globally, with positive and negative impacts. Positive impacts can improve the quality of human life, while negative impacts can be in the form of environmental problems that can be disastrous for life to come. The negative impacts that arise from poor environmental management must be watched out for to avoid dangers in the future therefore environmental awareness is the responsibility of all mankind without exception (Situmorang 2017). Environmental problems in the global area manifest the fading of the dominant consciousness to protect the environment (Markowitz et al. 2013).

Basically, the use of natural resources is carried out with a perspective obtained based on the experience and knowledge of the community (Heryanto et al. 2018). Environmental perceptions can be defined as how an individual human organizes and interprets his understanding of the environment. The application of environmental perceptions and ethics is found in the culture of a society (local wisdom). Local wisdom has a significant role in environmental problems because local wisdom has played a role in preserving the environment (Widodo et al. 2012). Local wisdom itself is knowledge or collection that develops from various experiences and diverse understandings from the community towards an environment (Schwann 2018). Local wisdom, including deeply rooted beliefs, is an inherent part of society to survive in accordance with environmental conditions and needs (Sufia et al. 2016). According to Wibowo et al. (2012), local wisdom is one of the important factors in achieving holistic environmental, cultural, and economic sustainability. Knowledge of natural culture provides immeasurable facts in understanding the ecological processes and provides an overview of local efforts to protect the environment (O'Neill et al. 2017). In natural conditions that continue to experience degradation, ecological awareness is needed to run in harmony with internalizing ecosystem awareness. As the global population grows, culture and people's way of life also develop. Development increases pressure on natural resources. Management systems must adapt to this changing context, and maintaining the biodiversity that supports the system and its management becomes more important to pay attention (Boedhihartono 2017). Traditional knowledge and practices are at the core of the management of local systems, which in many situations can still work sustainably in contemporary societies (Berkes et al. 2000). Local wisdom can also be lost gradually due to the concept of unsustainable development, where the impact of losses is visible on the local community and detrimental to other communities (Utomo et al. 2020). Conservation of biodiversity is one of the main goals to achieve environmental sustainability, although communities have long been dependent on soil ecosystems and changing socio-economic conditions, traditional approaches or local wisdom for biodiversity conservation are not of interest to the public now (Zulfikar et al. 2020).

Local wisdom in Indonesia plays a very important role in environmental conservation. Subagyo (2012) states that humans are part of nature, where the relationship between the environment and human activities can be seen from the wise Social Indigenous System. Various aspects of wisdom are very adaptive to nature and very useful for society because they are the basis for the substance of knowledge, techniques that are easily recognized, easy to apply, easy to master, and easy to practice in life. One of the indigenous tribes who practice environmental conservation in their belief is the Tengger Tribe. An example of the application of conservation in the local wisdom of the Tengger community is their local wisdom in maintaining the forest's sustainability, sticking to the harvest ritual, and their belief in implementing Tri Hita Karana (Sumarmi 2018). Some

holy or sacred places in Tengger are also the real evidence of traditional conservation created by their ancient local wisdom (Batoro 2012; Kurnianto et al. 2017). The Tenggerese indigenous people also apply in situ plant conservation with their traditions and simple knowledge of allowing medicinal plants to grow in their natural habitat (Batoro 2012; Kuspraningrum et al. 2020).

The Tengger Tribe has many great local wisdom values in environmental conservation. The following review article was written with the aim of determining the environmental conservation carried out by the Tengger Tribe. The review also intended to know the influence of the Tengger Tribe's beliefs on environmental conservation.

TENGGER TRIBE

East Java is a province on Java Island, Indonesia, with the provincial capital of Surabaya. This province has a variety of natural potentials, one of its potentials is the existence of Mount Bromo, which is known as the prima donna and tourist attraction when visiting East Java. Mount Bromo is a volcanic type of mountain (Ifa et al. 2019). This mountain is a volcano that is still active and still emits sulfur-smelling smoke from its crater (Kusumadinata 2015). Mount Bromo location includes the Bromo Tengger Semeru National Park (TNBTS) area which has locations in four districts, namely Lumajang, Malang, Pasuruan, and Probolinggo (Sasongko 2011) (Figure 1). This park is a biodiversity hotspot in East Java Province, for example, found at least 8 species of *Selaginella*, a very diverse for a single location (Setyawan and Sugiyarto 2015).

Around Mount Bromo, there is a tribe that lives on its slopes. The tribe is called Tengger Tribe. This tribe is part of the Javanese tribe but with different cultural forms. The area of Tengger is approximately 40 km from North to South and 20-30 km from East to West and is above an altitude of 1000-3675 m (Haliim 2018). The Tengger Tribe is spreading across several (36) villages in districts in East Java, with the majority of the population being Hindu and still adhering to Tengger customs. These villages include Ngadas, Jetak, Wonotoro, Ngadirejo, and Ngadisari (Sukapura Sub-district, Probolinggo District); Ledokombo, Pandansari, and Wonokerso (Sumber Sub-district, Probolinggo District); Tosari, Wonokitri, Sedaeng, Ngadiwono, and Podokoyo (Tosari Sub-district, Pasuruan District); Keduwung (Puspo Sub-district, Pasuruan District); Ngadas (Poncokusumo Sub-district, Malang District); and Argosari and Ranu Pani (Senduro Sub-district, Lumajang District) (Haliim 2016).

The Tenggerese are traditional farmers who live in groups on the hills not far from their agricultural land. Etymologically, Tengger means standing upright or still without moving in Javanese. Another meaning of Tengger is Tengger nobility (its people have noble minds) and mountainous areas because Tengger is located on the slopes of the Tengger and Semeru mountains (Haliim 2016). The Tengger Tribe is closely related to the Tengger Inscription in the Rameswarapura Inscription, which is stated in 1275 AD that the King of Kartanegara gave tax freedom to the Tengger people and was assigned to represent the people of the entire archipelago to carry out ceremonies on Mount Bromo. The inscription is strengthened by the Penanjakan inscription dating back to 1324 Saka (1402 AD) which states that there is a village called Wandalit in the Tengger mountains inhabited by Hulun Hyang (servants of God for religious people) with a surrounding area called hila-hila (holy), so that it is exempt from paying taxes by the Majapahit government center (Ayuninggar et al. 2013).

The name of the Tengger Tribe consists of the word "*Teng*" taken from the name Roro Anteng, while the word "*Ger*" is taken from the name Joko Seger. It is said that the people of the Tengger Tribe are descended from Roro Anteng and Joko Seger. Both of them are a husband and wife who have entered the age of marriage which is almost 25 years old, but have not been blessed with a child. Then the husband and wife performed austerities at Mount Bromo. And after being imprisoned, Nyi Roro Anteng and Joko Seger were blessed with children. According to their promise the last son, Raden Kusuma, would be given as the redeemer of his promise. As his final message, Raden Kusuma said that his siblings must live in harmony and advised that every 14 *kasada* a tribute for agricultural products was carried out (the origin of the *kasada* ceremony) (Hikmah et al. 2020).

The Tengger community is widely known as Hinduism, which combines with Tengger traditional beliefs. The Hinduism Tenggerese does not recognize Ngaben as a death ceremony, like the Hinduism in Bali (Haliim 2016). The inhabitants of the Tengger Tribe are believed to be direct descendants of the Majapahit Kingdom, which are known to obey Hindu rules and religion. Where the majority of the Tengger Tribe embrace the teachings of Hindu Mahayana. The name of the Tengger Tribe refers to the original Javanese language and still contains only one syllable. However, in the era of the development of communication technology nowadays, there are many names of children from the 2000s that do not reflect the typical Javanese Tengger name (A'rof and Ahwan 2018).

Sociologically, the people of the Tengger Tribe in their lives tend to prioritize a sense of relationship, tolerance, and prioritize cooperation in various matters (Haryanto 2014). The local wisdom of the Tengger Tribe is the identity of the Wong Tengger. The identity of the Wong Tengger is harmony and tolerance (Haliim 2016). This is because the Tengger Tribe has four kinds of religions: Islam, Hinduism, Buddhism, and Christianity (Hikmah et al. 2020). These differences impact political decision-making or social problems that do not use voting but deliberation to reach consensus. This is a positive thing obtained from the Tengger Tribe community as a reflection and reference for identity and Indonesian unity and integrity (Haliim 2016). For the Tengger Tribe, religion is a belief in their creator, while the Tengger tradition is their way of respecting their ancestors (Hikmah et al. 2020).

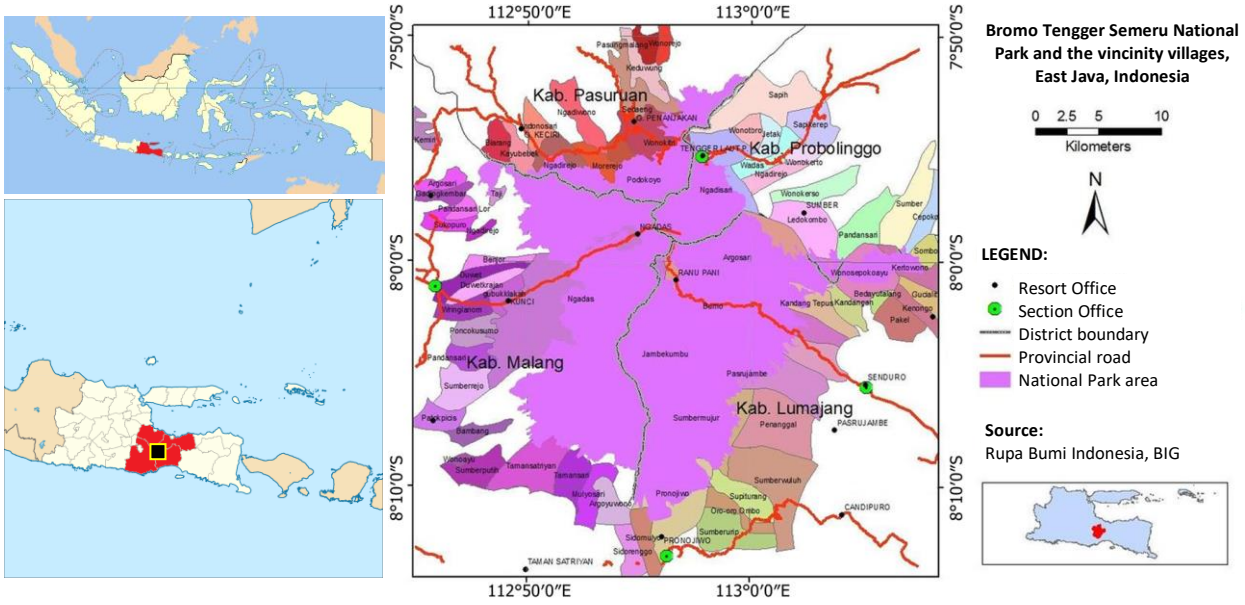

Figure 1. The Bromo Tengger Semeru National Park, East Java Indonesia and surrounding village settled by Tenggerese

The Tengger Tribe, which is a multi-religious tribe, can maintain its diversity through various traditions and customary norms of Tengger. This religious harmony is reflected in the tradition of *gentenan* (turns with other) to help the celebration of fellow residents, *sayan* (celebration invitation), *genten cecelukan* or *gentenan nedha* (turns inviting food), and *nglayat* or *salawatan* (helping neighbors who are affected by disaster) (Haryanto 2014). In the Tengger Tribe, there are mountains and waterfalls in terms of nature. Meanwhile, from a cultural perspective, there is a welcoming evening of one Sura which is carried out with the washing of the heirloom and village cleansing, *metirta matirta* as a processional stage in welcoming the month of *Sura*. The tradition of carrying out the welcoming ceremony for the month of the *Sura* of the Tengger Tribe is related to ethnobotany because it uses various types of plants (crops) to complement the event (Ayuningtyas and Hakim 2014).

The traditional activities of the Tengger Tribe are led by traditional healers who have a very large role and influence in society. Traditional shamans are chosen from generation to generation and appointed through a traditional ceremony held on Mount Bromo. In addition to the traditional shaman appointment ceremony, various other traditional ceremonies are often held in Mount Bromo and the Sand Sea, which is in the TNBTS area. The language used by the community is Javanese with the Tengger dialect (Sayektiningsih et al. 2008). In an effort to preserve local culture, there is a role for a Pandhita shaman in instilling values and prevention through the ritual of *pujan barian* with reciting mantras of repelling *balak* and *ngepras* or cleaning the village. In addition, through the ritual *santi aji* , the shaman provides advice and knowledge about banten or offerings with village heads and religious leaders as goal stabilizers in every community activity (Setiaini 2019).

One of the local wisdom of the Tengger Tribe is the way they dress. The traditional black Tengger shirt, a seamless shirt, *udeng*, and a yellow sash. Men usually wear *sarongs* around their necks, but when they work they are usually worn over their faces and heads to keep dust out and make it easier for them to work. And for certain occasions, they wear a sarong as a lendeh or bebet, for example attending family events and official events in the village. As for women, they usually wear a *robogan* cloth or *sewek* that is tied with a tie and slung around their neck usually the cloth is slung sideways, but when they work, the cloth is slung backward so as not to interfere with their work. Sometimes cloth is also used as a belly band or sembung when working in agricultural fields (Gifari et al. 2019).

The Tengger Tribe is a tribe that contributes to saving the environment. The Tengger Tribe maintains a harmonious relationship with nature, referring to God the Creator (Sang Hyang Widhi), the spirits of the ancestors, and the spirit of the village guard. The behavior of the Tengger Tribe with nature maintains transcendental harmony with the power of the cosmos because every violation is believed to result in karma, reinforcements or *kuwalat* (Sutarto 1997; Walsh 2000). The Tengger Tribe uses the forest and the surrounding environment to support their daily life. One of them is the use of wild plants that have been hereditary for consumption as a way of survival in the Bromo Tengger Semeru National Park or *Taman Nasional Bromo Tengger Semeru* (TNBTS) area (Setiawan et al. 2020). Some of daily life, beliefs, and traditions of Tengger Trible can be seen in Figure 2.

BELIEFS AND TRADITIONS OF TENGGER TRIBE

Beliefs and traditions are closely related to implementing traditional ceremonies, which are an integral part of the culture. Therefore, it is necessary to maintain the development and socialization from generation to generation to maintain its sustainability. Traditional ceremonies reinforce cultural norms and values, generate a sense of security for the people in their environment, and

serve as guidelines in determining attitudes and behavior in their daily lives. The atmosphere in the Tengger area is controlled by a teaching called *kala patra village* or *mawa cara village*, which means an orderly atmosphere must be adapted to the situation and conditions of the local village. This shows that the Tenggerese custom is dynamic because it creates feasibility in social life, resulting in a curse if it is violated. In this case, the Tenggerese customs have become the inner fence for the community to maintain of ancestral heritage related to the relationship between humans and humans, humans and their environment, and humans and the Creator (Sriwardhani 2007).

According to Agustapraja (2017), traditional ceremonies that are still held in the Tengger area include *kasada*, *karo*, *unan-unan* (held once a day), *barikan* (held after an earthquake, natural disaster, eclipse, or other event that affects the life of the village community), *pujan mubeng* (held on the ninth month or *panglong kesanga*, namely on the ninth day after the full moon), birth, *entas-entas*, *tugel kuncung* or *tugel gomba*, marriage, death, and *liliwet*. The explanation of the beliefs or customs of the Tengger Tribe is as follows:

Kasada

The *kasada* ceremony is one of the traditions of the Tengger Tribe in interacting with the natural and social environment. The ceremony with an ethnographic background is used to strengthen the development of living values education. This tradition is motivated by the existence of the Tengger Tribe as farmers in the Bromo highlands, which illustrates a form of ecological adaptation, actualization of local wisdom, and a form of life skills education for the younger generation. In the *kasada* tradition, there are values of character education with a national perspective (Hadi 2017). The *kasada* ceremony is carried out once a year in a certain month, followed by local people to respect their ancestors (Hikmah et al. 2020). *kasada* which in the Tengger Tribe is the name of the month, with another name *asuji* is the last month or 12, which in the Gregorian calendar does not always fall in the 12th month, because the Tengger Tribe has its own calendar system, which has an average day age of 30 days (each month rounded off). In the *kasada* ceremony, there are several series of events starting from taking holy water at Madak Tirta, then taking holy water to the slopes of Mount Bromo, which will later be brought to Pura Agung Luhur, that the main event is held, starting from the offering of *ongkek* to prayer and the selection of the next shaman who will lead a village. After that, continue to Madakaripura Waterfall (Nempung et al. 2014).

Karo

The *karo* ceremony is a big celebration of the Tengger Tribe. The word *karo* means two or both. The activity is carried out in the *karo* month (the second month in the Tengger Tribe calendar), which lasts one to two weeks. The *karo* ceremony has a history of the Prophet's kanjeng servant named Setya and Aji Saka's servant named Setuhu. The two of them disagreed, but neither won, and both died, so this ceremony was held as a warning to avoid disaster due to misunderstanding. The *karo* ritual ceremony is led by a village shaman who usually wears new clothes, beginning with a ritual ceremony at the house of the local village head and bringing a variety of foods arranged in such away. This ceremony is similar to the celebration of Eid al-Adha Muslim holidays, where the Tengger people visit each other to the homes of relatives and neighbors as well as the slaughter of livestock for the community (Gifari et al. 2019).

Entas-entas

The *entas-entas* ceremony is the final salvation ceremony for the deceased, which is intended to perfect the ancestral practice of entering the realm of eternity or nirvana. The *entas-entas* traditional rituals include resik atau *andeg-andeg, alms, andeg-andek klakah, menduduk, kayopan agung, nglukat,* and *wayon* which lasts up to three days and is equipped with ceremonial equipment such as traditional clothing for the *dukun, prasen, and perapen.* The *Entas-entas* ritual begins with making petra by wong sepuh with an arrangement of pampung leaves (*Oenanthe javanica*) intended as a seat or lemek, senikir flowers (*Tagetes erect*a) to get rid of evil spirits, tanalayu flowers (*Anaphalis longifolia*) so that the spirit is accepted by Sang Hyang Widi, prick bamboo (*Dendrocalamus asper, Gigantochloa apus*) symbolizes bones, bamboo ropes so that they do not become loose as muscles, reeds (*Imperata cylindric*a) are clothed, cepel (cauldron) symbolizes the crater, and cowek symbolizes the sea of sand of Mount Bromo. The number of petra and offerings chanted according to the number of spirits to be invited is called *andeg-andeg klakah.* Sitting is a series of *entas-entas* traditional rituals using a goat (S*acrificecapra aegagrus*), a cow (*Bos taurus*) intended as a ride. The peak event is called nglukat or *gubahan klakah,* which is a washing ceremony, in the end the petra ritual is burned on the Pedanyangan by wong sepuh where the Pandhita shaman closes with the *wayon* ceremony (Batoro 2011).

Unan-unan

The *unan-unan* ceremony is one of the cultures of the Tengger Tribe. This tradition is carried out to repel reinforcements and clean the village. The term *unan-unan* comes from the word Tuno which means to lose or lose. The purpose of this ceremony is to complete the deficiencies that have been made for one windu (5 years according to the Tengger calendar). In the Tengger Tribe calendar, each month has 30 days. Meanwhile, certain months have 29 days. So that if the add up has a difference of five to six days in a year. To make up for the shortfall, the difference in days is included in the month of the *dhesta* or the eleventh month which only exists in the calendar every five years. So that in the month of *dhesta* the people of the Tengger Tribe hold a tradition of *unan-unan*. During the *unan-unan* tradition, the head of the buffalo is decorated and placed on the ancak or coffin. On top of the *ancak* are placed 100 sticks of buffalo satay, 100 *tumpeng*, and 100 snacks wrapped in klotok leaves. Then the *ancak* was paraded by all Tengger Tribe residents to the Pamujan Studio which is on a hill not far from the residents' village. The procession is led by traditional healers, village heads, religious leaders, and traditional leaders of the Tengger Tribe (Gifari et al. 2019).

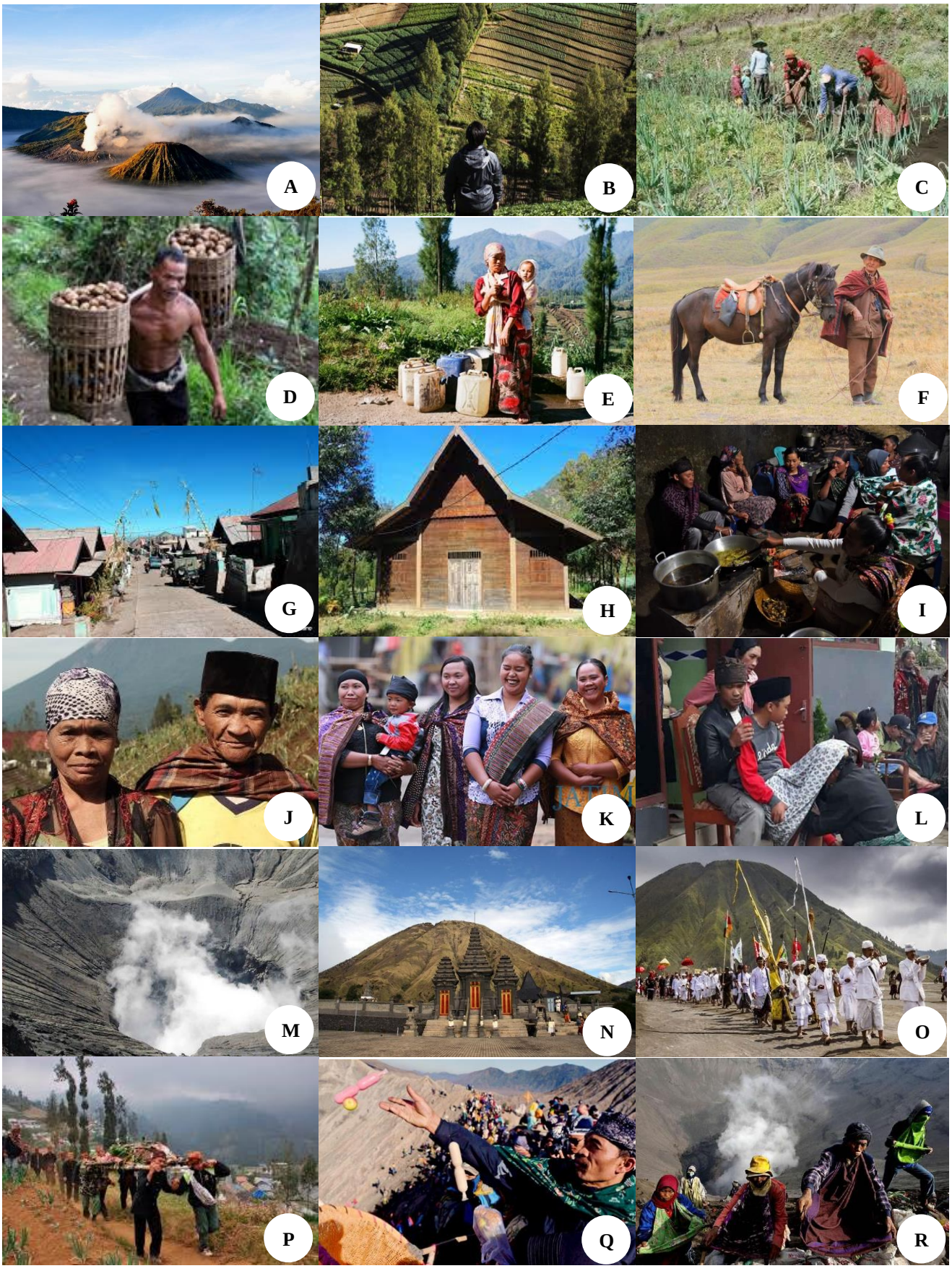
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Figure 2. Environments, daily life, beliefs, and traditions of Tengger Trible, East Java, Indonesia. A. Scenic panorama of Mount Bromo, the center of life of Tenggerese. B. Land conservation for sustainable upland farming in Tengger area. C. Vegetable farming as main income source. D. Potato as main agricultural yields. E. Collecting freshwater. F. Horses for tourist transportation as extra income. G. Typical settlement of Tenggerese. H. Traditional house of Tenggerese. I. Welcoming guests in the kitchen to warm up. J-K. Face of old couple Tenggerese, and a group of women. L. *Tetesan merajakani*, the influence of Islam on the Tenggerese culture. M-R. *Kasada*, the biggest ritual ceremony of Tenggerese: Mount Bromo crater, the center of ceremony (M), Pura luhur temple, the center of worship (N), Heading to the ceremony site (O-P), Offerings of agricultural products to the Mount Bromo crater and collecting (Q-R). S-X. Some other important ceremonies: *Entas-entas* (S), *Unan-unan* (T), *Galungan* (U), *Karo* (V), *Puja mubeng* (W), and *Sadranan* (*Nyadran*), a ceremony adopted from the surrounding Muslims (X). Y-AA. Tenggerese arts: *Ujung* (Y), *Sodoran* (Z), *Probo mutrim* (AA)

Ojung

The *ojung* (*ujung*) tradition is a tradition of fighting with rattan sticks used by warriors. *Ojung* as a weapon and shield with a rattan length of about 1 m and a diameter of 3 cm. During the match there are traditional music accompaniments called okol and madura kidungan. This musical instrument is rarely found in other areas, which consists of 3 *dung-dung* (siwalan tree roots) that are perforated in the middle so that they sound like bass and kerca and one klenengan musical instrument as a song organizer (Gifari et al. 2019).

Galungan

The *galungan* ceremony is one of the ceremonies to commemorate the victory feast which is held after the *Nyepi* holiday. Where all Tengger people go together to the temple to pray to the Hyang Widi. *Galungan* itself comes from ancient Javanese which means victory. Also, the word galungan has a similar meaning to *dungulan* which means to win. This ceremony is also to commemorate the creation of the universe and its contents (Gifari et al. 2019).

Mulunen

The *mulunen* ritual is an inherited tradition that occurs whenever a village in the Tengger area needs a new dukun either because the former healer died or withdrew from that role. This ritual is intended to seek out and announce new healer candidates. The candidate can pass the nomination only if he or she can memorize and recite holy mantras fluently. This procession is carried out in conjunction with the *kasada* ritual. However, there are still steps to be taken: the prospective shaman must hold and lead the seven rituals of *nemokne manten*. The reference to the *mulunen* ritual is the religion of the Hindu in Tengger people. Therefore, those who carry out the *mulunen* ritual and the chosen Dukun candidates are part of the Tengger community, descendants of the Tengger community, Hinduism, and men (Sudiartha 2017).

Pujan mubeng

The *pujan mubeng* ceremony is a tradition that is held in the ninth month or *panglong kesanga*, which is on the ninth day after the full moon. The Tengger community, both young and old, went around the village hitting a ketipung led by a shaman. Where this tradition is carried out by walking from the eastern village boundary then circling the four corners of the village which ends with eating together at the shaman's house with food derived from the contribution of the Tengger community. This ceremony is meant to clear the village from disturbances and disasters. The tour ends with a meal at the shaman's house.

Leliwet

The *leliwet* tradition is a tradition of the Tengger people in the form of salvation related to nature or agriculture. *Leliwet* is organized by the Tengger community, especially for those who will start planting or harvesting. This *leliwet* tradition is usually done together with a *karo* ceremony. The purpose of the *leliwet* ceremony is to ask God to keep away from corruption or evil spirits. In addition, it is hoped that the crops will thrive and be abundant. And if this *leliwet* ceremony is carried out after harvest, then that is a thanksgiving for the agricultural products produced to God (Yuliati and Ambayoen 2017).

ENVIRONMENTAL CONSERVATION IN THE TENGGER TRIBE BELIEFS

Environmental conservation in the beliefs of the Tengger Tribe is realized from the existence of traditional ceremonies or local traditions. All the rites contained in the Tengger community are manifestations of a religious system based on cultural values (Ningsih 2015). The existence of Bromo Tengger Semeru National Park or *Taman Nasional Bromo Tengger Semeru* (TNBTS) is very important to preserve flora and fauna and the balance of the ecosystem. Apart from that, it also has a role to support research, education, recreation, and cultivation activities. However, the destruction of sacred sites in the Tengger area is interpreted as an environmental disaster and the destruction of the ecosystem. Therefore, it is necessary to prioritize the active empowerment of the Tengger community in preserving TNBTS (Mujanah et al. 2016). This active empowerment involves the Tengger community in planning, implementing, receiving benefits, as well as in the process of monitoring and evaluating the management of TNBTS, namely by means of identity as Wong Tengger, facilitating the application of critical education about the importance of land conservation around TNBTS, and facilitating the construction of facilities and infrastructure for the continuity of efforts preservation of the National Park (Haliim 2018).

There are three local wisdom values of the Tengger Tribe, namely the value of obedience (*setuhu*), the value of mutual cooperation (*sayan*), and the value of honesty (*prasaja*). The value of compliance Wong Tengger is manifested by to carry out the existing traditional process mechanisms by following the predetermined schedule and stages. The value of mutual assistance (*sayan*) is manifested in implementing development in the Tengger Tribe area. And the value of honesty (*prasaja*) is manifested in the accountability process for the use of the budget by the Tengger community (Sopanah 2014). In addition, there is a value of togetherness and harmony due to the involvement of various parties in the implementation of the ceremony as well as the value as a cultural tourism asset (Sriwardhani 2007). In addition, in the Tengger Tribe there are also values known as welas asih pepitu (seven love), namely *welas asih marang Bapa Kuasa* (God), *welas asih marang ibu pertiwi* (country and homeland), w*elas asih marang bapa biyung* (parents), *welas asih marang rasa jiwa* (feeling soul), *welas asih marang sepadane urip* (fellow human being), w*elas asih marang sato kewan* (animals), and *welas asih marang tandur tetuwuh* (plants) (Waluyo 1997).

The conservative attitude of life and consistency of the Tengger Tribe in carrying out traditional rituals and living habits according to ancestral teachings are the basis for environmental conservation. The values of the *kasada* tradition are the values of being willing to sacrifice, mutual cooperation, helping each other, being persistent, respecting the work of others, maintaining the balance of the past and future, love for preserving nature, and social responsibility (Hadi 2017). In addition, the forms of local wisdom of the Tengger Tribe in environmental conservation, especially the management of forest and environmental resources, are manifested in the existence of orders which include abstinence from cutting pine trees around the punden, ritual cleaning around the punden, land preparation stage, ritual asking permission to the land preparation process, beneficial saplings should not be cut down, and a selective cutting system for stands in the forest. Where this is very supportive of the preservation of environmental conservation (Sarah and Siswoko 2013).

Most of the Tenggerese still depend on the resources and plants around where they live so that indirectly, the community conducts conservation to conserve existing resources. This is done to ensure life and welfare, especially in fulfilling complementary materials in the welcoming procession for the month of Sura (Ayuningtyas and Hakim 2014). The Tengger community has a unique socio-cultural pattern of life related to the positive behavior of the community in the use of space and its adaptation to the surrounding environment. The pattern of life in the context of spatial planning, namely spatial conceptions based on customary areas and administrative areas, the placement of the orientation of the elements that form a place to live, land ownership systems, and adaptation of houses to the climate. Local wisdom in the context of environmental preservation regulates the estimated planting season, traditional technology systems in farming management, captive management systems, management and protection systems for forest and water resources, and environmental preservation traditions in the Tengger area (Ayuninggar et al. 2011).

The values about karmaphala are used as cultural values of the Tengger people in their social behavior. Where not

only maintains relationships with others, but also relationships with nature. As a community that depends on nature, the Tengger people feel the need to balance the existing ecosystem. It makes them not careless and greedy to exploit natural resources arbitrarily. Because there is a belief in the perch community, if people destroy nature, it will make nature angry and bring disaster to them. The values about the balance of life with nature are also influential in the norm system that regulates the social relations of the Tengger Tribe, one of which is in managing nature and tourism (Utomo 2018).

The role of the shaman as a figure of traditional and religious elders in a continuous manner in realizing social, legal, and religious norms is the application of saving the environment through Tengger's environmental activism. In environmental preservation, religion plays an integral role in knowledge and traditional ceremonies act as a consultant or influence policies towards the Tengger environment. There are forms of environmental saving (conservation) behavior in terms of harmonization between land, forests (trees), water sources, animals, and self-introspection behavior to protect the environment through traditional Tengger ceremonies (Negara 2010). The environmental conservation behavior carried out by the Tengger community includes the following:

First, Land for the Tengger community is entrusted by their ancestors that must be guarded, so that no transfer of rights to other people is permitted and cannot be sold to communities outside Tengger. In addition, the Tengger community manages agricultural land with techniques from their ancestors, starting from cultivating the land (making terraces) and techniques in planting, maintaining, and harvesting activities. Where the type of terracing used is the gulud terrace which has been used for a long time and has been passed down from generation to generation (Yuliati and Ambayoen 2017). In addition, conservation of land is also carried out by managing yards for traditional ritual activities, community socialization, and children's playgrounds related to natural conditions and the meaning of life. Where the Tengger people make several yards as a model of land conservation based on agroecosystems with an emphasis on the typical plants of the Tengger Tribe (Subadyo and Poerwoningsih 2019).

Second, Forests are a source of food for humans and livestock and a source of energy. People from the forest can access types of useful plants and including mushrooms, medicinal plants, and woods that can be used as fuel and building materials. In the case of tree cutting, there is a prohibition on cutting trees in the forest with a penalty if cutting down must replant 100 plants (Yuliati and Ambayoen 2017). The use of plants as traditional medicine by the Tengger community has been going on for a long time (Kurniawan and Jadid 2015). The Tengger community uses a lot of ethnic knowledge to process biological natural resources into drugs used to cure diseases. In this case, the community needs to provide a forum to protect the interests of biological resources, including their use in the field of indigenous peoples' medicines (Kuspraningrum et al. 2020). The existence of the forest is highly respected because the forest is part of the traditional rituals of the Tengger Tribe because the ritual materials are obtained from the forest. So that if you destroy the forest, it is like disturbing traditional ceremonies. Trees in the forest are also believed to be the dwelling place for spirits, either the tree's body itself or the spirits or other living creatures that occupy them. Cutting down trees carelessly is the same as eliminating tree life from the earth and driving away creatures that inhabit it without manners, which is very immoral behavior (Gifari et al. 2019). Conservation of mountain forests has a beneficial impact on sustainable tourism destinations and an increase in biodiversity (Hakim and Soemarno 2017). In addition, as an environmental service for clean air quality (Siswanto and Batoro 2019).

Third, Conservation of water sources for the Tengger community by not destroying the area around the water source and not accommodating the water source even though other villages use the water. If a water channel is damaged, then installing a new water channel is done by mutual cooperation (Yuliati and Ambayoen 2017).

Fourth, Conservation of animals in the Tengger community, such as the prohibition of not killing animals because they also have the right to live and are a sign for the village of abuses in the Tengger area. Conservation of animals is also carried out by preventing large trees from being cut down because people believe that plants are a place for various flora to live, let alone the presence of birds that show their habitat's potential (Siswanto and Batoro 2019). In addition, conservation is carried out in countermeasures against hunting animals protected by Bromo Tengger Semeru National Park (Achmadi 2015).

Fifth, Conservation is also carried out by introspecting on one's behavior towards the environment through the consistent implementation of traditional ceremonies. There is a tradition of *unan-unan* that asserts that humans (Tengger) cannot escape from nature. The determination of the implementation, arrangement and placement of various ceremonial facilities and their main objectives is closely related to nature. The timing of the implementation is based on an axis from nature. The arrangement and placement of the ritual facilities are directed by nature. Ecological orientation is the focus of the implementation of the ritual stages (Sukmawan et al. 2020).

APPLICATION OF ENVIRONMENTAL CONSERVATION IN TENGGER TRIBE BELIEFS AND LOCAL WISDOM

Tengger Tribe's relationship with nature beliefs

The Tengger Tribe is living side by side with nature for such generations. Almost all of their needs are fulfilled by utilizing the natural resources. Water that is used for daily needs such as bathing, cooking, and irrigating fields is taken from the Tengger Mountains and the Ngamprong springs as the main water source (Astriyantika et al. 2014). In addition, the Tengger Tribe also uses the forest for other purposes, such as collecting firewood, mushrooms, grass, and medicinal plants (Listiyana and Mutiah 2017). The people of Tengger know about the forest and the natural resources in it from the hereditary tradition of the Tengger

people who really worship the forest because according to their belief the forest is a legacy of wealth that can be used throughout life and must be passed on to the next generation (Pramita et al. 2013). Therefore, the Tengger Tribe strives to preserve the environment.

The Tengger Tribe appealed to the public to protect nature. Several officials were confirmed as honorary elders of the Tengger tradition. The tradition can be shown when the smell of incense wafted out, white smoke billowed from the brazier. In addition, prayers and inauguration ceremonies were performed. Prayers are pronounced in Tengger language. The Tengger Tribe has a wide and beautiful landscape that must be maintained. The forest must be maintained, so that nothing is damaged. The life pattern of the Tengger Tribe refers to agriculture, especially vegetables such as cabbage, potatoes, carrots and corn. However, since the Mount Bromo area was opened to become a tourist area, the lifestyle of the Tengger people has increasingly advanced with the opening of new jobs such as becoming tour guides by renting horses or jeeps to explore the Mount Bromo, also opening stalls, services, and other jobs which are able to provide economic value for the Tengger community and its surroundings. The existence of the Bromo Tengger Semeru National Park area has become an open area and has received a touch of tourism industrialization. This has led to external influences that could threaten the environment and the beliefs of the Tengger Tribe (Negara 2010). The interaction with tourists from various regions was able to increase progress in the economic sector and resulted in modernization which slowly eroded the native beliefs of the Tengger Tribe. However, according to Hikmah et al (2020), the results of the various tourism activities of Mount Bromo and various kinds of outside influences, did not make the Tengger people waver to abandon the customs that have become their traditions. Where the dynamics is that tourists participate and witness various kinds of traditional activities carried out by the Tengger community where previously the implementation of various ceremonies was only carried out by the Tengger Tribe.

Local wisdom of the Tengger Tribe in the environmental conservation

Tengger Tribe has local wisdom in the form of traditional cultural heritage from generation to generation such as the traditional ceremonies of *unan-unan*, *entas-entas*, *kasada*, *karo*, *pujan mubeng* (Febriani and Manda 2018). The Tengger Tribe is rich in traditional ceremonies, but has almost no artistic products. The traditional activities of the Tengger Tribe are led by traditional healers who have a very large role and influence in society (Marzuki 2016). The traditional shaman itself is chosen from generation to generation and appointed through a traditional ceremony held on Mount Bromo. This local wisdom also has values related to environmental conservation. In the context of a harmonious relationship with nature, the Tengger people embody environmental preservation through traditional headers. The role of the traditional header in the Tengger community is not only as the leader of the Tengger customs and rituals, but also as village officials. Where in that position, a traditional header can become an agent of social change in environmental conservation. A traditional header is a respectable and respected figure, where all actions, regulations, and what is conveyed by the traditional header are always obeyed by the Tengger Tribe. A traditional Tengger tribal header can act as an intermediary in translating ancestral messages into contemporary factual language, integrating his knowledge into traditional ceremonies, as well as a consultant or influencing the policies of the village head who are deemed to be detrimental to the environment and customs of Tengger (Negara 2010).

Initially, corn was the staple food of the Tenggerese (Sazjiyah 2020). At this time, they do not like to plant corn because of its low economic value and replace it with vegetables with high economic value. Even so, part of their agricultural land is still planted with corn because not all Tengger people replace their staple food with rice. It's just that, to harvest corn, Tengger people have to wait quite a long time, almost a year. Until now, *Nasi Aron Tengger* or corn rice is still listed as a traditional food in the culinary archipelago (Binada 2019).

The wisdom of the Tengger Tribe community in managing their territory is formed in their attitude that they will not want to sell land to non-indigenous people. The Tengger Tribe also applies a customary provision regarding environmental violations, namely if someone cuts five non-commercial trees in the Bromo Tengger Semeru National Park area, then he is required to pay with 50 sacks of cement and plant 300 pine trees in the former felled locations (Batoro et al. 2013). There is a wisdom that the people of the Tengger Tribe do not realize in protecting the surrounding natural potential, one of which is by conserving several water sources such as the Ledok water source, which is considered "haunted" by local residents (Fermansah and Mamilianti 2019). This causes the water source to receive special treatment to not be exploited.

Most of the Tenggerese have their main livelihood as farmers (Pramita et al. 2013). This means that the Tengger Tribe maintains its life in harmony with nature, which is the main life support. The attitude of harmonizing the life of the Tengger Tribe with nature is reflected in the existence of customs among them to carry out traditional ceremonial activities before starting agricultural processing activities (Fatmawati 2016).

Environmental conservation efforts of the Tengger Tribe

Conservation in brief can be interpreted as efforts to maintain/protect ecosystem functions. The Tengger Tribe has an effort to carry out environmental conservation. Several efforts have been made, such as implementing agriculture with a terracing system and maintaining the village environment's cleanliness from tourist waste (Subadyo 2016). This can be seen with the trash cans in strategic corners. In addition, the people of the Tengger Tribe facing Ranu Pani's condition try to clean the kiambang manually every day (Fitrani 2013). The manual cleaning process uses traditional tools such as bamboo

rakes, iron rakes, used sacks, rope, and long bamboo (Presillia et al. 2018).

Nature conservation efforts are also carried out by the Tengger Tribe through the tradition of kenduri and kirab (Ahwan et al. 2019). This customary tradition is a form of gratitude for nature, especially forests, where humans depend on their lives and a means to invite children and all levels of society to preserve nature through culture (Irsyad et al. 2020). *Kenduri* is carried out in the middle of the forest as an expression of gratitude for the community for the forest which is a place to make a living and depend all of their lives (Ratih and Juwariyah 2020). Environmental damage due to conversion of agricultural land and settlements must be addressed immediately. The threat of environmental and ecological damage can already be seen from various disasters such as floods and landslides and drought due to reduced water sources (Luthfi and Wijaya 2011). Therefore, through the traditional tradition of kirab and feast, it is expected to be able to invite children to protect nature starting from children (Huda and Khasanah 2019).

The perch tribe is also very protective of animals or protecting animals by prohibiting hunting of animals. The method used in overcoming the hunting of animals protected by the Tengger community is carried out by a moralistic method, in which hunters will be advised and fostered mentally and spiritually so that they become better aware (Amiruddin and Asikin 2014). As revealed in the results of the research, the perpetrators of hunting were given educational sanctions, namely being ordered to raise horses, clean the places of worship (*danyang*), the perpetrators of being diruwat, even the perpetrators were announced busy in the village (Achmadi 2015). This is done for spiritual self-awareness, according to the Tengger Tribe.

If the perpetrator of hunting protected animals is not a resident of Tenggerese, the prevention is immediately handed over to the authorities and resolved under the applicable National Law in Indonesia (Thontowi 2015). Efforts to tackle cases of poaching of protected animals in the Tengger Tribe community are more focused on making the perpetrators and the residents involved so that the case can be resolved through deliberations attended by traditional stakeholders, actors and residents involved (Liuw 2013).

Examples of cases of animal hunting are as follows. Based on the results of the Supreme Court's decision on June 30, 2014, 2 perpetrators of poaching were caught. The two perpetrators were Lumajang residents around Bromo Tengger Semeru. The two actors were caught carrying equipment to catch birds in the form of 2 green palm fibers with a size of 5 meters each and a width of 1.5 meters, 1 wooden cage, 2 small white plastic, 2 sickle blades, 4 white bumbung made of paralon, a rope / small slap of brown with a length of 3 meters going into the forest area of Bromo Tengger Semeru National Park. Likewise, on September 14, 2014, a man who hunted him was also a Malang resident who was around Bromo Tengger Semeru. The perpetrator was secured by a forest guard officer and evidence was confiscated in the form of 1 air rifle, 1 punglor jail bird, 1 cucak wilis, and 2birds manten dead.

Supporting factors in overcoming poaching of protected animals: (a) legal regulations, the Tengger Tribe has an institutional structure, namely religious leaders and traditional shaman institutions. The traditional dukun institution is in charge of overseeing the implementation of customary rules and customary law. The traditional dukun institution consists of traditional legend shaman, sanggar, and elders. With the existence of the traditional shaman, there is coordination with conservation organizations to protect the natural environment. The community welcomes the cooperation of Bromo Tengger Semeru National Park in tackling hunting of protected animals; (b) legal culture, the value of ecological wisdom is still owned by the Tengger community so that the Tengger Tribe make customary law a system of social control. As for the prevention of cases of hunting of protected animals, resolved in amicable manner by deliberation. In addition, the sanctions given to perpetrators tend to be awakening. So that the customary law that applies in the Tengger Tribe is more effective than the national law.

INFLUENCE OF TENGGER BELIEFS AND LOCAL WISDOM ON ENVIRONMENTAL CONSERVATION

The Tengger Tribe has its own unique socio-cultural institutions and customs, religions, beliefs, arts, languages, and social or institutional organizations (Mukhtaromi 2013). In general, the Tenggerese live in the agricultural sector, especially potato, leek, cabbage, corn, carrots and a small part manage tourism, trade and livestock (Ayuninggar et al. 2013). In general, the life of the Tengger Tribe still depends on nature. This makes them try to keep nature as part of their life.

The customary law of the Tengger people is very strong, even though the Tengger customary law community is open, namely following the times. Customary law and State law go hand in hand, so that the Tenggerese customary law community always obeys the laws of the State. The form of customary law in Tengger is unwritten. Although the legal form is unwritten, if there is a violation of customary law, it will be subject to sanctions in accordance with the applicable customary provisions.

The function of the law in society is very diverse, in every society, the law functions more to guarantee security in society and guarantee the achievement of the social structure expected by the community. Law is a tool to control people's behavior. Non-legal means of social control include religion, morality, customs, education, art, press, and role models of leaders. Likewise, what happened to the Tengger people who made customary law a system of social control in society.

In their spiritual life, the Tengger Tribe recognizes the existence of Karmaphala (Putra 2017). Karmaphala comes from the Sanskrit language which consists of two words, namely "*karma"* and *"phala"*. *"Karma"* means action and "*Phala*" means fruit, result, or reward (Maryastini et al. 2020). So Karmaphala means the result of one's actions

(Kemenuh 2020). Based on the law of cause and effect, or reaction action, all causes will inevitably produce effects (Phala). Karmaphala means the fruit of an action/behavior that has been done or will be done (Parwata and Atmadja 2020). In the Hindu concept, doing or behaving consists of: actions through thoughts, actions through words, and actions through behavior (Suweta 2020). These three are what will bring results for those who do. If the actions are good, the results will be good, and vice versa (Wigunadika 2018).

This value about Karma Phala is the cultural value of the Tengger Tribe in their social behavior. Not only his relationship with others, but also his relationship with nature (Izzah 2013). They maintain a harmonious interaction with nature and have their own rationality (Nurcahyono and Astutik 2018). As a community that depends on nature, the Tengger Tribe feels the need to maintain a balance with the existing ecosystem (Pahlevy et al. 2019). With this social awareness, they will not be reckless and greedy to exploit natural resources arbitrarily.

The Tengger Tribe views that their relationship with nature that supports their life is not only influenced by their social awareness that they depend their economic life on natural resources (Putra et al. 2018). However, they also view the relationship between the two in a religious magical cosmic context. In this cosmic magical thinking, humans are placed as an inseparable part of nature.

CONCLUDING REMARK

Tengger Tribe lives around Mount Bromo slopes and is part of the Javanese tribe, but different cultural forms. The name of the Tengger Tribe consists of the word "*Teng"* taken from the name Roro Anteng, while the word "*Ger*" is taken from the name Joko Seger. It is said that the people of the Tengger Tribe are descended from these two figures. The Tengger Tribe, which is a multi-religious tribe, can maintain the harmony and diversity through various traditions and customary norms of Tengger. Beliefs or customs are closely related to implementing traditional ceremonies which are an integral part of culture. It is necessary to maintain the development and socialization from generation to generation so that its sustainability is maintained. Environmental conservation in the beliefs of the Tengger Tribe is realized from the existence of traditional ceremonies or local customs. All the rites contained in the Tengger community are manifestations of a religious system based on cultural values. There are three local wisdom values of the Tengger Tribe, namely the value of obedience (*setuhu*), the value of mutual cooperation (*sayan*), and the value of honesty (*prasaja*). The value of compliance *Wong Tengger* is manifested to carry out the existing traditional process mechanisms by following the predetermined schedule and stages. The value of mutual assistance (*sayan*) is manifested in the implementation of development in the Tengger Tribe area. The value of honesty (*prasaja*) is manifested in the accountability process for the use of the budget by the Tengger community.

The Tengger Tribe has lived side by side with nature for generations. Almost all needs are met by utilizing natural resources. The water used for daily needs such as bathing, cooking, and irrigating fields takes it from the Tengger Mountains and Ngamprong springs as the main water source. In addition, the Tengger Tribe also uses the forest for other purposes, such as collecting firewood, mushrooms, grass, and medicinal plants. The people of the Tengger Tribe have local wisdom in the form of traditional cultural heritage from generation to generation such as the traditional *unan-unan*, *entas-entas*, *kasada*, *karo*, *pujan mubeng* ceremonies. The Tengger Tribe has an effort in carrying out environmental conservation. Some efforts have been made, such as implementing agriculture with a terracing system, maintaining the cleanliness of the village environment from tourist waste. The beliefs held by the Tengger Tribe are closely related to environmental conservation. The Tengger Tribe also made efforts to conserve nature through the tradition of kenduri and kirab. The perch tribe is also very protective of animals / animals by prohibiting hunting of animals. The method used in overcoming the poaching of animals protected by the Tengger community is carried out by the moralistic method. The belief held by most of the Tengger Tribe is Hinduism. This resulted in the Tengger Tribe being guided by the teachings of Hinduism. In Hinduism there is the term Karmaphala that means all actions will be rewarded. This teaching then becomes the guide for the Tengger Tribe in making environmental conservation efforts. Thus, it is hoped that the belief of the Tengger Tribe community will have a good effect on environmental conservation through the teachings of karmaphala.

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Ethnobotanical study of medicinal plants used by local people of Mojana Wadera Woreda, North Shewa Zone, Amhara Region, Ethiopia

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Abstract. *Haile AA. 2022. Ethnobotanical study of medicinal plants used by local people of Mojana Wadera Woreda, North Shewa Zone, Amhara Region, Ethiopia. Asian J Ethnobiol 5: 35-43.* This study was conducted in Mojana Wadera Woreda of North Shewa Zone (Ethiopia) to document the indigenous knowledge of local communities on medicinal plants. The data was collected using structured and semistructured interviews with herbalists. Information on medicinal plants was collected from June 2020 to October 2020. Fourteen (10 males and 4 females) key informants were deliberately selected during the data collection, but no group discussion was conducted due to the coronavirus epidemic. Descriptive statists (percentage and frequency) were used to summarize ethnobotanical data and preference ranking, and the Information consensus factor (ICF) was also included. A total of 56 medicinal plants from 52 genera, and 38 families, were identified in the study area, where they were used to treat human and animal diseases. Family-wise, Asteraceae was the most dominant family, followed by Lamiaceae. Herbs were the most dominant growth forms as they accounted for about 29 (52.72%) species, while shrubs had 17 (30.9%) species. Most herbal remedies were prepared by mixing 25.45% of the roots and leaves. The preparation was usually done by crushing to 45.45%, and during the preparation, the herbs were usually fresh. Most medicines were administered orally to the sick. According to the key informant's response, the plants in the study area are under threat. Therefore, the conservation of medicinal plants related to indigenous knowledge is important for future generations.

Keywords: Indigenous knowledge, informant consensus factor, medicinal plants, Mojana Wadera

INTRODUCTION

The role of medicinal plants in health care is significant in developing countries (Smith-Hall et al. 2012; Sofowora et al. 2013; Kassa et al. 2020). According to WHO, 80% of the population in developing countries rely on medicinal plants for healthcare (Khan et al. 2015; Van Wyk and Gorelik 2017). Moreover, many modern-day drugs originated from plants (Farnsworth 1996). However, although plants play an important role in medicinal value, it is difficult to determine many plants' medicinal properties and potential due to their low perception of traditional plants (Makule et al. 2014). Therefore, it is important that this potential is not confined to a single community and that all do their part to pass it on to the next generation and discover a new drug (Heinrich 2003; Suleiman 2015).

Ethiopia is the fifth major country in tropical Africa in terms of the diversity of flora, next to Tanzania, Cameroon, Congo, and South Africa (Jadán et al. 2021). In the Flora of Ethiopia and Eritrea, about 6,027 vascular plant species (including subspecies), with about 10.74% endemism, were documented (Kelbesa and Demissew 2014). From the total vascular plants, 1,882 are common in both countries, while 3,875 have been recorded from Ethiopia and 270 from Eritrea only. Similarly, in the diversity of plant groups, angiosperms and dicotyledons were the most dominant, which estimated about 5,815 and 4,413 species (including subspecies), respectively. Ethiopia is rich in biodiversity, topographical complexity, and climate variability, varied altitudinal gradients ranging from Danakil Depression (125 masl) to the Semien Mountains (4533 masl), which jointly result in different vegetation types (Asefa et al. 2020). According to Tena (2014) and Bekele (2007), more than 1000 medicinal plants species have been reported in Ethiopia, and about 33 of these species are endemic to the country.

Although there is a lot of cultural knowledge in Africa, data on traditional medicinal plants are not systematically documented (Nyamwaya 1967). This means that knowledge of traditional medicine is not recorded and is passed from generation to generation orally. If this trend continues, it poses a risk. Ethiopia is one of the six plant-rich countries of Africa, where about 60% of the plants are said to be indigenous, and most of them with healing potential (Nigatu et al. 2018). Even though a country with a great variety of cultures and diversity of medicinal plants, the alarming population growth with increasing demand and consumption is distracting medicinal plants resources from their natural habitat (Meaza et al. 2015). Threats to medicinal plants in Ethiopia include human migration, agricultural expansion, forest fires, and drought (Kidane et al. 2018; Tefera and Kim 2019). Thus, in this country, studies and research are much needed on conservation, management, cultivation, and ethnobotanical knowledge, including medicinal plant species (Asnake et al. 2016; Kassa et al. 2020).

Despite the significant role of medicinal plants in treating both human and livestock ailments in Ethiopia, a very limited attempt has been made to explore, document,

and promote these widely used medicinal plants in the country (Assen et al. 2021).

Hence, plant research and related indigenous knowledge should be an urgent task to protect and save the indigenous knowledge to transfer this knowledge to future generations. Many studies have been done in Ethiopia on ethnobotanical medicinal plants (Kefalew et al. 2015; Yohannis et al. 2018; Tefera and Kim 2018; Tibebu and Mesele 2019; Gonfa et al. 2020; Assefa et al. 2021; Ayalw and Merawi 2021; Megersa et al. 2022; Megersa and Woldetsadik 2022). However, little research has been done so far in the Mojana Wadera woreda in the North Shewa zone of Ethiopia. Therefore, the present study aimed to document indigenous knowledge of medicinal plants in Mojana Wadera woreda found in the North Shewa zone, Amhara Region, Ethiopia.

MATERIALS AND METHODS

Description of the study area

The study was conducted in Mojana Wadera Woreda found in North Shewa Zone, Amhara Region, Ethiopia (Figure 1). This woreda is bordered by Menz Lalo Midir on the northeast, Termaber on the east, Menz Mam Midir on the north, and Basona Werana on the south. Mojana Wadera Woreda is located at 090 91’ to 090 94’N and 360 61’ to 390 67’E. The mean altitude of the area is 2678-2935 masl. A unimodal rainfall pattern characterizes the climate of the study area, and the area receives an average annual rainfall of 928 mm, While the minimum and maximum temperatures are 11.18^0C and 24.67^0C, respectively (Kenzemed et al. 2020). The vegetation cover is less compared to other places. According to the 2012 Ethiopian national census data, 75,394 people live in Mojana Wadera woreda, while about 99.87% of the residents practice Ethiopian Orthodox Christianity as their religion. The area is dominated by *Eucalyptus globulus* and *Juniperus procera* tree species. The livelihood of Mojana Wadera depends on agriculture. The major crops produced in this woreda are wheat, barley, and beans.

Selection of potential kebeles and informants

In the study area, 5 kebeles (In Ethiopia, Kebele is the smallest administrative unit) (Namely: Begoch Gat, Brka, Engida washa, Gan Arda, and Zub Amba) were selected. These kebeles were selected based on the capacity of key informants and the supply of herbs. The data was collected from June 2020 to October 2020. During data collection, 14 (10 men and 4 women) traditional healers (key informants) between the ages of 33-75 were included. The key informants were selected purposively.

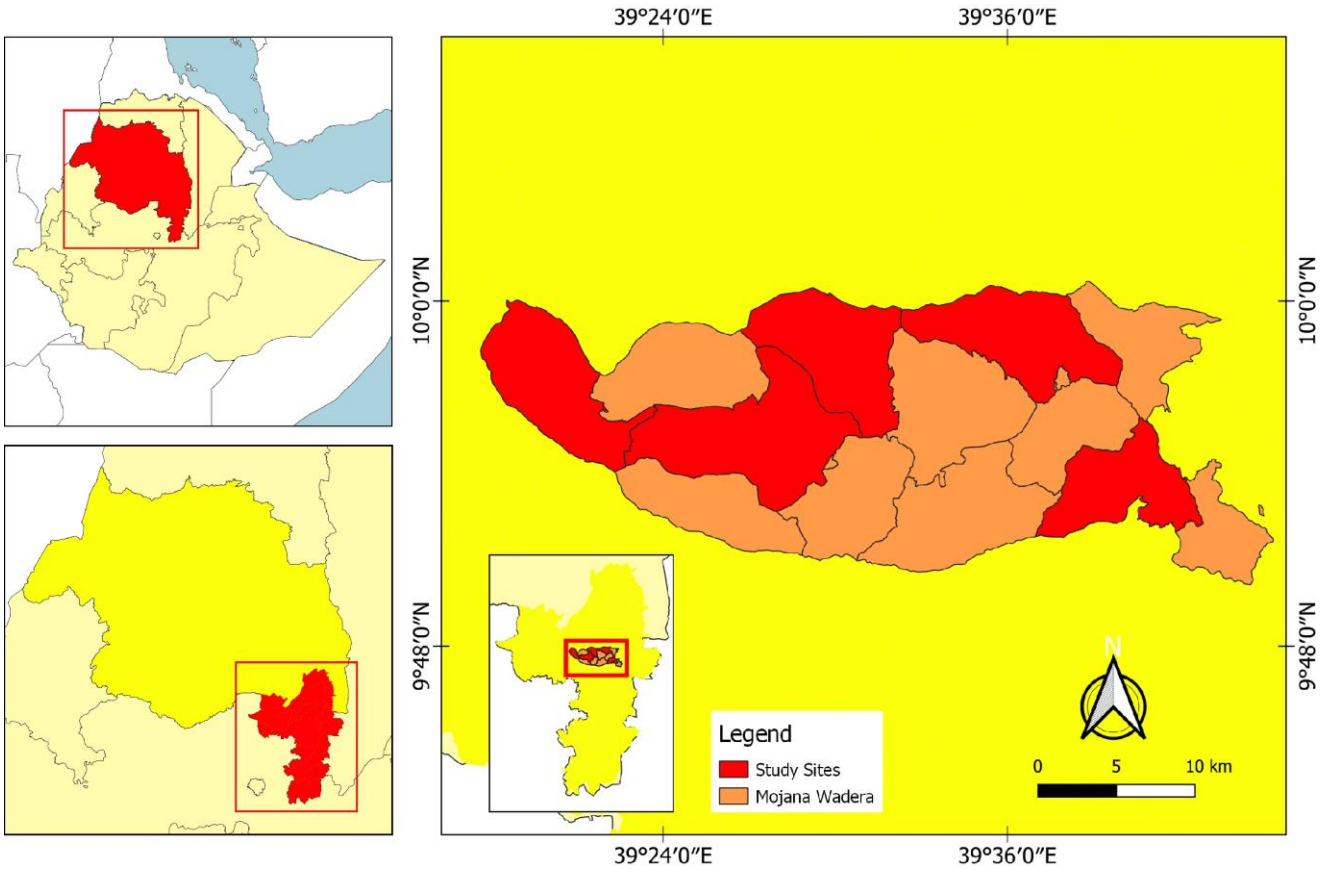

Figure1. Location map of Mojana Wedara Woreda, Amhara National Regional State, Ethiopia

Ethnobotanical data collection and plant specimen's Identification

Data was collected from knowledgeable people about medicinal plants through semistructured and structured interviews (Malik 2020). Each selected traditional healer was interviewed individually about medicinal plants, local names, plant parts used in medicine, methods of preparation for each type of ailments, and ways of remedy administration.

Due to the coronavirus pandemic, there was no group discussion on the data collected on medicinal plants with key informants (Covid19). Still, the information was collected directly from the key informants individually. Botanical experts identified the specimens of reported medicinal plants at Debre Berhan University by comparing the relevant volumes of the flora of Ethiopia and Eritrea. The identified specimens were deposited at Debre Berhan University.

Data analysis

Descriptive statistic procedures like percentage and frequency distribution were applied for analyzing and summarizing the data.

Preference ranking

To compare the most effective medicinal plants used by a community to treat a particular diseases, a preference ranking was conducted following by Martin (1995) and Malik (2020) for the most important medicinal plants used in treating a particular illness. For this, five key informants were selected to identify the best preferred medicinal plant species for the treatment of stomachache because it is a frequently occurring disease in the study area. Each informant was provided with the mentioned medicinal plants reported to cure the illness with the leaves of the medicinal plants used being paper tagged and then was asked to assign values of 1 to 4 were used in this ranking (1= less used, 2= good, 3= very good, and 4= excellent. This means that the informant is given 4, which means this plant is the most preferred one but given (1), the plant species is less used to treat stomachache (Table 2).

Informant Consensus Factor (ICF)

The Informant Consensus Factor (ICF) is used to identify the agreement of the informants on the reported use of plant species to treat a particular illness. The ICFS were calculated as follows:

$$ICF = nur\text{-}nt/nur\text{-}1$$

Where: nur = number of use citations (nur) minus the number of species used (nt), ICF = Informants Consensus Factor, divided by the number of use citations in each category minus one (Heinrich et al. 1998). The factor provides a range of 0 to 1, where 1 is a high value acts as a good indicator for a high rate of informant consensus.

RESULTS AND DISCUSSION

Diversity of medicinal plants in Mojana Wadera Woreda

A total of 56 medicinal plant species distributed in 52 genera and 38 families were collected and documented (Table 1). From a total of medicinal plants, 92.85% were used to treat human ailments, while 7.15% were used to treat livestock diseases. Among the families that contributed more medicinal species were Asteraceae, represented by 6 (10.7%) species, Lamiaceae with 5 (8.93%) species, Fabaceae 4 (7.4%), Solanaceae and Polygonaceae were represented with 3 species each, and the other 32 families were contributed to 35 (62.5%) of the species represented 1 or 2.

Growth forms of medicinal plants

In the study area, the growth pattern of medicinal plants was mainly herbs, 29 (52.72%) species, followed by shrubs with 17 (30.9%) species (Figure 2).

Plant parts Used to prepare remedies in the study area

Traditional healers use different parts of the plant to prepare the medicine. In this study, most of the plant parts used for medicinal purposes were mixed with roots and leaves (25.45%). The leaves and roots are covered equally (21.8%) (Figure 3).

Methods of medicinal plants preparation and forms

Traditional medicine was prepared through crushing, pounding, grinding, powdering, heating, and juice in the study area. Crushing was the most common (45.45%) method of preparing herbal medicines, followed by the powdering preparation method (27.27%). Similarly, Pounding and grinding (9.09%), heating (10.9%), and juice (10.9%) were the other preparation methods of the remedy used in the study area. Most of the herbal remedies in the study area were made from fresh herbs. Similarly, according to most respondents, herbal remedies were prepared by drying parts of the plant, which will be pounded and stored, then given to the patient when they have a problem.

Route of application

In the study area, the drug was given to the patient through the mouth, skin, nose, or other body parts. Of the prepared traditional medicines, 53.58% were given to patients orally, and 26.79% were given dermal (Figure 4).

Comparison of important medicinal plants in the study area

Preference ranking

Five medicinal plants were selected, after which key informants were asked to rate their value based on the effectiveness of these medicinal plants for treating stomachache (value =1 to 4). *Tavenerara abyssinia* was ranked as one of the most effective plant species for stomachache, followed by *Thalictrum rhynchocarpum*, according to key informants, while *Achyranthes aspera* was the least medicinal plant for treating stomachache (Table 2).

Table 1. List of medicinal plants used by Mojana Wadera Woreda People, Ethiopia

Local name	Plant family	Scientific name	Habit	For treating	Treated illness	Used parts	Methods of preparation	Route of application
Telenji	Amaranthaceae	*Achyranthes aspera* L	Herb	Human	Stomachache	Root	Crushed and mixed with water and drunk on an empty stomach until recovery	Oral
Smiza (sensel)	Acanthaceae	*Justicia schimperiana* Hochst. ex Nees	Shrub	Human	Evil eye	Root	Mixed with *Carissa spinarum and* put on fire, then sniff	Nasal
Nechshinkurt	Alliaceae	*Allium sativum* L	Herb	Human	Asthma	Bulb	Boiled with *Zingiber officinale*, and the filtrate will be sniffed	Nasal
Chikugn	Asteraceae	*Artemisia abyssinica* Schtz, Afra Jacq	Herb	Human	Diarrhea	Root/ leaf	Crushed and mixed with water then drink	Oral
Senafch	Brassicaceae	*Brassica nigra* L	Herb	Human	Wound	Seed	The powder will be mixed with Vaseline and applied to the affected part.	Dermal
Digita	Fabaceae	*Calpurnia aurea* (Ait.) Benth	Shrub	Human	Jaundice	Leaf	The oiled steam is taken.	Nasal
Etsefaris	Cannabaceae	*Cannabis sativa* L	Herb	Human	Epilepsy	Leaf & root	The root and leaf crushed then sniffed through nostrils	Nasal
Yebeg lat	Brassicaceae	*Capparis tomentosa* L	Herb	Human	Sudden bleeding	Leaf	The crushed leaf juice will be applied to the bleeding body.	Nasal
Habeshasuf	Asteraceae	*Carthamus tinctorius* L	Herb	Human	Constipation	Seed	The powder will be boiled, then drink the filtrate.	Oral
Koshashle	Asteraceae	*Cirsium englerianum* O. Hoffm	Herb	Human	Headache	Root	The boiled steam taken through nostrils.	Nasal
Etse eyesus	Menispermaceae	*Stephania abyssinica* A. Rich	Climber	Human	Stomachache	Root	Crushed and mixed with water, and the filtrated will be drunk.	Oral
Lomi	Rutaceae	*Citrus aurantiifolia* (Christm.) Swingle	Shrub	Human	Dandruff	Fruit	The juice will be applied to the affected part	Dermal
Azohareg	Ranunculaceae	*Clematis simensis* Fres	Climber	Human	Skin rash	Root	The powder mixed with butter apply to the affected part	Dermal
Yejib shinkurt	Amaryllidaceae	*Crinum abyssinicum* Hochst. ex A. Rich	Herb	Human	Swellings	Root & leaf	Leaf and root will be crushed and mixed then applied to the affected part.	Dermal
Bisana	Euphorbiaceae	*Croton macrostachyus* Hochst	Tree	Human	Dandruff	Twig	The twig juice is applied to the head	Dermal
Yemidirenbuay	Cucurbitaceae	*Cucumis ficifolius* A. Rich	Herb	Human	Retained placenta	Root	By mixing the powder with water then drink	Oral
Tejsar	Fabaceae	*Cymbopogon citratus* (DC ex Nees) Stapf	Herb	Livestock	Blotting	Leaf & root	The root and leaf will be crushed and mixed with water then given to cattle.	Oral
Ameraro	Solanaceae	*Discopodium penninervium* Hochst	Shrub	Human	Swellings	Leaf & root	Crushed, mixed with vaseline then applied to the affected part.	Dermal
Gme	Boraginaceae	*Ehretia cymosa* Thonn	Herb	Human	Mental disorder	Leaf & root	Powder of leaf and root is put on fire then smoked	Nasal
Adal *(*Asta*)*	Ericaceae	*Erica arborea* L	Shrub	Human	Lung illness	Root & fruit	The Crushed will be mixed with honey then eaten.	Dermal
Enslal	Apiaceae	*Foeniculum vulgare* Miller	Herb	Human	Evil eye	Root & leaf	The root and leaf are pounded then the powder is put on fire then, sniffed	Nasal
Ameja	Hypericaceae	*Hypericum quartinianum* A.Rich.	Shrub	Livestock	Anthrax	Root & leaf	The powder will be mixed with water then given to cattle	Oral
Weynagift	Asteraceae	*Inula confertiflora* A. Rich	Shrub	Human	Skin rash	Leaf	Juice of the leaf is applied to skin rash	Dermal
Zohun-kechamo	Oleaceae	*Jasminum abyssinicum* Hochst.ex DC	Climber	Human	Herpes	Root & leaf	The crushed powder will be applied to the affected part	Dermal
Habesha tid	Cupressaceae	*Juniperus procera* L	Tree	Human	Mefthe siray	Leaf	The small leaf is mixed with *phytolacca dodecandra* of seven leaves, and one cup of Kulkual milk is mixed with fresh cow milk and then drunk. Finally, the antidote is eaten with hen liver and telba.	Oral
Shinqaq (Enduhahla)	Crassulaceae	*Kalanchoe shimperiana* A. Rich	Herb	Human	Wound (small swelling)	Leaf	The leaf put get fire then immediately fresh put to the affected part	Dermal

Yeferes Zeng	Lamiaceae	*Leonotis ocymifolia* (Burm.f.) Iwarsson	Shrub	Human	Cough	Leaf	The juice will be mixed with coffee then drunk	Oral
Feto	Brassicaceae	*Lepidium sativum* L	Herb	Human	Toothache	Seed	The roasted and pounded fresh powder will be held on the tooth until recovery	Oral
Telba	Linaceae	*Linum usitatissimum* L	Herb	Human	Diarrhea	Seed	The powder will be boiled then drink like soup	Oral
Qelewa	Myrsinaceae	*Maesa lanceolata* Forssk	Tree	Human	Wound	Seed	The crushed seed of *Maesa lanceolata* powder will be applied to the affected part	Dermal
Shenet	Myricaceae	*Myrica salicifolia* Hochst. ex A. Rich	Tree	Human	Tonsillitis	Bark	The dried bark powder will be mixed with water and then drunk until recovery.	Oral
Ades (Barsenet)	Myrtaceae	*Myrtus communis* L	Shrub	Human	cough	Leaf	Crushed juice of leaf will be mixed with water then drunk	Oral
Tinbaho	Solanaceae	*Nicotiana tabacum* L	Shrub	Livestock	Leeches	Leaf	The crushed leaf will be mixed with water and then given to cattle.	Oral
Tikur azmud	Ranunclaceae	*Nigella sativa* L	Herb	Human	Headache	Seed	The crushed powdered is sniff	Oral
Dmakesse	Lamiaceae	*Ocimum lamiifolium* Hochst	Herb	Human	Febrile illness	Leaf	The crushed root will be mixed with coffee then drunk	Oral
Weyra	Oleaceae	*Olea europaea* sub.sp.cuspidata L	Tree	Human	Impotency	Root	The root seedling of *Olea europaea* will be pounded and then tied on pinus for 3 days.	Oral
Endod	Phytolaccaceae	*Phytolacca dodecandara* L'Herit	Shrub	Human	Dandruff	Fruit	The juice of the fruit will wash the affected part.	Dermal
Gorteb	Plantaginaceae	*Plantago lanceolata* L	Herb	Human	Stomach troubles	Root	The root is crushed, then mixed with water and drunk	Oral
Etse libona	Polygalaceae	*Polygala abyssinica* Fres	Herb	Human	Stomachache	Root	The crushed root will be mixed with water and then drunk.	Oral
Gesho	Rhamnaceae	*Rhamnus prinoides* L'Herit	Shrub	Human	Tonsillitis	Twig	The crushed twig will be mixed with water then drunk	Oral
Tsegereda	Rosaceae	*Rosa hybrid* L	Shrub	Human	Ear problem	Leaf & flower	Boiled in water and a drop of suspension will be dropped into the ear	Ear
Rosmeri	Lamiaceae	*Rosmarinus officinalis* L	Herb	Human	Stomachache	Leaf & root	the crushed leaf and root will be mixed with water then drunk	Oral
Meqmeqo	Polygonaceae	*Rumex abyssinicus* Jacq	Herb	Human	Wound	Root	The crushed root powder will be applied to the affected part.	Dermal
Tult	Polygonaceae	*Rumex nepalensis* Spreng	Herb	Human	Tonsillitis	Leaf	The leaf will be crushed and given to patient	Oral
Embwacho	Polygonaceae	*Rumex nervosus* Vahl	Shrub	Human	Dandruff	Leaf	Fresh leaves will be rubbed on the affected area	Dermal
Tenadam	Rutaceae	*Ruta chalepensis* L	Herb	Human	diarrhea	Seed	The pounded seed will be mixed with coffee then drunk	Oral
Hulegeb	Lamiaceae	*Salvia nilotica* Jacq	Herb	Human	Nose bleeding	Leaf	The leaves will be crushed and sniffed.	Nasal
Shikoko gomen	Asteraceae	*Solanecio gigas* (Vatke) C. Jeffrey	Shrub	Human	Rabies	Root &leaf	The ground root and leaf will be mixed with water then drunk	Oral
Dingetgna	Fabaceae	*Taverniera abyssinica* Rich	Shrub	Human	Stomachache	Root	The root of *Taverniera abyssinica* will be chewed and then swallowed during the infusion.	Oral
Sirebizu	Ranunculaceae	*Thalictrum rhynchocarpum* Dill. & A. Rich	Herb	Human	Stomachache	Root	Root will be chewed	Oral
Tosign	Lamiaceae	*Thymus schimperi* Ronniger	Herb	Human	Ascariasis	Leaf	The leaf will be crushed and boiled then drunk like tea	Oral
Abish	Fabaceae	*Trigonella foenumgraecum* L	Herb	Human	Gastric problem	Seed	The pounded seed will be boiled then drunk like soup in the morning	Oral
Qetetina	Scrophulariaceae	*Verbascum sinaiticum* Benth	Herb	Human	stabbing pain	Root	The root will be chewed	Oral
Grawa	Asteraceae	*Vernonia amygdalina* Del	Tree	Livestock	Anthrax	Root & leaf	The crushed leaf & Root will be mixed with water then given to cattle	Oral
Gzawa	Solanaceae	*Withania somnifera* (L.) Dun	Shrub	Human	Evil eye	Root & leaf	The root and leaf will be crushed and put on fire then taken smoke	Nasal
Zinjible	Zingiberaceae	*Zingiber officinale* Roscoe	Herb	Human	Cough	Rhizome	Crushed and boiled then drunk like tea	Oral

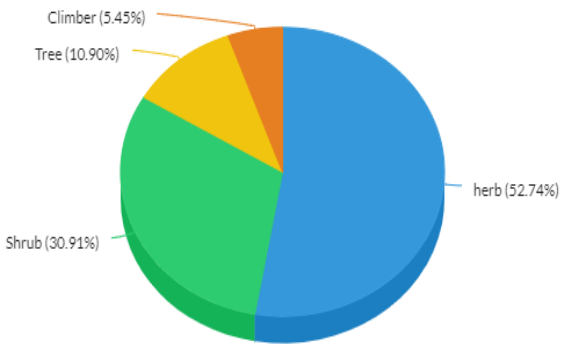

Figure 2. Growth forms of medicinal plants in Mojana Wadera Woreda, Ethiopia

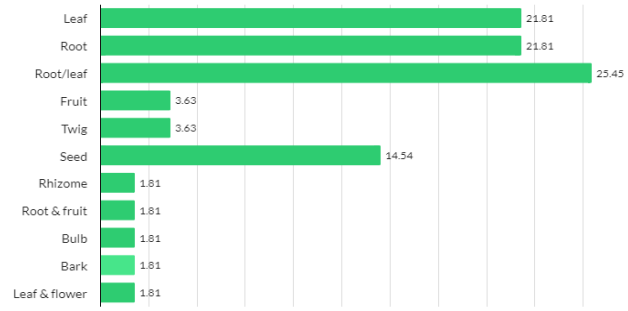

Figure 3. Plant parts used to prepare remedies in the study area

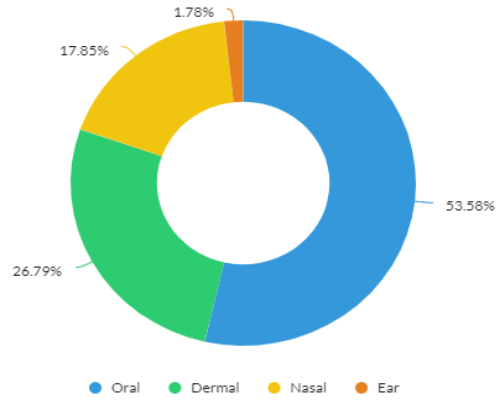

Figure 4. Route of administration in the study area

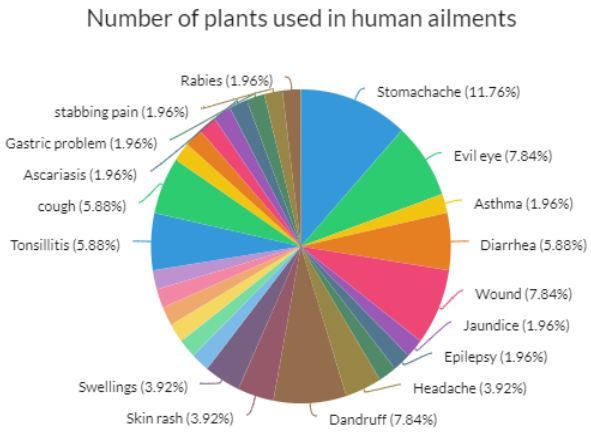

Figure 5. Distribution of different human ailments with a respective number of medicinal plants in the study area

Table 2. Preference ranking of medicinal plant species to treat stomachache

Key informants	*Cissampelos mucronata*	*Polygala abyssinica*	*Taverniera abyssinica*	*Achyranthes aspera*	*Thalictrum rhynchocarpum*
1	2	4	4	3	4
2	4	4	3	2	3
3	3	3	4	3	4
4	3	1	4	4	4
5	4	3	4	2	3
Total	16	15	19	14	18
Rank	3	4	1	5	2

Table 3. Results of Informants consensus factors (ICF) values for more prevalent health problems of the District

Category of disease	List of plant species used and number of citation in the bracket	Total number of species	Number of citation	ICF
Stomachache	*Achyranthes aspera* (9), *Stephania abyssinica* (11), *Polygala abyssinica* (13), *Taverniera abyssinica* (14), *Thalictrum rhynchocarpum* (12)	5	59	0.93
Evil eye	*Justicia schimperiana* (11), *Foeniculum vulgare* (10), *Withania somnifera* (12)	3	33	0.94
Wound	*Brassica nigra* (6), *Maesa lanceolata* (8), *Rumex abyssinicus* (11)	3	25	0.91
Diarrhea	*Artemisia abyssinica* (12), *Linum usitatissimum* (6), *Ruta chalepensis* (5)	3	23	0.909
Jaundice	*Calpurnia aurea* (14)	1	14	1

Informant consensus factor

Based on the incidence of the disease in the study area, these diseases were grouped into different categories. Then, ICF was calculated for each category of disease (Table 3). The value of the factor ranges from 0 to 1; if the value of 1 indicates there is a high rate of agreement between informants. As the results showed, Jaundice scored the highest informant consensus factor of 1, followed by Evil eye (0.94), stomachache (0.93), wound (0.91), and diarrhea (0.90), respectively (Table 3). A high value of ICF indicates there is a consistency between key informants to treat jaundice by the same plant species, while a low value indicates there is a variation between key informants' agreement between them on plant species usage in treating a given disease category.

Proportion of medicinal plants used in the study area to treat different human ailments

Respondents say they used other herbs in combination or individually to treat human ailments. For example, 6 (11.76%) of the 51 medicinal plants listed to treat human ailments used to treat stomachache were used to treat stomach ailments (Figure 5).

Discussion

Of 56 medicinal plants, 92.85% were used to treat human ailments, while 7.15% treated livestock. Key informants are more experienced in treating human diseases, but they are less likely to treat their animals because the disease is less common. These findings are in line with other findings in Ethiopia; these findings are agreed with other research areas in Minjar Shenkora district in North Shewa zone, Amhara region from a total of 118 identified medicinal plant species, 63.55% were used to treat humans. In contrast, the remaining 15.25% of species were used to treat livestock ailments (Kassa et al. 2020). In the neighboring country of Kenya, Mutwiwa et al. (2018) also report that of the 51 plant species from their study, 91.67% were used to treat human diseases, while only 7.94% were used for the treatment of livestock diseases. The Asteraceae families were the most common medicinal species in this study area. Similarly, a study in Menz Gera Midir district in North Shewa Zone, Amhara region (Yohannis et al. 2018) showed that Asteraceae were ranked first, contributing 16 species, followed by Lamiaceae with 12 species. This result agrees with others finding that Asteraceae were the most dominant taxa (Uzun and Koca 2020).

Herbs were the most dominant plant growth forms, covering 29 (52.72%) species, followed by shrubs with 17 (30.9%) species. This result is consistent with a study covering 29 (52.72%) species, followed by shrubs with 17 (30.9%) species. Furthermore, this result is consistent with a study conducted by Amsalu et al. (2018) in Gozamen Woreda (East Gojjam Zone), in which herbs were the dominant growth forms. Also, this result is consistent with different parts of the world in which herbs were the dominant growth forms (Mahwasane et al. 2013; Hong et al. 2015; Khan et al. 2015; Hu et al. 2020).

Traditional healers use different plant parts to prepare the medicine in the study area. In this study, most of the plant parts used for medicinal purposes were mixed with roots and leaves (25.45%). This is agreed with Birhan et al. (2017) Enarj Enawga District (East Gojjam Zone), multiple plant parts are recommended for remedy preparation. But, disagree with Malik et al. (2019) that leaves were covered 62% for remedy preparation in Pakistan. The leaves and roots are covered equally (21.8%). Traditional medicine is prepared through crushing, pounding, grinding, powdering, heating, and juice in the study area. Crushing is generally covered by 45.45%, which is an essential way to prepare herbal medicines, and the powdering preparation method covers 27.27% for medicinal purposes. This study is consistent with Kassa et al. (2020) in Minjar-Shenkora District, North Shewa Zone, and Amsalu et al. (2018) Gozamin Wereda, East Gojjam Zone. Similarly, pounding and grinding (9.09%), heating (10.9%), and juice (10.9%). All these are the preparation methods of the remedy used in the study area. But, these results disagree with other authors that preparation of medicinal plants was by infusion covered 54% in Moroccan Rif (Chaachouay et al. 2019), while in the Ayta Communities in Dinalupihan, Bataan, Philippines, the method of preparation was by drinking, which covered 44% (Tantengco et al. 2018). Most of the herbal remedies in the study area are made from fresh herbs. Similarly, according to most respondents, herbal remedies are prepared by drying parts of the plant will be pounded and stored, then giving the patient the medication when they have a problem. Of the prepared traditional medicine, 53.58% was given to patients orally (Figure 3). This result is agreed with Osman et al. (2020) studied in the Raya Kobo District.

In the study area, *T. abyssinia* was the most preferred and important medicinal plant species by traditional healers to treat stomachaches. A high ICF value indicates a consistency between key informants to treat jaundice by the same plant species. In contrast, a low value indicates a variation between key informants' agreement on plant species usage in treating a given disease category.

In conclusion, the results of this study show the existence of indigenous knowledge of medicinal plants used in Mojana Wadera woreda. A total of 56 medicinal plants were identified in the study area. They belonged to 53 families; from these, Asteraceae and Lamiaceae were the most representative families. Most medicinal plants are used to treat human ailments. The growth forms of medicinal plant species are mostly herbs. The major plant parts were the mixture of leaves and roots to prepare a remedy. The route of administration of the prepared remedy is mainly orally. The key informants in the woreda are trusted by the community and certified by its residents. These key informants secretly pass on their knowledge to their children. This, in turn, contributes to the spread of knowledge. Therefore, today's study is a late way to discover new drugs in the future based on these collected documents of medicinal plants in Mojana Wadera Woreda.

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An ethnobotanical study of plants used in socio-religious activities in Bhutan

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Abstract. *Jigme, Yangchen K. 2022. An ethnobotanical study of plants used in socio-religious activities in Bhutan. Asian J Ethnobiol 5: 44-51.* Ethnobotany encompasses all elements of plants' natural and direct interaction with humans. Plants have been linked to human civilization since antiquity. Like Hindu people, Buddhists worship plants or use their components in different ways to perform various socio-religious ceremonies. However, this indigenous knowledge is diminishing rapidly due to the disinterest shown by the younger generation. Therefore, there need to document this indigenous knowledge regarding the usage of religious plants. The present study was conducted in Kanglung Gewog under Trashigang Dzongkhag, Bhutan, to document the plant species used for religious purposes. The ethnobotanical data were collected through semi-structured telephone interviews. A total of 24 plant species belonging to 16 families and 22 genera used in religious practices were documented. Among the 16 families, the most utilized species belong to the family Poaceae (4 species), followed by the family Ericaceae and Cupressaceae (3 species each) and Pinaceae (2 species). Out of these, trees account for 58 percent of all plants reported, followed by herbs (25%), shrubs (13%), and climbers (4%). The tree's trunk's most utilized parts, followed by the leaves, whole plant, seeds, and fruits. The majority of the plants recorded (58%) are used for religious ceremonies, and 42 percent of the plants are used for making religious items. The people of Kanglung have extensive indigenous knowledge on using plants in socio-religious activities. Still, rapid socio-economic development and the disinterest of the younger generation have become a major threat to preserving this indigenous knowledge. Therefore, it is necessary to preserve this indigenous knowledge on using plants in socio-religious activities by proper documentation and identification of plant species used to save these plants from further loss and sustainable utilization.

Keywords: Ethnobotany, indigenous knowledge, Kanglung, plants, rituals, socio-religious activities

INTRODUCTION

Bhutan has rich biodiversity and is home to a diverse array of flora and fauna, including 5603 species of vascular plants, 400 lichens, 200 mammals, and about 700 birds (NBC 2011). Bhutan is a country with the strongest traditions of conservation of nature and the environment, which is also reflected in the constitution.

Natural resource conservation has been a vital part of many indigenous cultures throughout the world (Niroula 2016). Bhutan's natural biological history has been conserved through the millennia due to the kings' farsightedness and strong laws and policies. Apart from these, religious traditions have also played a significant role in environmental conservation. The major heritage of environment conservation is the dedication of areas of forest or groves to various deities and spirits by the rural peoples, and sometimes conservation for the rituals (Geng et al. 2017). The indigenous people are illiterate, but they have carefully preserved their ancient practices, folklore, rites, and way of life in the forest through folk beliefs (Brahma et al. 2014).

Plants have played an important role in human civilization for a long time. Humans have recognized their reliance on plants since the beginning of time, primarily for food, construction materials to build houses (shelter), clothing, and the main ingredient of health care (medicine) (Geng et al. 2017; Moallem et al. 2017; Jima and Megersa 2018; Chhetri et al. 2019; Purushothaman et al. 2020; Bailly 2021). Aside from these basic human needs, the plants are deeply entwined with religions such as Buddhism and Hinduism. According to Chhetri et al. (2019), there is almost no religious ritual in Hinduism or Buddhism that does not require plants or plant parts. In addition, several plants are part of various ritual purposes and are a source of livelihood for the local people (Geng et al. 2017). Thus, people's religious beliefs have played a significant role in developing views of nature and defining relationships of man's role in nature, thereby establishing a link between religious life and natural systems. Such beliefs and practices can help to rethink and respond to the world's environment and the management of natural resources (Niroula 2016).

The people are deeply religious, practicing Buddhism, Hinduism, and Christianity. However, most people practice Buddhism as their primary religion (Sharma 2016). In Buddhism, people engage in various religious activities throughout the year, where the plants have their own distinct roles and significance (Namsa 2011). Plant parts like bark, twigs, leaves, flowers, fruits, branches, and seeds are used. Man's intimate relationship with plants has helped men develop a sense of reverence for nature and natural resources (Chhetri et al. 2019). They added that almost no religious ceremony in Hinduism or Buddhism does not

involve the use of plants or plant components. However, in Buddhism and Hinduism, plants or plant components are employed in various religious rituals. People worship, perform rituals, make offerings, and make religious items using whole plants or plant components such as flowers, leaves, trunk, bark, and roots.

According to Pandey and Pandey (2016) the *Aegle marmelos* are thought to be related to Lord Shiva, and the ladies of the Indo Gangetic plain used to worship this tree to have their aspirations realized. Similarly, *Ocimumten uiflorum*, popularly known as "Tulsi", is related to the holy event "Tulsi Vivah", which is the ceremonial marriage of Tulsi with Lord Vishnu, and it is also said to be an incarnation of goddess Lakshmi (goddess of knowledge) (Pandey and Pandey 2016). Furthermore, Doburuie (Assamese tribes) utilize Piro grass, bamboo, and many other holy plants leave to prepare the temporary altar, *Thelypteris angustifolia* (wild fern), *Imperata cylindrica* (sharp grass), and a split bamboo are put on the altar facing the rising sun (Sharma and Pegu 2011). Gupta (1971) stated that trees have an important role in the Bible and Korean religion. Twenty-two trees were used such as *Amygdalus communis, Prunus dulcis, Malus domestica, Ceratonia siliqua, Cupressus sempervirens, Phoenix dactylifera, Diospyrose benum, Ficus carica, Boswellia* sp., *Aquilaria* sp., *Quercus* sp., *Pinus* so., *Pistacia vera, Platanus orientalis, Punica granatum Populus euphratica, Ficus sycomorus*, *Tamarix* sp., *Pistacia atlantica, P. terebinthus, Tetraclinis articulate*, *Juglans regia*, and *Salix* spp. He added that the finest exudation used to make incense comes from *Balsamodendron* sp., *Aquilaria agallocha*, *Shorea robusta*, and *Pinus deodara*. Similarly, the *Areca catechu* flower is used in marriage rituals in South India and Gujerat, while *Euphorbia* sp. is considered holy to the goddess of snakes and is donated in temples by people in Bengal and South India.

Similarly, Sarma and Devi (2015) documented that 54 species with religious importance, such as *Cynodon dactylon*, *A. marmelos*, *Ocimum sanctum*, and *Piper betle* are solely employed in all Hindu religious ceremonies from Nalbari and Sonipur districts in Assam. Important species used for Prasad preparation during a religious ceremony include *Vigna radiata*, *Cicer arietinum*, *Mangifera indica*, *Musa* sp., *Saccharum officinarum, Cocos nucifera*, and *Zingiber officinale*. *Musa balbisiana* (banana) is a very holy tree that represents Lord Vishnu, and its fruit is dedicated to Lord Vishnu and Laksmi (god of wealth) in exchange for a happy married life and a prosperous financial situation (Pandey and Pandey 2016). Similarly, Chhetri et al. (2019) added many plants, such as *Ficus religiosa*, *Azadirachta indica*, *O. sanctum*, *Centella asiatica*, *Curcuma longa*, and *C. dactylon* have divine properties and are thus employed in a variety of religious activities and rites in Hinduism.

Buddhists view *Oroxylum indicum* as the most sacred plant because its flower buds open at night and fall before daylight and are not even touched by bees, indicating its purity. Its seeds, resembling paper silk, are used in every auspicious ceremony (Chhetri et al. 2019). According to Namsa et al. (2011), the Monpas (ethnic group) of Arunachal Pradesh have long used *Daphne papyracea* to make handmade paper for painting and writing holy scripts in Buddhist temples. The sweet-scented blossoms of *Daphne bholua*, a member of the Thymelaceae family, are used as gifts in temples (Gupta 1971). In research conducted by Hongmao et al. (2002), the woods of *Tectona grandis*, *Artocarpus heterophylla*, and *Gmelina arborea* were utilized to create sculptures in Xishuangbanna, one of the most biologically diverse places in southwest China. The oil extracted from the seeds of *Mesuaferrea* sp. and *Aleurites moluccana* was also used to light the temple, and plants such as *Nymphaea lotus*, *Hedychium chrysoleucum*, *Crinum asiaticum*, and tropical fruits such as *Annona reticulata*, *Citrus grandis*, and *M. indica* were used as offerings at Buddhist ceremonies and are also served as a daily food for monks at the temple (Hongmao et al. 2002). Weckerle et al. (2011) added *C. funebris*, *Gaultheria fragrantissima* and *Ligustrum sempervirens* are used for incense and joss stick production in Southwest China.

The use of plants in religious activities is mentioned in religious literature and has been passed down from generation to generation, primarily through religious leaders and parents to their children by word of mouth (Pandey and Pandey 2016). However, due to modernization and the influence of Western culture, younger generations are less concerned with such belief systems and practices, and they are also less interested in understanding religious literature. Several workers have made a significant contribution to the ethnobotany from various parts of the world (Rana et al. 2016). For example, researchers such as Brahma et al. (2014) reported 48 species of plants from 36 families, Chhetri et al. (2019) reported 74 species from 44 families; Geng et al. (2017) reported 32 species from 17 families; Niroula (2016) reported 69 species from 34 families; Pandey and Pandey (2016) reported 9 species from 9 families; Pangging et al. (2019) reported 61 species from 33 families; Rana et al. (2016) reported 36 species; Debbarma et al. (2014) reported 59 species from 42 families; Sharma and Pegu (2011) reported 30 species from 23 families; Singhal et al. (2017) reported 30 species from 22 families; Staub (2011) reported 24 species from 16 families; Weckerle et al. (2011) reported 17 species, and Wijana et al. (2020) reported 46 species of plants with socio-cultural and religious beliefs.

Numerous studies have documented different plants from India, China, Nepal, and Indonesia with socio-cultural and religious beliefs, however, there has been very little documentation from Bhutan. Furthermore, proper scientific research and documentation in this field are critical. Like many other developing nations, ethnobotany is a relatively new topic of study in Bhutan. People who live in rural regions have a strong relationship with their surroundings' natural resources and have firsthand knowledge of the numerous applications of plants that they require. In Bhutan, only a few researchers, such as Wangchuk et al. (2016) and Wangchuk and Tobgay (2015), have studied the medicinal plants in Bhutan, however, the religious elements of plants are not given any attention and are not well researched. Therefore, an attempt has been made to

study all sacred plants used by the people of Kanglung Gewog (an administratively demarcated region constituted by many villages) under Tashigang Dzongkhag (District), with a particular focus on how the plants are used in various religious activities.

MATERIALS AND METHODS

Study area

The present study was conducted in the Kanglung Gewog under the Trashigang District, Bhutan. Kanglung Gewog lies in 27°17′13.743″N latitude and 91°31′27.725″E longitude, situated at an altitude of 1830 meters above sea level. Temperatures in the summer vary from 16°C to 24°C, while temperatures in the winter range from 3°C to 13°C. It has a land size of 63.30 square kilometers and is bordered by Dremitse Gewog in Mongar District. Kanglung comprises eight villages (Pangthang, Ritsangdoong, Maanthong, Mertsham, Thragom, Yonphoopam, Yonphoola, and Rongthoong), totaling 5453 inhabitants. People practice Buddhism as their primary religion. The study area is shown in Figure 1.

Study population

The research population consisted of 31 people; three participants from each village (8 villages), three lay monks (Gomchen*)*, and four monks from Yonphula Dratshang and Kanglung Shedra knowledgeable about the plants utilized in different religious activities.

Data collections

Telephone interviews were used to acquire information about the use of several plant species in religious events in the community. The field visit and physical data collection were not feasible due to COVID-19 restrictions and subsequent lockdown in the country. However, the plants are photographed and presented as an annexure. Data was gathered via a semi-structured questionnaire. The head of the family was interviewed, however, in the absence of the head of the family, other elder members were interviewed. The interviews were held in the local language (*Sharchop*). The telephone interview included 31 informants (20 men and 11 females). Individual plant data such as local name, botanical name, common name, family, habit and habitat, plant part(s) utilized, and usage mode was documented. The plant species are identified and classified using the book Flora of Bhutan by A. J. C. Grierson and D. G. Long.

RESULTS AND DISCUSSIONS

The current study documented 24 plant species from 22 genera and 16 families associated with socio-cultural and religious beliefs among people residing in the Kanglung Gewog under Trashigang District. Plant species are listed alphabetically, along with their botanical names, families, local names, parts utilized, and usages are given in Table 1 and Figure 6. Among the 16 families, the most utilized species belong to the family Poaceae (4 species), followed by the family Ericaceae and Cupressaceae (3 species each) and Pinaceae (2 species) (Figure 2). Trees account for 58 percent of all plants reported, followed by herbs (25%), shrubs (13%), and climbers (4%) (Figure 3). The tree's trunk is the most commonly utilized plant part, followed by the leaves, whole plant, seeds, and fruits (Figure 4).

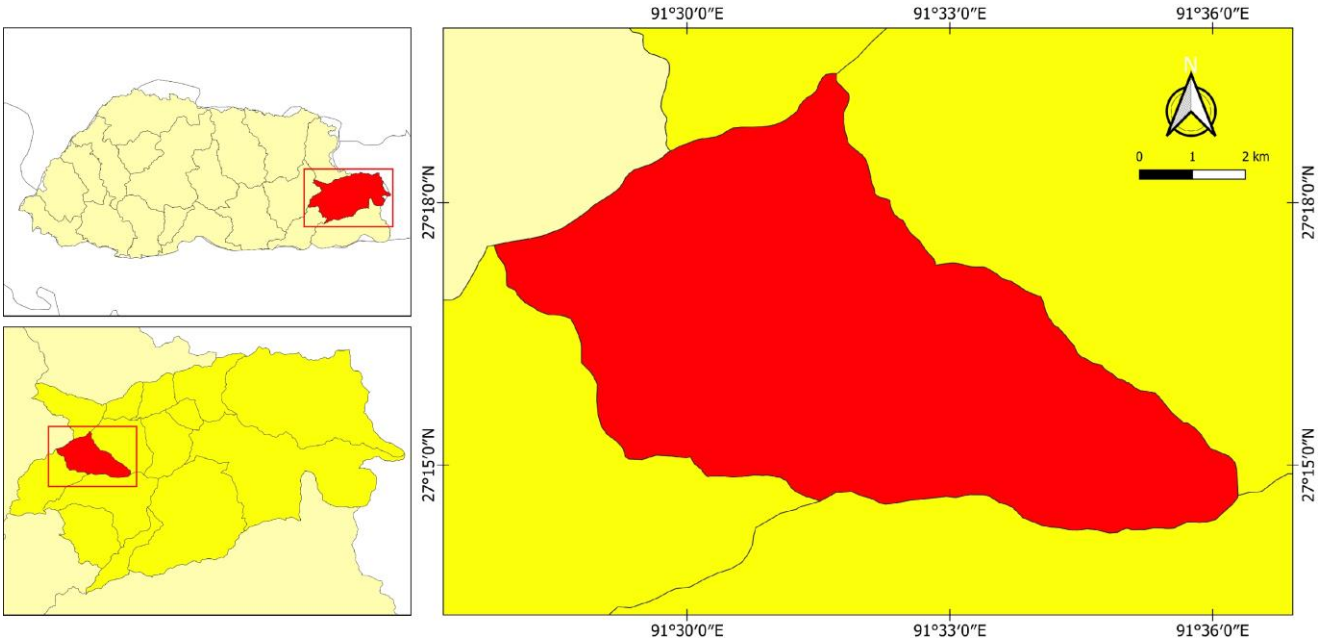


Figure 1. Map of Kanglung, Trashigang District, Bhutan

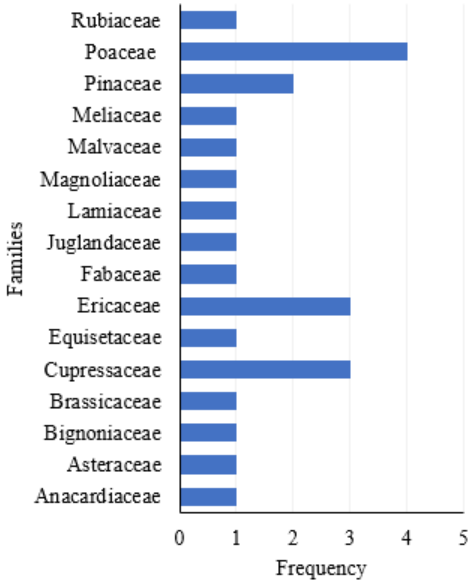


Figure 2. Use of plants based on families

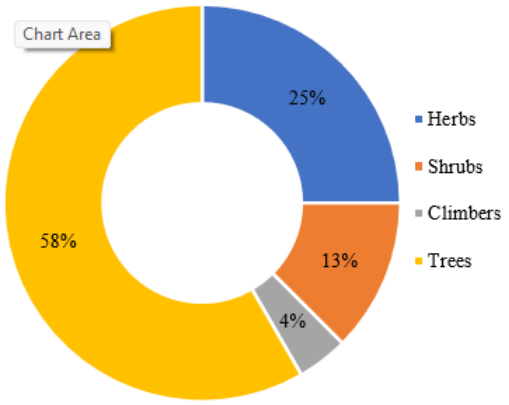


Figure 3. Use of plants based on the habit

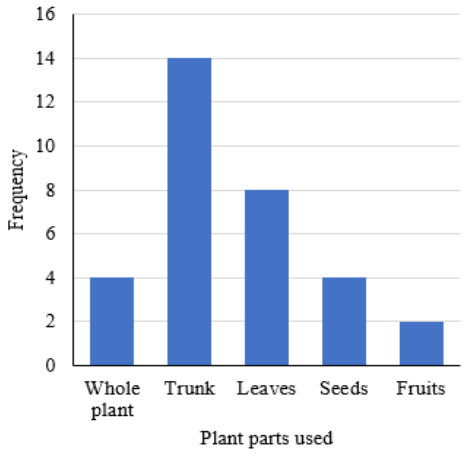


Figure 4. Frequency of plant parts used

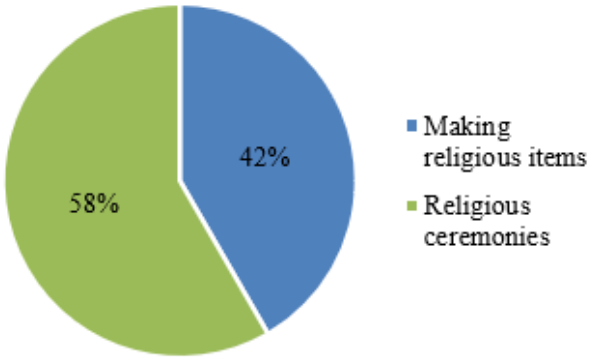


Figure 5. Plants used in religious activities

Plants used in the religious activities

Humans regard themselves as distinct people, each with distinctive ideas, habits, interests, and eccentricities (Niroula 2016). People's religious beliefs have played an important part in shaping perceptions of nature and defining man's connection with nature, establishing a link between religious life and natural systems.

Based on the mode of utilization, the plant species used in religious activities can be grouped into two categories: making religious items and religious ceremonies. The majority of the plants recorded (58%) are used for religious ceremonies, and 42% of the plants are used to make religious items (Figure 5). Out of 24 useful plant species documented in the Kanglung gewog, there were 13 plant species such as *Artemisia vulgaris*, *Bambusa vulgaris*, *Brassica campestris*, *Cryptomeria japonica*, *Equisetum arvense*, *Oryza sativa*, *G. fragrantissima*, *Rubia manjith*, *Zea mays*, *Pinus bhutanica*, *Pinus roxburghii*, *Triticum aestivum* and *O. Indicum* that were utilized in the religious ceremonies including rituals. These plants are used to make smoke offerings, burnt as incense, on prayer flag poles, and to ward off evil spirits during rituals. The other 11 plants species such as *Bombax ceiba*, *Erythrina arborescens*, *C. corneyana*, *J. regia*, *Juniperus recurva*, *Magnolia champaca*, *Rhus chinensis*, *Rhododendron ciliatum*, *Rhododendron setosum*, *Toona ciliata*, and *T. grandis* were used for making religious materials/items such as an incense stick, mask for mask dance and altar. Table 1 shows the specific applications of the plants.

Table 1. Plants species used by the people of Kanglung in their socio-cultural and religious activities

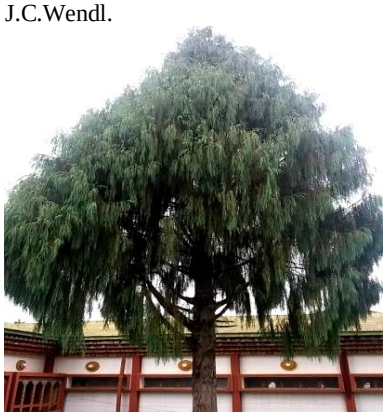
Botanical name	Common name	Local name	Family	Habit	Part(s) used	Usage
Artemisia vulgaris L.	Mugworts	Mey-reng-ma	Asteraceae	Herb	Whole plant	Used during rituals as a smoke offering (*Sang*).
Bambusa vulgaris Schrad. ex J.C.Wendl.	Bamboo	Leshing	Poaceae	Tree	Trunk	Used as a prayer flag pole.
Bombax ceiba L.	Silk-Cotton	Pema Gayser Shing	Malvaceae	Tree	Fruits & trunk	Cotton from the fruits is used to make wicks for lighting butter lamps during rituals, and the trunk is used to make a mask for the mask dance.
Brassica campestris L.	Mustard	Memba	Brassicaceae	Herb	Whole plant	Used during ritual to drive away the evil spirit.
Cupressus corneyana Knight & Perry ex Carrière	Weeping Cypress	Tsenden Shing	Cupressaceae	Tree	Trunk & Leaves	The trunk makes incense, while the fresh leaves are burned as a smoke offering (*Sang*) during rituals.
Cryptomeria japonica (Thunb. ex L.f.) D.Don	Japanese cedar	-	Cupressaceae	Tree	Leaves	Burnt as incense during religious rites.
Equisetum arvense L.	Common Horsetail	Nurchung	Equisetaceae	Herb	Whole plant	Used during rituals.
Erythrina arborescens Roxb.	Coral Tree	Kharshing	Fabaceae	Tree	Trunk	Used for making a mask for the mask dance.
Gaultheria fragrantissima Wall.	Wintergreen	Shagshing -ma shing	Ericaceae	Shrub	Leaves	During the ritual, fresh leaves and twigs are burned as a smoke offering (*Sang*).
Juglans regia L.	Walnut	Khey Shing	Juglandaceae	Tree	Fruits & trunk	Fruits are used during rituals, and the trunk is used for making altars.
Juniperus recurva Buch.-Ham. ex D.Don	Juniper	Shoogpo shing	Cupressaceae	Tree	Leaves & trunk	Burnt as incense to purify their worship place and surrounding. It is used as one of the ingredients for making incense by the manufacturer.
Magnolia champaca (L.) Baill. ex Pierre.	Champak	Champa Shing	Magnoliaceae	Tree	Trunk	Used for making altar.
Oroxylum indicum (L.) Kurz	Midnight horror	Namkaling	Bignoniaceae	Tree	Seeds	Used as an offering in rituals.
Oryza sativa L.	Paddy	Bara	Poaceae	Herb	Seeds	Used during rituals to drive away from the evil spirit.
Pinus bhutanica Grierson, D.G.Long & C.N.Page.	Bhutan Pine	Chang Shing	Pinaceae	Tree	Leaves & trunk	Fresh leaves are burnt for smoke offering, while the trunk is used as a prayer flag pole.
Pinus roxburghii Sarg.	Chir Pine	Roinang Shing	Pinaceae	Tree	Leaves & trunk	Fresh leaves are used for smoke offerings, while the trunk is used as a prayer flag pole.
Rhododendron ciliatum Hook.f.	Rhododendron	Baloo	Ericaceae	Shrub	Trunk & Leaves	Burnt as incense during religious rituals. They burnt it every morning and moved around their houses carrying the fragrant fumes to purify the surroundings. It is an important ingredient in manufacturing incense.
Rhododendron setosum D.Don	Rhododendron	Sooloo	Ericaceae	Shrub	Trunk & Leaves	Burnt as incense during religious rituals. They burnt it every morning and moved around their houses carrying the fragrant fumes to purify the surroundings. It is an important ingredient in manufacturing incense.
Rhus chinensis Mill.	Chinese sumac	Robtang shing	Anacardiaceae	Tree	Trunk	Used for making phallus (*Kharam shing*) to protect them from evil spirits and malicious talks (*Kharam*).
Rubia manjith Roxb.	Manjith	Lani ru	Rubiaceae	Climbers	Whole plant	Used during rituals and also used as a coloring agent.
Tectona grandis L.f.	Teak	Teak Shing	Lamiaceae	Tree	Trunk	Used for making alter due to good quality of wood.
Toona ciliata M.Roem.	Red Cedar	Rawa Shing	Meliaceae	Tree	Trunk	Used for making a mask for the mask dance.
Triticum aestivum L.	Bread Wheat	Bong	Poaceae	Herb	Seeds	Used during ritual to drive away evil spirits and flour from the grains are used for making the ritual cake.
Zea mays L.	Maize or corn	Ashom	Poaceae	Herb	Seeds	Used during ritual to drive away evil spirits and flour from the grains are used for making the ritual cake.

Artemisia vulgaris L.

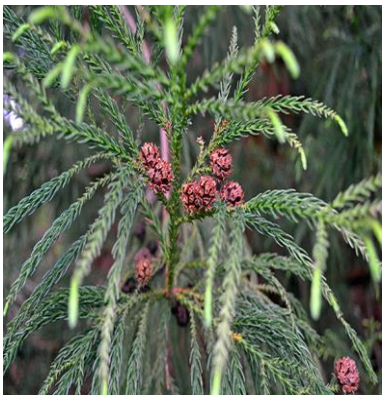
Bambusa vulgaris Schrad. ex J.C.Wendl.

Bombax ceiba L.

Brassica campestris L.



Cupressus corneyana Knight & Perry ex Carrière



Cryptomeria japonica (Thunb. ex L.f.) D.Don

Equisetum arvense L.

Erythrina arborescens Roxb.

Gaultheria fragrantissima Wall.

Juglans regia L.

Juniperus recurva Buch.-Ham. ex D.Don

Magnolia champaca (L.) Baill. ex Pierre.

Oroxylum indicum (L.) Kurz

Oryza sativa L.

Pinus bhutanica Grierson, D.G.Long & C.N.Page.

Pinus roxburghii Sarg.

Rhododendron ciliatum Hook.f.

Rhododendron setosum D.Don

Rhus chinensis Mill.

Rubia manjith Roxb.

Tectona grandis L.f.

Toona ciliata M.Roem.

Triticum aestivum L.

Zea mays L.

Figure 6. Some plant species from the study area

In conclusion, the study on socio-religious plants utilized by the people of Kanglung gewog found that plant resources are crucial for food, shelter, and medicine and for completing any socio-cultural or religious ceremonies. Furthermore, given the global context of climate change and increasing depletion of biological diversity due to modernity, different uses of plant resources in socio-cultural or socio-religious activities can be a significant step toward their protection and conservation of the environment. The current study demonstrates that the Kanglung community is rich in sacred plants and has an extensive understanding of plant religious beliefs, demonstrating the symbiotic relationship between humans and nature. However, indigenous cultures' age-old traditional practices, wisdom, and religious conceptions of indigenous cultures, on the other hand, are dwindling. The depletion of indigenous knowledge among the people of this community was severe owing to the disinterest of the young generation as a result of modern education, urbanization, and modernization. Therefore, this material will be extremely useful to current and future generations in preserving our indigenous knowledge and customs, and it will be beneficial in preserving cultural heritage.

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Diversity of edible plants traded in Legi Market, Surakarta, Indonesia

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Abstract. *Nurshillah C, Anggorowati D, Putri ER, Balgis M, Nurwulandari M, Murtiningsih, Agustina N, Wulandari P, Liza N, Himawan W, Setyawan AD. 2022. Diversity of edible plants traded in Legi Market, Surakarta, Indonesia. Asian J Ethnobiol 5: 52-61.* A traditional market is used to conduct buying and selling transactions conducted by direct bargaining. The market is used as a center of socioeconomic activities and a social heritage representation. Many commodities are commonly traded in traditional markets, such as staple foods and other edible plant products such as vegetables, spices, tubers, and fruits. Some of them also have additional functions as herbal remedies. This research aims to inventory edible and medicinal plant species traded in the traditional market in Surakarta, Central Java, Indonesia, namely Legi Market. The method used in this research is the qualitative descriptive method. Direct research observations, including plant surveys and in-depth interviews with Legi Market traders, are used to collect the data. The results showed that the Legi Market plays a vital role in the availability of the crops produced by village farmers. There are 92 species of edible plants recorded in the Legi Market, predominately with the Fabaceae group. Furthermore, leaf products were identified as the most commercialized plant parts. In terms of medicinal purposes, 17 species were listed to be used as treatment agents, with the rhizome being the most functioned part.

Keywords: Edible plant, food diversification, Surakarta, traditional market

INTRODUCTION

Market is defined as a place for trading activities to meet people's daily needs. Indonesia's number of traditional markets still dominates due to many people on lower middle incomes, even below the poverty line. In addition, traditional markets are much preferable to modern shopping centers because customers can buy their needs at lower prices. Therefore, the presence of conventional markets is significant because it is used as the foundation or economic basis of a region (Tambunan 2020). Based on this reason, local markets are still sustained in this modern era where modern retail, e-commerce and supermarkets offer much more convenience.

According to Aliyah (2020), a traditional market in Indonesia's oldest kind of market. Individuals from ancient times gathered in a certain location to offer and seek goods. It was the only place for people to do trading activities in the past (Andriani and Ali 2013). Subsequently, this tradition is passed to the next generations as social heritage. Mostly, the traders usually sell their commercial goods in a simple stall in the local market or sit on the mat (*lesehan*) with their commodities displayed in front of them (Ariyani and Nurcahyono 2018). In addition to providing goods for buyers, the traditional market also has a significant function in providing jobs for the local community (Malano 2011).

Many commodities are commonly offered in traditional markets, including household utensils, clothes, and agricultural products. Regarding diet components, traditional markets sell various kinds of edible plants. Many kinds of plant products can be found in the traditional markets, such as vegetables, fruits and staple foods. In addition, many parts of the plants are offered, such as leaves, fruits, rhizomes, and bulbs. The plant commodities commonly are cultivated by the seller or reselling the product from the local farmers (Posthouwer et al. 2018). Additionally, the traditional market offers goods collected from the surrounding areas. Thus, this place encourages the local community's economy while strengthening food security and diversification.

Several types of edible plants sold belong to medicinal plants. Society is currently keen on natural products, not only for daily food but also to maintain their wellbeing. People usually prefer to consume herbal remedies to prevent and heal ailments than conventional medicines. As mentioned by van Wyk and Prinsloo (2020), herbal medicines are believed by many to have natural ingredients that have few or without side effects because they come from natural sources. The use of plants as herbal medicine is suggested to have been practiced since ancient times. Therefore, traditional markets have a big role in providing medicinal plants and preserving cultural heritage between generations (Uzun and Koca 2020).

Surakarta is one of the big and famous cities on the island of Java which still highly upholds its culture. Some people prefer herbal remedies because they are more natural and safer than modern medicine. Furthermore, traditional markets are still crucial for society when modern retail has developed and e-commerce has begun to dominate the shopping system. One of the traditional markets in Central Java, Indoneisa, is Legi Market (an Indonesian typical of traditional market). It is situated in Banjarsari Sub-district, Surakarta, in a quite strategic location. According to Arifin et al. (2021), this market is the most important place for selling agricultural materials in the south of Central Java Province, Indonesia. It consists of approximately 1900 vendors and operates between 6 am and 6 pm. The name of Legi Market is derived from the day name according to Javanese folk called *'legi'*, which is when numerous visitors gather in the local market. This research aims to inventory various edible species of plants believed in providing health benefits offered in Legi Market, Surakarta, Central Java, Indonesia.

MATERIALS AND METHODS

Study area

This research was carried out in Legi Market in Setabelan Village, Banjarsari Sub-district, Surakarta, Central Java, Indonesia (Figure 1) between December 2020 and January 2021. This market is situated on Letjen S. Parman Street and is quite accessible from surrounding public places. Legi Market is located only 2,8 km (about 11 minutes) and 1,4 km (4 minutes) from Tirtonadi terminal and Balapan station, respectively. In addition, this market is also situated nearby to the modern shopping center, called Luwes Kestalan, which is only 1,6 km away. This market can be reached using public transportation, such as buses or private vehicles. Many purchasers always visit Legi Market because this market provides various needs, mainly foodstuffs, and local cuisines. Usually, the food commodities are still in good condition since they are provided by the local farmers surrounding the market. According to the sellers, the operational time of Legi Market is 24 hours, but the peak hour usually occurs in the morning to the mid-day.

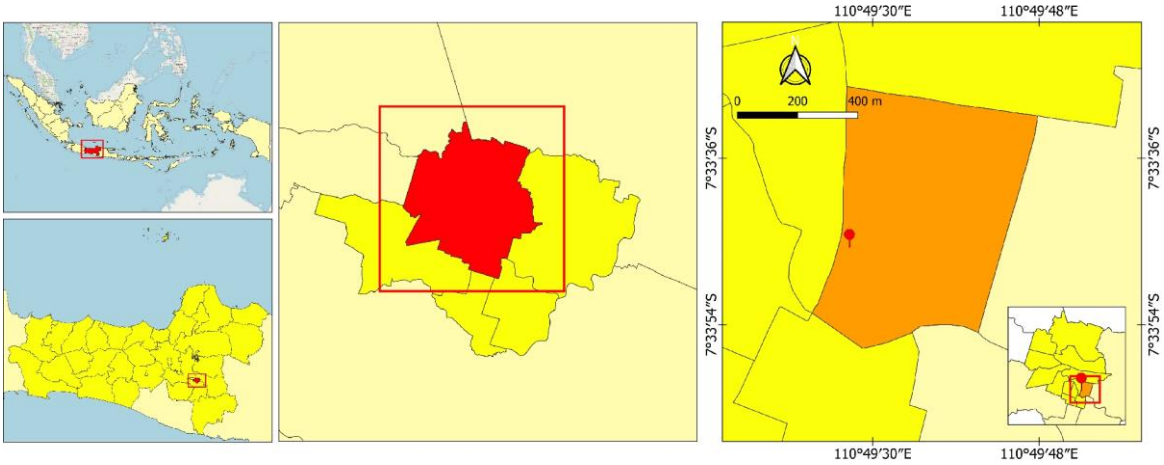

Figure 1. Location of Legi Market in Setabelan Village, Banjarsari Sub-district, Surakarta City, Central Java, Indonesia. Source: UO Kelurahan Survey, Google Earth, Bakosurtanal

Figure 2. Legi Market building, Surakarta, Central Java, Indonesia in 2020

Based on Aliyah et al. (2007), Legi Market was constructed during the reign of Mangkunegoro I and had renovated in 1992. The name 'Legi' is derived from ancient Javanese culture that divided days into a five-day market week. *Legi* was the day that people in the past usually conducted the transaction. This culture inspired the naming of local markets based on historical events. In 2007, the total trader in this market was 1290 (Aliyah et al. 2007). However, the current number of the trader was unclear. Unfortunately, Legi Market was fired in 2018. This accident lead the movement of IKKAPAGI (*Ikatan Keluarga Pedagang Pasar Legi*) and Department of Trade Service to revitalize this market (Arifin et al. 2021). It is mentioned that the alteration was to make Legi Market more modern by adding several facilities, such as Tap Reader Machine (TRM) to pay e-retribution, surveillance cameras and adopting the green building concept. Additionally, some regulations have been applied, such as not littering and each trader has to clean the stall after selling time. The physical distancing rules are also practiced in Legi Market to avoid virus transmission during the Covid-19 pandemic. Based on the study conducted by Khomah and Harisudin (2016), Legi Market's advantages compared to the other markets in Surakarta include the low prices, the longer operational hours, and the variety of products it offers.

Procedures

The qualitative descriptive method was carried out in this study. The primary data were collected through direct observation and in-depth interviews with the market vendors. Twenty-eight traders who offered various kinds of plant commodities were selected and mostly, they were more than 30 years old. Information about plant products traded, the part of the plant consumed, the vernacular names, medicinal purposes and the list of diseases being treated were collected.

Data analysis

The edible plant data obtained were categorized after being identified using journals and other supportive sources. First, the online source http://www.plantsoftheworldonline.org/ was used to identify the plant species. Then, the plant data were classified based on their family group, category of products, and part of the plant utilized. Regarding plants for medicinal reasons, the information about the ailments list was added to the table. Both food and medicine plants were analyzed descriptively.

RESULTS AND DISCUSSION

Food plants diversity

Based on this study, 92 species were sold in Legi Market (Table 1). The plant's family varies from 35 groups, with profound domination of Fabaceae, followed by Zingiberaceae, Solanaceae, and Brassicaceae (Figure 3). On the contrary, Agaricaceae, Amaryllidaceae, Annonaceae, Asteraceae, Cactaceae, Caricaceae, Gnetaceae, Lamiaceae, Leguminosae, Moraceae, Myristicaceae, Oxalidaceae, Pandanaceae, Piperaceae, Ranunculaceae, Sapindaceae, and Vitaceae were only represented by one species per family.

Vegetable

The vegetable was the biggest crop commodity traded in the Legi Market. It accounted for 36% of the entire plant's trade (Figure 4) with the domination from Fabaceae. This family was reported as the most encountered group in Ir. Soekarno Market, Central Java, Indonesia with 13 species (Deanova et al. 2021) and 16 species were traded in Beringharjo Market, Yogyakarta, Indonesia (Iskandar et al. 2021). At the same time, herbal medicine markets in South Africa mostly offered Fabaceae plants at about 11% of the total commodities (Rasethe et al. 2019). Those findings have a similar result with this study, which listed ten species belonging to the Fabaceae group. All of them were categorized as vegetables, with *Pachyrhizus erosus*. being the only exception because it was considered a fruit. This species is locally known as *bengkuang* and is commonly eaten raw. In Indonesia, *bengkuang* is a raw material in the making *rujak*, which is fruits-based food with peanut sauce. Lim (2014) reported that *P. erosus* is similar to white potato in terms of food value. However, *P. erosus* contains fewer calories, so it is not a staple food.

Seven species were recorded from the Brassicaceae family, with *Brassica* being the common genus. Species in this family mainly were leafy vegetables supplied from the sellers from outside Surakarta city, such as Boyolali, Sragen, Purwodadi, and Karanganyar, Central Java, Indonesia (Gama et al. 2018). The locals commonly grow leafy vegetables through intercropping with other valued plants, such as chili and another annual crop (Mariyono et al. 2010). Ease of cultivation and process, many edible parts, and the abundance encourage people to grow these plants (Konsam et al. 2016). The diversity of botanical foods traded in the Legi Market is not limited to the species level. Those are intra-species commodities that belong to this family, such as *Brassica oleracea* var. *italic* (broccoli), *B. oleracea* var. *botrys* (cauliflower), and *B. oleracea* var. *capitata* (cabbage) (Table 1).

Spice

Spice products took 34% of the total plant commodities provided in Legi Market. Zingiberaceae is regarded as the most common species in the spice category. Almost all species in this family were considered spices, with the rhizome as the most utilized part. However, *Elettaria cardamomum* Maton was the only species from Zingiberaceae that seeds are used for cooking and medicinal purposes. Hence, the customers seek this species to give a unique fragrance and flavor for dishes in a cooking recipe. Therefore, the spice commonly known as cardamom is sold at a high price and is regarded as the 'queen of spices' internationally (Ashokkumar et al. 2019).

Table 1. List of edible plants commodities that are commonly traded in Legi Market, Surakarta, Central Java, Indonesia

Family	Scientific name	Common name	Local name	Category	The part used
Achariaceae	*Pangium edule* Reinw.	Football fruit	Keluwek	Spices	Fruit
Alliaceae	*Allium cepa* var. *aggregatum* G.Don	Shallot	Bawang merah	Spices	Bulb
Alliaceae	*Allium cepa* L. var. *cepa* L.	Onion	Bawang bombay	Spices	Bulb
Alliaceae	*Allium sativum* L.	Garlic	Bawang putih	Spices	Bulb
Amaranthaceae	*Amaranthus hybridus* L.	Spinach	Bayam	Vegetable	Leaf
Amaranthaceae	*Amaranthus tricolor* L.	Chinese spinach	Bayam merah	Vegetable	Leaf
Amaryllidaceae	*Allium ramosum* L.	Chinese chives	Kucai	Vegetable	Leaf
Anacardiaceae	*Mangifera indica* L.	Mango	Mangga	Fruit	Fruit
Anacardiaceae	*Spondias dulcis* Parkinson	Ambarella	Kedondong	Fruit	Fruit
Annonaceae	*Annona muricata* L.	Soursop	Sirsak	Fruit	Fruit
Apiaceae	*Apium graveolens* L.	Celery leaves	Seledri	Vegetable	Leaf
Apiaceae	*Coriandrum sativum* L.	Coriander	Ketumbar	Spices	Fruit
Apiaceae	*Cuminum cyminum* L.	Cumin	Jintan putih	Spices	Seed
Apiaceae	*Daucus carota* L.	Carrot	Wortel	Vegetable	Tuber
Arecaceae	*Cocos nucifera* L.	Coconut	Kelapa	Spices	Fruit
Arecaceae	*Salacca zalacca* (Gaertn.) Voss	Snakefruit	Salak	Fruit	Fruit
Asteraceae	*Cosmos caudatus* Kunth	Wild cosmos	Kenikir	Vegetable	Leaf
Brassicaceae	*Brassica juncea* (L.) Czern	Mustard	Sawi	Vegetable	Leaf
Brassicaceae	*Brassica oleracea* var. *italic* Plenck	Broccoli	Brokoli	Vegetable	Leaf
Brassicaceae	*Brassica oleracea* var. *botrytis* L.	Cauliflower	Kembang kol	Vegetable	Leaf
Brassicaceae	*Brassica oleraceae* var. *capitata* L.	Cabbage	Kubis	Vegetable	Leaf
Brassicaceae	*Brassica juncea* (L.) Czern	Mustard	Sawi	Vegetable	Leaf
Brassicaceae	*Nasturtium officinale* R.Br.	Watercress	Selada air	Vegetable	Leaf
Brassicaceae	*Raphanus sativus* L.	Radish	Lobak	Vegetable	Tuber
Cactaceae	*Hylocereus costaricensis* (F.A.C.Weber) Britton & Rose	Dragon fruit	Buah naga	Fruit	Fruit
Caricaceae	*Carica papaya* L.	Papaya	Pepaya	Fruit	Fruit, leaf
Convolvulaceae	*Ipomoea aquatica* Forssk.	Water spinach	Kangkung	Vegetable	Leaf
Convolvulaceae	*Ipomoea batatas* (L.) Lam.	Sweet potato	Ubi jalar	Staple	Tuber, leaf
Cucurbitaceae	*Citrullus vulgaris* Schrad.	Watermelon	Semangka	Fruit	Fruit
Cucurbitaceae	*Cucumis melo* L.	Melon	Melon	Vegetable	Fruit
Cucurbitaceae	*Cucumis sativus* L.	Cucumber	Mentimun	Vegetable	Fruit
Cucurbitaceae	*Cucurbita moschata* Duchesne	Butternut squash	Labu kuning	Vegetable	Fruit
Cucurbitaceae	*Sechium edule* (Jacq.) Sw.	Chayote	Labu siam	Vegetable	Fruit
Euphorbiaceae	*Aleurites moluccanus* (L.) Wild.	Candlenut	Kemiri	Spices	Fruit
Euphorbiaceae	*Manihot esculenta* Crantz	Cassava	Singkong	Staple	Tuber, leaf
Fabaceae	*Arachis hypogaea* L.	Peanut	Kacang tanah	Vegetable	Seed
Fabaceae	*Archidendron pauciflorum* (Benth) I.C.Nielsen	Jengkol	Jengkol	Vegetable	Fruit
Fabaceae	*Glycine max* (L.) Merr.	Soya bean	Kacang kedelai	Vegetable	Fruit
Fabaceae	*Leucaena leucocephala* (Lam.) de Wit	Lead tree	Petai Cina	Vegetable	Fruit
Fabaceae	*Pachyrhizus erosus* (L.) Urb.	Jicama	Bengkuang	Fruit	Tuber
Fabaceae	*Parkia speciosa* Hassk.	Stink bean	Petai	Vegetable	Fruit
Fabaceae	*Phaseolus vulgaris* L.	Bean	Buncis	Vegetable	Fruit
Fabaceae	*Phaseolus vulgaris* L.	Kidney bean	Kacang merah	Vegetable	Fruit
Fabaceae	*Vigna radiata* (L.) R.Wilczek	Mungbean	Kacang hijau	Vegetable	Fruit
Fabaceae	*Vigna unguiculata* (L.) Walp.	Long bean	Kacang panjang	Vegetable	Fruit
Gnetaceae	*Gnetum gnemon* L.	Melinjo	Melinjo	Vegetable	Fruit, leaf
Lamiaceae	*Ocimum basilicum* L.	Basil	Kemangi	Vegetable	Leaf
Lauraceae	*Cinnamomum burmannii* (Nees & T.Nees) Blume	Indonesian cinnamon	Kayu manis	Spices	Bark
Lauraceae	*Persea americana* Mill.	Avocado	Alpukat	Fruit	Fruit
Leguminosae	*Tamarindus indica* L.	Tamarind	Asam Jawa	Spice	Fruit
Moraceae	*Artocarpus heterophyllus* Lam.	Jackfruit	Nangka	Fruit	Fruit
Musaceae	*Musa X paradisiaca* L.	Mas banana	Pisang mas	Fruit	Fruit
Musaceae	*Musa X paradisiaca* L.	Plantain	Pisang raja	Fruit	Fruit
Musaceae	*Musa X sapientum* L.	Cavendish	Pisang ambon	Fruit	Fruit
Myristicaceae	*Myristica fragrans* Houtt.	Nutmeg	Pala	Spices	Seed
Myrtaceae	*Syzygium aqueum* (Burm.f) Alston	Watery rose-apple	Jambu air	Fruit	Fruit
Myrtaceae	*Syzygium aromaticum* (L.) Merr. & L.M.Perry	Clove	Cengkeh	Spices	Fruit

Myrtaceae	*Syzygium polyanthum* (Wight) Walp.	Bay leaf	Salam	Spices	Leaf
Oxalidaceae	*Averrhoa carambola* L.	Star fruit	Belimbing	Fruit	Fruit
Pandanaceae	*Pandanus amaryllifolius* Roxb.	Pandanus	Pandan wangi	Spices	Leaf
Piperaceae	*Piper nigrum* L.	Pepper	Lada	Spices	Seed
Poaceae	*Cymbopogon nardus* (L.) Rendle	Citronella grass	Serai	Spices	Leaf
Poaceae	*Oryza sativa* L.	Rice	Beras	Staple	Seed
Poaceae	*Zea mays* L.	Corn	Jagung	Staple	Fruit
Ranunculaceae	*Nigella sativa* L.	Black cumin	Jintan hitam	Spices	Seed
Rosaceae	*Fragaria ananassa* (Duchesne ex Weston) Duchesne ex Rozier	Strawberry	Strawberry	Fruit	Fruit
Rosaceae	*Pyrus communis* L.	Pear	Pir	Fruit	Fruit
Rosaceae	*Pyrus malus* L.	Apple	Apel	Fruit	Fruit
Rosaceae	*Malus domestica* Borkh.	Red apple	Apel merah	Fruit	Fruit
Rutaceae	*Citrus* × *aurantiifolia* (Christm.) Swingle	Lime	Jeruk nipis	Fruit	Fruit, leaf
Rutaceae	*Citrus hystrix* DC.	Kaffir lime	Jeruk purut	Fruit	Fruit, leaf
Rutaceae	*Citrus limon* (L.) Osbeck	Lemon	Jeruk lemon	Spices	Fruit, leaf
Rutaceae	*Citrus sinensis* (L.) Osbeck	Sweet orange	Jeruk manis	Fruit	Fruit
Sapindaceae	*Dimocarpus longan* Lour.	Longan	Kelengkeng	Fruit	Fruit
Solanaceae	*Capsicum annuum* L.	Green chili	Cabe kriting hijau	Spices	Fruit
Solanaceae	*Capsicum annuum* L.	Red chilli	Cabe kriting merah	Spices	Fruit
Solanaceae	*Capsicum annuum* L.	Chili	Cabe	Spice	Fruit
Solanaceae	*Capsicum frutescens* L.	Chilli padi	Cabe rawit	Spices	Fruit
Solanaceae	*Lycopersicon esculentum* Mill.	Tomato	Tomat	Vegetable	Fruit
Solanaceae	*Solanum melongena* L.	Green eggplant	Terong hijau	Vegetable	Fruit
Solanaceae	*Solanum melongena* L.	Purple eggplant	Terong ungu	Vegetable	Fruit
Solanaceae	*Solanum tuberosum* L.	Potato	Kentang	Vegetable	Tuber
Vitaceae	*Vitis vinifera* L.	Red grape	Anggur merah	Fruit	Fruit
Zingiberaceae	*Alpinia galanga* (L.) Willd.	Galangal	Lengkuas	Spices	Rhizome
Zingiberaceae	*Curcuma aeruginosa* Roxb.	Pink and blue ginger	Temu ireng	Spices	Rhizome
Zingiberaceae	*Curcuma longa* L.	Turmeric	Kunir	Spices	Rhizome
Zingiberaceae	*Curcuma zanthorrhiza* Roxb.	Curcuma	Temu lawak	Spices	Rhizome
Zingiberaceae	*Curcuma zedoaria* (Christm.) Roscoe	White ginger	Temu putih	Spices	Rhizome
Zingiberaceae	*Elettaria cardamomum* L. Maton	Cardamom	Kapulaga	Spices	Seed
Zingiberaceae	*Kaempferia galanga* L.	Aromatic ginger	Kencur	Spices	Rhizome
Zingiberaceae	*Zingiber officinale* Roscoe	Ginger	Jahe	Spices	Rhizome
Zingiberaceae	*Zingiber officinale* var. rubrum	Red ginger	Jahe merah	Spices	Rhizome

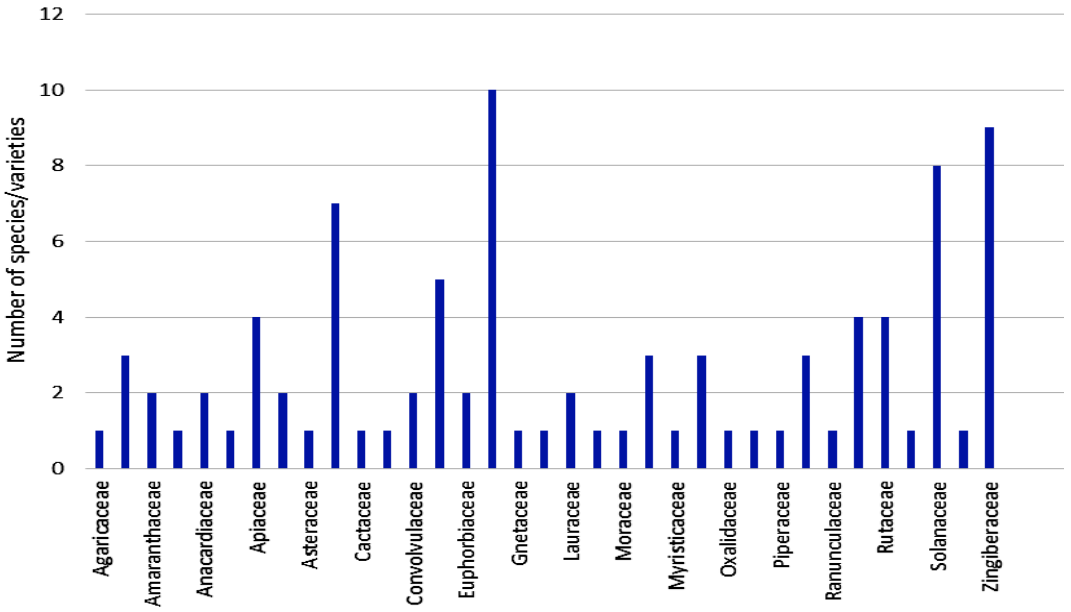

Figure 3. Families of edible plants traded in Legi Market, Surakarta, Central Java, Indonesia

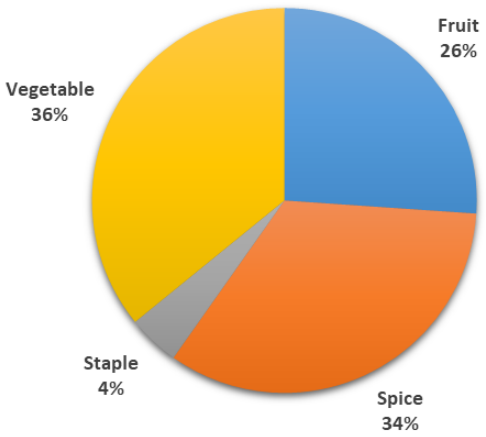

Figure 4. Categories of edible plants traded in Legi Market, Surakarta, Central Java, Indonesia

In this market, Solanaceae also predominantly the spice trade. Based on the interview, the Legi Market is the center of *Capsicum annuum* (chili) sales in the Surakarta residency area. The biggest suppliers come from Boyolali, Klaten, Wonogiri, Sukoharjo and Karanganyar. Meanwhile, from outside Surakarta including Lumajang, Mojokerto, Pemekasan, Sumenep, Pare, Madura, Banyuwangi (Soepatini et al. 2018). In addition, Yamamoto et al. (2014) mentioned that *Capsicum* has four species growing in Indonesia, indicating this country has a profound potential to breed *Capsicum* compared to other Southeast and East Asia regions. This study agrees with Mariyono et al. (2010) that Indonesia has a significant role in international chili trade that estimated 5% of the total market share. According to Table 1, various types of chili are traded in Legi Market, including *cabai kriting hijau*, *cabai kriting merah*, and *cabai rawit*. Both *C. annuum* and *C. frutescens* were also frequently encountered in Tamian Tribe, Aceh, as the raw ingredients for hot sauces in traditional cuisines (Navia et al. 2020). In general, chili is usually grown in the home garden and dry land agroforestry areas by the locals, not only for the market sale but also to meet everyday needs.

Fruit

In terms of edible plants as fruit, this study listed 24 species belonging to this group. Rosaceae made up the most considerable proportion with four species, followed by Musaceae, mainly comprised of intra-species. Commonly, the fruits are consumed fresh or processed into other products to increase the selling value and maintain their durability. *Fragaria ananassa* was the major fruit commodity in this market. Even though strawberry is not native to Indonesia, it can thrive in Tawangmangu, Central Java. This location is a highland area that provides the ideal strawberry condition to grow well. Furthermore, Tawangmangu was the only place to cultivate strawberries in the Karanganyar District near Surakarta (Rizka 2018). Thus, the harvest productions usually are distributed to the markets close to this area. Another fruit offered in Legi Market was banana, which has various kinds, including *pisang mas*, *pisang raja* and *pisang ambon*. Those species have a profound role in Javanese culture, as Hapsari et al. (2017) mentioned. Thus banana cultivars can usually be found abundantly in traditional markets. Another fruit traded in Legi Market that significantly correlates with the local culture is *Artocarpus heterophyllus*. The fruit, commonly known as jackfruit, can be eaten raw or the young fruit as a major ingredient in making *gudeg*. This is the local cuisine from Yogyakarta that is made from the young jackfruit cooked with coconut milk, chicken, and egg (Nurhayati et al. 2016).

Staple

Staple plant sales contributed only 4% to the total edible plant trading in Legi Market. It is predominately by *Oryza sativa* and *Zea mays*, followed by *Ipomoea batatas* and *Manihot esculenta*. Indonesian people are very dependent on rice as their staple food, leading almost all local markets to supply numerous rice varieties. However, some indigenous tribe was reported has more diverse in terms of the staple diet. As Saragih et al. (2021) mentioned, most Dayak Tribe in Kalimantan consumes *M. esculenta* in their everyday diet. The consumption rate will be higher if the locals experience rice scarcity.

Conversely, *I. batatas* have the least attention in terms of staple food. This is because it used to be associated with food for low-income societies. But, it has gained great attention as the people's perception has shifted to a healthy lifestyle (Mwanga et al. 2017). Additionally, *I. batatas* were regarded to help combat the malnutrition food scarcity by providing excellent nutritional values.

Part of the plants consumed

Consumers tend to use the specific part of the edible plants for daily use. Therefore, the number of the plant's part usage displays the local knowledge about edible plants (Manzanero-Medina et al. 2020). This research identified seven parts of the edible plants traded in the Legi Market (Figure 5). The fruit was a part that was highly changed in this market and comprised more than half of the total plant commodities (51 species). It followed by leaf at 23%, while the rest parts accounted for less than 10% each.

Fruit

The most common fruit part traded in Legi Market belonged to the Solanaceae family. From the vegetable category, it consisted of *Solanum melongena* and *Lycopersicon esculentum*. The former, commonly known as eggplant, is usually consumed by cooking as a vegetable. However, in West Java, this plant generally consumes fresh and other raw vegetables, fried foods, and traditional sauce as dressing (Mulyanto et al. 2018). Many of the fruit found sold in this market was utilized as a spice or gives additional flavor in processed food, such as *Pangium edule* (*keluwak*), *Coriandrum sativum* (*ketumbar*), *Cocos nucifera* (*kelapa*), *Aleurites moluccanus* (*kemiri*), *Tamarindus indica* (*asam Jawa*), and *Syzygium aromaticum* (*cengkeh*). Additionally, some species in Rutaceae have several parts for different purposes. For

instance, the leaves of *Citrus* × *aurantiifolia*, *Citrus hystrix*, and *Citrus limon* are commonly used for food preparation, apart from their fruits utilization for the same function.

Leaf

Plant's leaves trading comprised almost a quarter of the total plant sale. Leaves are also part of the highly available plants in the local market in North Sumatra and Mexico (Silalahi et al. 2015; Manzanero-Medina et al. 2020). The presence of leafy vegetables, such as *Amaranthus hybridus*, *Amaranthus tricolor*, *Cosmos caudatu*s, and *Ipomoea aquatica* was quite high, indicating those plants were in great demand by the consumers. Additionally, many individuals cultivated the plants with edible leaves to fulfill their daily diets in their home gardens. However, if the products exceed the daily needs, some of the harvests will be traded in the local market. The abundance of these items leads to a low price.

Nevertheless, other leaves utilized for spice are usually offered at a higher charge. This fact is supported by Arellanes et al. (2013) that *Lippia graveolens* and *Thymus vulgaris* were marketed as more expensive than greenery vegetables. Leaves used for spice in Legi Market include *Syzygium polyanthum*, *Pandanus amaryllifolius*, and *Cymbopogon nardus*.

Rhizome

The marketing of the rhizome organ contributed about 8% in Legi Market, consisting of the Zingiberaceae group. The shape of a rhizome sometimes is similar from one to another. In order to differentiate them, the trader usually uses the morphology characteristic, such as the texture, color, and shaper, as well as the scent. The colors to characterized rhizome are *Curcuma aeruginosa* is blue, *Curcuma longa* is orange, *Curcuma zanthorrhiza* is dark orange, *Curcuma zedoaria* and *Kaempferia galanga* are white, *Zingiber officinale* is cream, and *Z. officinale* var. *rubrum* has a reddish color (Jalil et al. 2021).

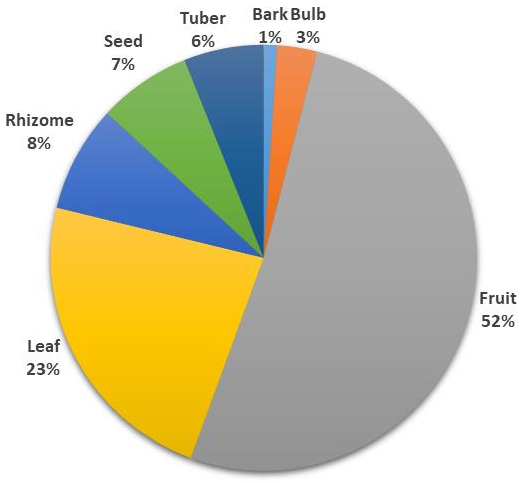

Figure 5. Parts of edible plants traded in Legi Market, Surakarta, Central Java, Indonesia

Seed

Legi Market traders sold seed products at 7% of the plant's part selling like the rhizome. Most seeds were utilized for spice, except *Arachis hypogaea* as a vegetable, and *O. sativa* is a staple food. One of the native species found in this market is *Myristica fragrans* or nutmeg (Kuete 2017). It requires a tropical climate that provides humid and warm conditions to thrive. Still citing Kuete (2017), nutmeg's numerous functions for dishes preparation and as the herbal plant for various ailments, nutmeg also contains toxic effects. Myristicin oil was the compound responsible for nutmeg toxicity.

Conversely, *Nigella sativa* was reported to have a low level of toxin (Dubey et al. 2016). The locally called *jintan hitam* has an excellent trade prospect that is forecasted to continue to increase (Dessie et al. 2020). The high demand for this plant is due to its profound role in the culinary and pharmaceutical industries.

Tuber and bulb

Tuber and bulb categories had 6% and 3% part of the plants trading, respectively. Both *I. batatas* and *M. esculenta* are not only consumed by the tubers but the leaves can also be processed into vegetables and have commercial value. In addition, another tuberous plant provided was *Raphanus sativus* which could be eaten raw or cooked in advance. In terms of bulb part, all of the species came from Alliaceae, such as *Allium cepa* var. *aggregatum* (*bawang merah*), *A. cepa* var. *cepa* (*bawang bombay*), and *A. sativum* (*bawang putih*). These components were frequently sold in local markets because of the high demand for food processing as flavoring food. The distinctive scent makes *Allium* species are essential in the food industry (Aremu and van Staden 2013).

Bark

The bark part was the least traded as plants commodity in Legi Market. The low percentage means few consumers utilized this part plant for daily purposes. The only bark plant recorded in this market was *Cinnamomum burmannii*. This plant is native to Indonesia and has been widely cultivated by smallholder farmers in Jambi (Menggala and Damme 2021). Currently, Sri Lanka is the biggest producer of cinnamon worldwide (Sarma et al. 2014).

Medicinal plants diversity

Apart from their function as food commodities, the plant products available in Legi Market are also categorized as herbal remedies. Based on the interview, it is known that there are 17 types of diseases, and common disorders can be healed using various herbal medicines. It is recorded that most plants are functioned to treat stomach-related pains. It is followed by other ailments, such as cardiovascular-related diseases, inflammation, and immune booster (Table 2).

This finding is similar to Petrakou et al. (2020) study on the herbal market in Greece that stated most of the medicine plants recorded were used for digestive ailments. At the same time, the biggest proportion of plants traded in China and West Java, Indonesia, markets functioned for

stomach-related diseases (Gu et al. 2020; Iskandar et al. 2020).

Based on Table 3, it is clear that 17 types of medicinal plants sold in Legi Market were categorized as multi-function plants. It means a kind of plant has more than one purpose used by society. The data obtained in Legi Market were classified into three groups, namely as 'medicine and spices' consisting of 13 types of plants (76%), 'medicine and vegetables' consisting of three types of plants (18%), and as medicine and fruit which consists of a type of plant (6%). This grouping pattern adopts the research performed by Iskandar et al. (2020) in West Java market. However, the medicine and vegetables dominated the result by consisting of more than ten species compared to only three species in this study.

The medicine and vegetables are the greatest groups in Legi Market. The popular usage of medicinal plants, especially in Java, is the main ingredient for *Jamu.* It is a traditional herbal drink made from spices for curing disease and maintaining healthy conditions (Elfahmi et al. 2014). Types of spices in making *Jamu* include galangal, turmeric, ginger, and *temu ireng*. The traditional herbal drink is believed could improve the immune system and prevent diseases when consumed regularly. Mathai et al. (2022) also stated that some medicinal plants contain natural compounds to control viral infection, especially plants with anti-inflammatory effects. Thus, it is necessary to do further research on plants with medicinal properties to develop a promising and safe treatment method to cure ailments (Jabbar et al. 2019). Community experience and knowledge regarding all uses of medicinal plants can be collected to be used as a basis for the development of research using medicinal plants (Muadifah et al. 2019).

The use of herbal medicines is mostly made from the plant's part; for instance, fruits, leaves, stems, and rhizomes (Jabbar et al. 2019). In this study, the most frequently used plant parts are rhizome (35%), followed by seed, leaf, fruit (18%), and bulb (11%) (Table 4).

Rhizome is a type of spice that has many types. Rhizomes tend to be non-perishable and are widely used fresh and dry. Rhizome spices usually contain many complex carbohydrate compounds, which can be in the form of starch or fiber. Rhizome-type plants can also be easily preserved by drying or processing them into dried slices (Putri and Fibrianto 2018). The majority of people use rhizome-type spices because they are considered to have a more sharp taste and aroma sensation, even though many studies mentioned that leaves were the highest utilized part. For example, the herbal market in Morocco, Turkey, and Subang, West Java, commonly offer leaves that are believed to have medicinal usage (Putri et al. 2016; Awan et al. 2021; Chaachouay et al. 2021).

Table 2. Various medicinal plants traded in Legi Market, Surakarta, Central Java, Indonesia

Common name	Scientific name	Category	Parts used	Uses
Aromatic ginger	*Kaempferia galanga*	Medicine, spices	Rhizome	Fix menstruation cycle
Black cumin	*Nigella sativa*	Medicine, spices	Seed	Inhibit bacterial growth
Ginger	*Zingiber officinale*	Medicine, spices	Rhizome	Nausea relief
White ginger	*Curcuma zedoaria*	Medicine, spices	Rhizome	Treat stomach pain
Turmeric	*Curcuma longa*	Medicine, spices	Rhizome	Inflammation
Curcuma	*Curcuma zanthorrhiza*	Medicine, spices	Rhizome	Overcome indigestion
Pink and blue ginger	*Curcuma aeruginosa*	Medicine, spices	Rhizome	Improve digestion process
Clove	*Syzygium aromaticum*	Medicine, spices	Fruit	Overcome flatulence
Coriander	*Coriandrum sativum*	Medicine, spices	Fruit	Maintain heart condition
Nutmeg	*Myristica fragrans*	Medicine, spices	Seed	Against free radicals
Shallot	*Allium cepa*	Medicine, vegetables	Bulb	Fight cancer cells
Garlic	*Allium sativum*	Medicine, vegetables	Bulb	Cold relief
Lime leaves	*Citrus × aurantiifolia*	Medicine, spices	Leaf	Relieve inflammation
Lime	*Citrus × aurantiifolia*	Medicine, fruit	Fruit	Boost immune system
Bay leaf	*Syzygium polyanthum*	Medicine, spices	Leaf	Maintain digestion process
Pepper	*Piper nigrum*	Medicine, spices	Seed	Heal constipation
Celery leaves	*Apium graveolens*	Medicine, vegetables	Leaf	Lower blood pressure

Table 3. The traded plants usage in Legi Market, Surakarta, Central Java, Indonesia

The plant's function	Total	Percentage (%)
Medicines and spices	13	76
Medicine and vegetables	3	18
Medicine and fruit	1	6
Total species	17	100

Table 4. The part plants sold in Legi Market, Surakarta, Central Java, Indonesia

Plant parts	Total	Percentage
Rhizome	6	35
Seed	3	18
Leaf	3	18
Bulb	2	11
Fruit	3	18
Total species	17	100

In conclusion, the study found 92 total species traded in Legi Market, including vegetables, spices, fruits, and carbohydrate staple food. The portion of the plant used varies, but the most part traded at 52% was the fruit. Moreover, Legi Market provides profound support to the locals by supplying nutritious food products and strengthening the local economy. Regarding medicinal purposes, those are 17 plant species that have medicinal value for numerous diseases, and the rhizome is the highest used part. This fact leads to the idea that Legi Market also serves natural products as an alternative treatment for curing ailments in society.

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Medicinal plants used by the community of Lipulalongo Village, Banggai Laut District, Central Sulawesi, Indonesia

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Abstract. *Haruna MF, Kenta AM, Herawati. 2022. Medicinal plants used by the community of Lipulalongo Village, Banggai Laut District, Central Sulawesi, Indonesia. Asian J Ethnobiol 5: 62-68.* Plants have been traditionally used for medicinal purposes to cure diseases or maintain body wellness and health. However, the utilization of medicinal plants by a particular community is unique and specific to the context of area, thus it might differ from one community to another. This study aimed to document the diversity of plant species used by the community in Lipulalongo Village, Labobo Sub-district, Banggai Laut District, Central Sulawesi, Indonesia, as well as to reveal the method of use of such plants in their medication practices. The research used a cruising survey method, and data collection used interviews, field observation, and identification. The study recorded 21 species of medicinal plants, namely *Phaleria macrocarpa* Boerl, *Andrographis paniculata* Burm.f., *Orthosiphon stamineus* Bent, *Coleus scutellarioides* (L.) Benth., *Averrhoa bilimbi* L., *Psidium guajava* L., *Capsicum annum* L., *Annona squamosa* L., *Syzygium aromaticum* (L.) Merr. & L.M.Perry, *Morinda citrifolia* L., *Gossypium arboreum* L., *Sesbania grandiflora* (L) Pers., *Cymbopogon citratus* (DC.) Stapf, *Curcuma domestica* Valeton, *Curcuma zedoria* (Christm.) Roscoe), *Areca catechu* L, *Alpinia galangal* (L.) Willd), *Carica papaya* L., *Theobroma cacao* L., *Chamaedaphne* sp., and *Blumea balsamifera* (L.) DC. The leaf was the most utilized plant organ rather than fruit, stem, bark, rhizomes, or tubers. Boiling and drinking was the most common method of preparation and mode of application, respectively. Diseases that can be prevented and treated using medicinal plants are fever, diarrhea, colds, coughs, sore teeth, skin diseases (e.g., boils, tinea versicolor, and ringworm), digestive tract diseases in the stomach, and therapy after giving birth.

Keywords: Banggai Laut, fruit, medicinal plants, rhizomes, tubers

INTRODUCTION

The environment cannot be separated from humans because it provides many benefits (Nurmayulis and Hermita 2015). One element of the environment that provides the most important uses for people plants. Throughout history and civilization, various plant species have been utilized and deliberately cultivated on human-modified landscapes (e.g., agricultural lands, yards, and home gardens) or wildly grown on natural ecosystems (e.g., forests). Besides the important role as a source of food and shelter materials, many plant diversity is also essential as a source of medicinal plants (Hadi et al. 2015). Medicinal plants are plants that can prevent, reduce or even eliminate diseases, regulate human body systems (such as blood circulation and respiratory system), and increase endurance and body fitness (Darsini 2013).

Medicinal plants have a strong relationship with traditional and indigenous practices because the use of plants for medication for a disease is not based on clinical trials in the laboratory but is generally originated and developed from the experience of people who have used them for decades, centuries or even millennia (Yuni et al. 2011; Az-Zahra et al. 2021). Traditional knowledge is based on ethnicity, cultural customs, or habits carried out by the local community. This custom is considered knowledge passed on from the ancestors to the next generation and has persisted for years.

In the modern era, as science and technology developed along with human civilization, many medicinal plants used in traditional practices have medicinal properties, such as anti-bacterial, anti-inflammatory, and so on. Nowadays, despite the extensive uses of chemical drugs, the utilization of medicinal plants is still prevalent along with the increasing level of welfare, awareness, and need for a healthy life, or so-called the paradigm of back to nature. In this regard, plants used for medicinal purposes are internationally known as herbal medicine (Indriati 2014). Various parts of medicinal plants are used for medication, such as root parts, bark, leaf, flowers, and even fruit and seeds.

The community of Lipulalongo Village, Labobo Sub-district, Banggai Laut District, Central Sulawesi, is one example of people in Indonesia who still use medicinal plants as traditional medicine. The indigenous tribes in Lipulalongo Village have traditional knowledge inherited from their ancestors regarding various types of biodiversity, which strongly relate to the culture of the community. Regarding the use of plants for medication, this practice is supported by the potential of natural resources in the form of various types of plants that grow in the area that have been utilized for generations. While the tacit knowledge of using plants for medicine by the Lipulalongo community is rich and extensive, the written documentation of such knowledge is lacking, if not absent. Therefore, this study aimed to document the diversity of

plant species used by the community in Lipulalongo Village, Labobo Sub-district, Banggai Laut District as well as to reveal the method of use of such plants in their medication practices.

MATERIALS AND METHODS

Study area

This research was conducted in August 2020 in Lipulalongo Village, Labobo Sub-district, Banggai Laut District, Central Sulawesi, Indonesia (Figure 1). Geographically, the village is located at 1°44'52.0"S 123°19'14.4"E. The village shares boundaries with Lalong Village to the north, Lipu-Talas Village to the south, Reason Village to the west, and Torpot Sea to the east. Lipulalongo Village has an area of about 18,000 ha with a total population of 1,040 people belonging to 312 households. The livelihoods of the people of Lipulalongo Village are mostly farmers and fishers.

Procedures

This study used a qualitative research method with data collected using surveys, interviews, and field observation. Data collection procedures were conducted as follows:

Step-1: Interview

Researchers provided open-ended interview questions in a structured manner. First, direct interviews were conducted with key informants who know traditional medication called *Sandro*. The questions in the interview were (i) the species of plants used for medicinal uses; (ii) the organ of plant being used; (iii) the disease or health problem to be cured; and (iv) the mode of application.

Step-2: Observation

Direct observation and collection of the samples of medicinal plants were conducted in the field with the guidance of *Sandro* by surveying the area in Lipulalongo Village.

Step-3: Identification

The medicinal plant samples were identified using references, including Practical Plant Identification by Cullen (2006), theplantlist.org, and the Encyclopedia of Flora and Steenis (2008).

Data analysis

The results of data collection were then analyzed using qualitative descriptive analysis. This study presents the results in tables and pictures of medicinal plant species along with the benefits and parts of plant organs used in medicine and traditional processing processes.

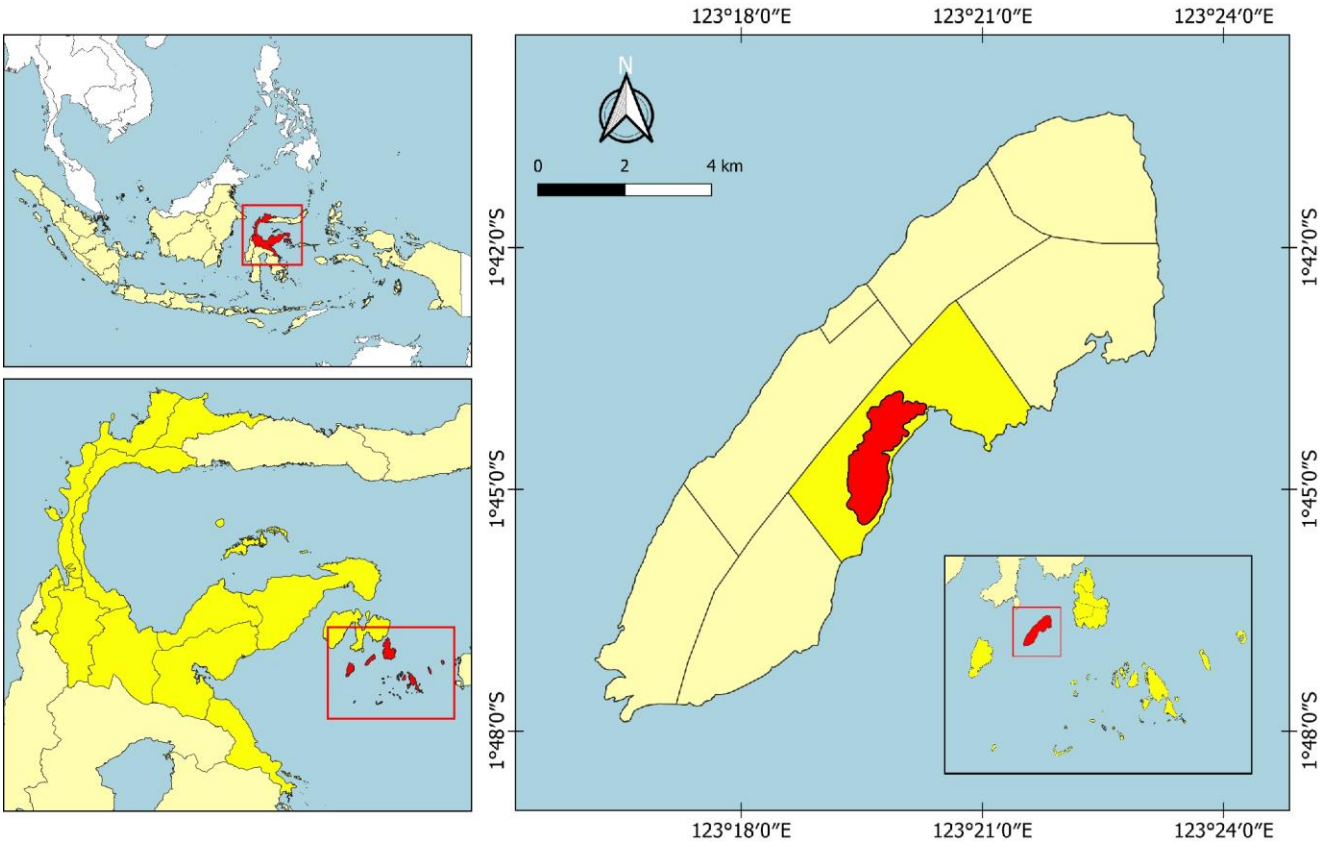

Figure 1. Location of the studied communities in the Labobo Sub-district, Banggai Laut District, Central Sulawesi, Indonesia. The location of villages sampled in the study area is Lipulalongo Village (red sign) (1°44'52.0"S 123°19'14.4"E)

RESULTS AND DISCUSSION

Based on observations and surveys of medicinal plants in Lipulalongo Village, Labobo Sub-district, Banggai Laut District, there are 21 species of medicinal plants used by local people in traditional medicine (Table 1, Figure 2). Of the various types of medicinal plants, all are plants that are simply cultivated by the community, and some of them are taken from the forest and then planted in the home garden.

The species of plants for medicinal uses in Lipulalongo Village can be found in the homegardens/yards, either growing naturally or deliberately planted. Some medicinal plants are also found in the gardens and forests around the village. However, the number of medicinal plant species used by the people of Lipulalongo Village (i.e., 21) is considered low. This is because people only get information about medicinal plants from generation to generation from their parents and *Sandro*. Therefore, it is necessary to conduct continuous research to develop qualitative and quantitative studies regarding the traditional knowledge of medicinal plants, which is also important to protect the local wisdom of the community as an intellectual collective of the Indonesian nation, as stated by Kandowangko et al. (2018).

The interview results also informed that the traditional medicines used by local people in Lipulalongo Village are inherited from their ancestors. However, not all families have the interest and ability to learn and know this, thus *Sandro* plays an important role in conserving traditional knowledge of medicinal plants. People use traditional medicinal plants because these are inexpensive and have minimal or no side effects if used correctly.

Part of the medicinal plants that the people of Lipulalongo Village widely use is a leaf. The leaf part of the plant is believed to have better benefits when compared to other parts. This is because the leaves contain compounds that have the potential to cure diseases, such as anti-inflammatory compounds, antioxidants, and other compounds, as well as they, have a soft fiber structure, so it is not difficult to obtain extracts of the compounds contained. In addition, the leaf is easy to obtain in a large quantity and does not highly affect the plant if harvested regularly compared to other organs. Also, the availability of the leaves is not affected by seasons if compared to, for example, flower or fruits. This is to the study by Akhsa et al. (2015), who stated that the use of leaves in traditional medication is easier to obtain, and the leaves are also easy to grow back, thus making it possible to be used continuously. A similar statement is also argued by Kandowangko et al. (2014), who stated that the use of the leaf organs of medicinal plants is an effort to conserve the preservation of medicinal plant species because it does not have a negative impact on the life of the plant. In some cases, the use of the leaves can be more effective if mixed with other plant parts such as root, stem, bark, rhizome, and tuber. However, using such organs as medicinal ingredients requires restrictions because they might immediately kill the plant. Besides the use of rhizome for medication, it is also used as natural spices for cooking, thus plants that are used for their rhizomes are obtained in the home garden to provide greater availability.

The result of an interview with *Sandro* explained that medicinal plants could be used to treat various diseases and health problems such as fever, diarrhea, colds, coughs, sore teeth, skin diseases (e.g., ulcers, tinea versicolor, and ringworm), digestive tract diseases in the stomach and therapy after giving birth (post-partum). However, before using for medication, the medicinal plant must be processed first, combining a species with other plants. The most common processing method carried out by the people in the Lipulalongo village is boiling and then squeezing. Here are some examples of using plants to cure disease or treat health problems and how to process by the people of Lipulalongo Village.

Drugs for blood pressure disease

The people of Lipulalongo Village use starfruit leaves (*Averrhoa bilimbi* L.), srikaya leaves (*Annona squamosa* L.), and cocoa leaves (*Theobroma cacao* L.) to treat blood pressure. However, few leaves of such plants are boiled with water and drank once daily. A similar disease can be cured using the fruit of *Phaleria macrocarpa* Boerl by drying the fruit's skin, then brewing it with a glass of hot water and drinking it when it is warm. The *P. macrocarpa* is a medicinal plant that can be used as an alternative treatment that contains flavonoids and has few side effects. Abed (2020) explained that blood pressure disease generally increases slowly as humans age, making hypertension a critical illness for the elderly. The flavonoid compounds contained in *P. macrocarpa* are effective in lowering blood pressure.

Treating diabetes

The people of Lipulalongo Village use the srikaya leaf plant (*A. squamosa*) to treat diabetes by taking a few leaves, boiling them in water, and drinking a glass of it once a day. The results of research by Rahmawati and Islamiyati (2018) that used *A. squamosa* leaf extract can reduce glucose levels in mice because this plant has a compound with anti-diabetic properties. This is also supported by research by Davis et al. (2018), which stated that *A. squamosa* hexane extract for 21 days significantly increased the decrease in glucose and triglycerides. Sharma et al. (2018) stated that the efficacy of *A. squamosa* extract contains anti-diabetic compounds in nature due to the presence of various types of active phytochemicals so that it can control diabetes mellitus.

After giving birth (giving birth)

The people of Lipulalongo Village use cingkeh leaves (*Syzygium aromaticum* (L.) Merr. & L.M.Perry) and cocoa leaves (*T. cacao*) to enhance body wellness after giving birth. A similar finding was also found by Fuadi (2017) that the people of Krueng Kluat Village believe that using traditional medicinal plants after childbirth, one of which is *S. aromaticum*, can discharge puerperal blood, re-tighten the abdominal muscles, heal wounds uterus and vagina, as contraceptives, restore fitness and health to the mother's body post-partum and weight loss.

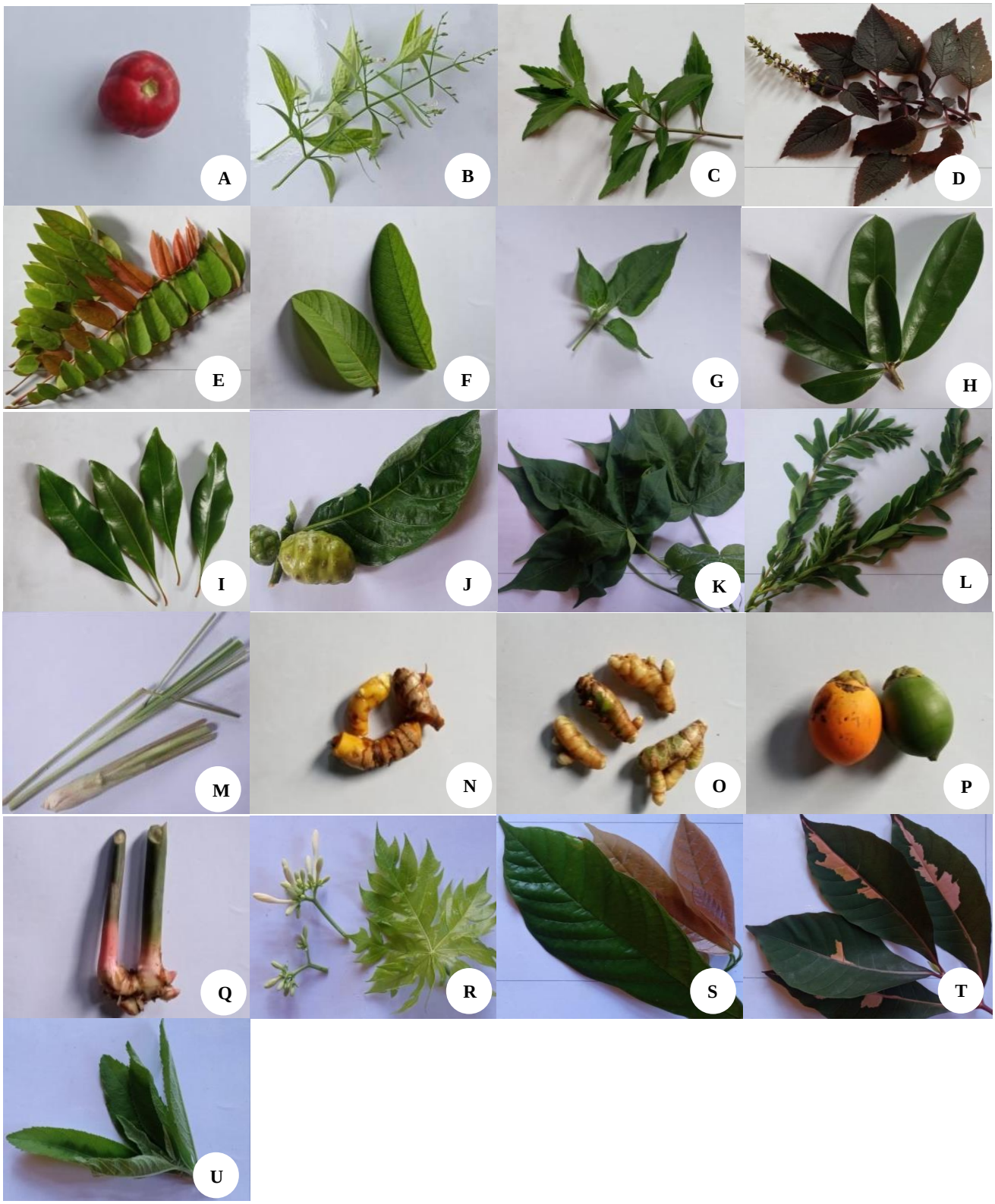

Figure 2. The types of medicinal plants found in the community of Lipulalongo Village, Labobo Sub-district, Banggai Laut District, Central Sulawesi, Indonesia. A. *Phaleria macrocarpa* (Boerl), B. *Andrographis paniculata* Burm.f., C. *Orthosiphon stamineus* Bent., D. *Coleus scutellarioides* (L.) Benth., E. *Averrhoa bilimbi* L., F. *Psidium guajava* L., G. *Capsicum annum* L., H. *Annona squamosa* L., I. *Syzygium aromaticum* (L.) Merr. & L.M.Perry., J. *Morinda citrifolia* L., K. *Gossypium arboreum* L., *Sesbania grandiflora* (L) Pers., M. *Cymbopogon citratus* (DC.) Stapf., N. *Curcuma domestica* Valeton., O. *Curcuma zedoaria* (Christm.) Roscoe., P. *Areca catechu* L., Q. *Alpinia galangal* L., R. *Carica papaya* L., S. *Theobroma cacao* L., T. *Chamaedaphne* sp., U. *Blumea balsamifera* (L.) DC. (Cullen 2006; Steenis et al. 2008; Herbie 2015; Rizal and Sustriana 2019)

Table 1. The types of medicinal plants found in the community of Lipulalongo Village, Labobo Sub-district, Banggai Laut District, Central Sulawesi, Indonesia

Species name	Family	Local name	Part(s) used	Method of use	Treatable disease	Habitat
Phaleria macrocarpa Boerl	Thymelaeceae	Buah mahkota dewa	Fruit	Decoction	Blood pressure disease	Homegarden
Andrographis paniculata Burm.f.	Acanthaceae	Sambiloto	Leaf	Decoction	Back pain, Kidney inflammation	Homegarden
Orthosiphon stamineus Bent	Lamiaceae	Kumis kucing	Leaf	Decoction	Back pain, Kidney stones, Diabetes	Forest
Coleus scutellarioides (L.) Benth.	Lamiaceae	Mayana	Leaf	Decoction	Hemorrhoids, Diabetes	Homegarden
Averrhoa bilimbi L.	Oxilidaceae	Belimbing	Leaf	Decoction	Blood pressure disease	Homegarden
Psidium guajava L.	Myrtaceae	Giawas	Leaf	Decoction	Toothache, Diarrhea medicine	Homegarden
Capsicum annum L.	Solanaceae	Marisa	Leaf	Decoction	Relieve pain	Homegarden
Annona squamosa L.	Annonaceae	Srikaya	Leaf	Decoction	Blood pressure disease, Diabetes	Homegarden
Syzygium aromaticum (L.) Merr. & L.M.Perry.	Myrtaceae	Cingkeh	Leaf, Fruit	Decoction	After giving birth, Asthma	Garden
Morinda citrifolia L.	Rubiaceae	Mangkudu	Fruit	Decoction	High blood pressure, Get rid of bad breath/body	Forets
Gossypium arboreum L.	Malvaceae	Kapas	Leaf	Poultices	Boils, Fractures	Forest
Sesbania grandiflora (L) Pers.	Leguminosae	Turi	Leaf	Decoction	Hot inside, White discharge on the surface of the tongue	Home garden and forest
Cymbopogon citratus (DC.) Stapf.	Poaceae	Mbonout	Leaf	Decoction, poultices	Body warmer	Homegarden
Curcuma domestica Valeton.	Zingiberaceae	Kunyit mosoni	Rhizome	Decoction, poultices	Cure gastric disease	Homegarden
Curcuma zedoaria (Christm.) Roscoe.	Zingiberaceae	Kunyit moute	Rhizome	Decoction, poultices	Typhus	Homegarden
Areca catechu L.	Arecaceae	Posos	Fruit	Decoction, poultices	Vomiting blood	Homegarden
Alpinia galangal L.	Zingiberaceae	Lengkuas	Rhizome	Decoction, poultices	Increase appetite	Homegarden
Carica papaya L.	Cariceae	Tapaya	Leaf	Decoction, poultices	Vaginal discharge	Homegarden
Theobroma cacao L.	Sterculiaceae	Coklat	Leaf	Decoction with *A. bilimbi*, *A. squamosa* leaves	Blood pressure disease, After giving birth	Garden
Chamaedaphne sp.	Ericaceae	Memel	Leaf	Poultices	Fever	Forest
Blumea balsamifera (L.) DC.	Asteraceae	Pakundalang	Leaf	Decoction	Cough, Asthma	Forest

Shahanas et al. (2019) stated that cocoa contains polyphenols consisting of flavonoids and non-flavonoids, which are proven beneficial for health. This is supported by Katz et al. (2011), that found cocoa contains more phenolic antioxidants such as flavonoids, including catechins, epicatechins, and procyanidins than other plant species. In more recent research, Yanez et al. (2021) revealed that cocoa beans contain antioxidant molecules that can inhibit the coronavirus type 2 (SARS-CoV-2), which causes severe acute respiratory syndrome (COVID-19).

Feverish/burning up

The people of Lipulalongo Village use turi leaves (*Sesbania grandiflora* (L) Pers.) to treat feverish/burning up in babies. The *S. grandiflora* is a plant with antioxidant potential because it is rich in vitamin A, vitamin C, thiamine, riboflavin, and nicotinic acid to protect humans from the dangers of oxidation (Ramesh et al. 2015). In addition, this plant has chemical constituents such as arginine, cystine, histidine, isolucine, phenylalanine, tryptophan, valine, threonine, alanine, aspargine, aspartic acid, saponins, oleic acid, galactose, rhamnose, glucuronic acid, flavonoids, and kaempferol (Bhoumik et al. 2016). Flavonoids are chemical compounds that have a very important role in microbial or anti-bacterial inhibitory activity (Padmalochana and Rajan 2014; Arunabha and Satish 2015).

Cough and asthma

The people of Lipulalongo Village use pakundalang/ sembung (*Blumea balsamifera* (L.) DC.) to treat cough and asthma by taking a few leaves, boiling them in the water, and drinking the water 2 times a day with added brown sugar. Our finding is in line with a study by Widhiantara

and Jawi (2021), which found that *B. balsamifera* plants can be used to treat sinusitis, colic pain, coughs, kidney stones, flu, or diuretics. This plant contains several phytochemicals, both volatile (terpenoids, fatty acids, phenols, alcohols, aldehydes, ethers, ketones, pyridines, furans, and alkanes) and non-volatile (flavonoids, flavanones, and chalcones). Compounds widely contained in the leaves of *B. balsamifera* are flavonoid groups including blumeatin, velutin, tamarixetin, dihydroquercetin7,4'-dimethyl ether, ombuine, rhamnetin, luteolin-7-methyl ether, luteolin, quercetin, 5,7,3',5'tetrahydroxyflavanone, and dihydroquercetin-4'methyl ether (Ruhardi and Sahumena 2021). Nursamsu and Firmansyah (2017) stated that people often use the leaves of *B. balsamifera* as a medicine for headaches, colds, pain, fever, diabetes, flatulence, and pain during the menstrual period. The whole plants or crude extracts of the *B. balsamifera* have activities of antitumor, hepatoprotective, superoxide radical scavenger, antioxidant, anti-microbial and anti-inflammatory, anti-plasmodial, anti-tyrosinase, platelet aggregation, increase percutaneous penetration, healing, wound, anti-obesity, and disease-resistant activities (Pang et al. 2014).

Diarrhea

The local community in Lipulalongo Village uses guava (*Psidium guajava* L.) to treat diarrhea. Guava leaves contain essential oils, tannins, flavonoids, phenolic compounds, carotenoids, and vitamin C, which can be used to treat dysentery, gastroenteritis, diabetes mellitus, stomach pain, and wounds (Irshad et al. 2020).

Back pain and kidney inflammation

The people of Lipulalongo Village use all parts of sambiloto (*Andrographis paniculata* Burm.f.) to reduce back pain and kidney inflammation. The mode of application is by drying the roots and stems in the sun, adding 5 leaves, then boiling the three ingredients in 1 cup of water, then waiting until it cools down and drinking it. Other uses are bloating, aches, and pains by boiling the leaves and drinking the boiled water. The *A. paniculata* plant extracts and pure compounds have been reported to have activities of anti-microbial, cytotoxicity, antiprotozoal, anti-inflammatory, antioxidant, immunostimulant, anti-diabetic, anti-infective, anti-angiogenic, hepato-renal protection, sex hormone/sexual function modulation, liver enzyme modulation, insecticidal activity and toxicity (Okhuarobo et al. 2014). In addition, this plant can inhibit viral factors from microbes, acute respiratory infections such as colds and sinusitis, and can also provide immune (Hossain et al. 2021). The results of research by Rahmi et al. (2022) showed that the ethanolic extract (80%) of *A. paniculata* leaves and its main diterpene lactone, andrographolide, may have antihyperuricemic and anti-inflammatory properties and are therefore used to treat gout.

Vaginal discharge

The people of Lipulalongo Village use a mixture of papaya leaves (*Carica papaya* L.) and cingkeh (*S. aromaticum*) to treat vaginal discharge problems in women. In doing so, one young papaya leaf and 5 cloves are dried, washed, sliced , and then boiled with 4 cups of water to make 3 cups and then drink three times a day. Vaginal discharge is caused by *Candida albicans* yeast infection in the vagina. One way of prevention or treatment is by consuming papaya leaf extract. The results of research by Suni et al. (2017) concluded that boiled water of papaya leaves has an inhibitory effect on *C. albicans.* Djunaidi et al. (2015) found that topical administration of concentrated papaya leaf extract 5% during pregnancy in mice increases post-partum vaginal tissue collagen density. Research by Nilofer and Chenthamarai (2021) concluded that *C. papaya* leaf extract contains antifungal compounds that can inhibit *C. albicans*. Papaya has long been used in traditional medicine. Apart from preventing vaginal discharge, the leaf extract treats several infectious diseases such as dengue fever, malaria, and chikungunya (Hariono et al. 2021). In addition to papaya extract, *S. aromaticum* can be used as an antifungal that causes *Candida vaginitis* (Yassin et al. 2020). The main compounds of clove extract are eugenol and -caryophyllene, which are strong anti-bacterial and antifungal agents. In addition, this plant contains essential oils that can inhibit the growth of *C. albicans* (Hiwandika et al. 2021).

In summary, the results of the survey In Lipulalongo Village found several medicinal plants that were found in community yards, and some were also found in gardens and forests. Most types of medicinal plants are deliberately planted for daily use. The researcher's recommendation in this study is to make a book on medicinal plants so that the culture of using medicinal plants is not extinct.

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