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An Ethnomedicinal Study of Plants Used for Healing of Infectious Diseases in Kuantan Singingi District of Riau Province, Indonesia

Dian Mayasari, Yosi Bayu Murti, Sylvia Utami Tunjung Pratiwi and Sudarsono*

Department of Pharmaceutical Biology, Faculty of Pharmacy, Universitas Gadjah Mada, Yogyakarta 55281 Indonesia

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ABSTRACT Indonesia is rich in biodiversity of medicinal plants used traditionally for healing several ailments. This explorative ethnomedicinal study aims to document the traditional healers and the medicinal plants for infectious diseases in Riau Province, Sumatera, Indonesia. Interviews with local healers resulted in the documentation of 44 species, 33 genera, and 23 families of plants. Zingiberaceae (20.0%) is the most widely used family. Most recipes are prepared as pounded (27.2%) and administered or taken orally (57.7%). The rhizome of *Curcuma longa*, *Alpinia galanga* and *Zingiber zerumbet* are used for several infectious diseases treatments, including dysentery and stomachache. The outcomes obtained in the study are worthy for further investigation to verify their ethnomedics, efficacy and safety for more scientific research and could contribute to the development of Indonesian herbal remedies to discover new plant-based drugs for anti-infectious disease agents.

INTRODUCTION

Indonesia is the second greatest biodiversity country in the world for its high number of indigenous medicinal plants (Elfahmi et al. 2014). Those diverse indigenous species are distributed on each island of the archipelago with their own respective uniqueness. Among the total of 17,000 islands, Sumatera Island belongs to five-biggest islands in Indonesia and exhibits marvelous vegetation types (Grosvenor et al. 1995). The investigation of the medicinal plants in the several regions and tribes of Sumatera Island has been well-documented by Silalahi et al. (2015) of the Batak Karo sub-ethnic from the North Sumatera, Susiarti, et al. (2008) from Teso Nilo National Park, Riau, Suwardi, et al. (2021) of the Aneuk Jamee tribe from South Aceh, and Hariyadi and Ticktin (2012) from Serampas, Jambi. However, investigation and documentation of medicinal plants for infectious diseases of Malay people in Kuantan Singingi district, Riau province are still lacking and this study will be the first one.

Herbal medicines are still commonly used by about eighty percent of the world population for primary healthcare, mainly in developing countries. They are preferable because they are easy to find, cheap, and has least side-effects compared to chemical drugs (Bussmann and Sharon 2006; Gebreyes and Melesse 2016). In spite of the progress of pharmacology, many plant-based traditional medicines are used to discover novel compounds for particular ailments. Several modern nervine drugs with anti-inflammatory effects have been discovered and derived from medicinal plant sources, for example, aspirin from extracted willow tree, and morphine from poppy flower seeds (*Papaver somniferum*) for pain relief (Yeung et al. 2020).

In developing countries, such as in Africa, up to eighty percent of the population uses traditional medicine as the primary healthcare system. In Latin America, around seventy-one percent of the population in Chile and forty percent of the population in Colombia use traditional medicines (WHO 2002). In several Asian countries, herbal medicine is still largely used and widely available in pharmacies as complementary alternative medicines (CAM), while in some regions, they are still the first choice for medical treatment in healthcare (Bussmann and Sharon 2006).

Infectious diseases continue to be the most mortality threat for the human population with a heavy burden of morbidity. Although infectious diseases are found worldwide, the types of infec-

*Address for correspondence:
Sudarsono
Sekip Utara St.
Senolowo, Yogyakarta 55281 Indonesia
Telephone: +62 811 282 101, (0274)543120
E-mail: sudarsono@ugm.ac.id

tions may vary depending on several factors, including the climate, sanitary conditions, and other environmental factors (Kotra 2007). Globally, it is estimated that 165 million *Shigella diarrhoeal*-related dysentery episodes occur in a year, where the ninety-nine percent occurs in developing countries (Berkley and Williams 2016). The diseases are then commonly treated with ginger root (*Zingibar officiale*), traditional healer called *Jamu Jahe* in Malay and Indonesian. Many infectious diseases, such as malaria and diarrhea, are treatable with these inexpensive, readily available medications. In Malaysia, the traditional *materia medica* includes over 50 species in the alternative, complementary treatments for malaria, which is spread by the mosquito species, *Plasmodium falciparum*. Many Asian countries continue to have seasonal malaria endemic areas despite global efforts at eradication. Common herbal remedies in these regions belonging to anti-emetic and anti-inflammatory agents have been tested and found zero cytotoxic effect on Madin-Darby Canine Kidney (MDCK) cells in vitro (Razak et al. 2014). These herbal healers are cinnamon leaves *(Cinnamomun iners)*, tree bark *(Cinnamomun verum)*, and turmeric root (*Curcuma zedoaria* and *Curcuma mangga*). Although they belong to the inexpensive medications, they are still often unaffordable by the very poor local inhabitants of these areas. It is an irony because they are surrounding ecosystem abounds with biodiversity full of medicinal species with proven phytochemicals, including tannins, saponins, and many powerful antioxidants such as flavonoids and isoflavones. Unfortunately, the zero protection for natural resources, particularly for indigenous medicinal plants, have led many species to extinction or at least are considered endangered due to the irresponsible exploitation for profit. This devastating effect on the ecological diversity in some developing countries can be seen from the overharvesting of Reishi mushrooms or Lingzhi (*Ganoderma luciidum*). It is commonly used as a cure for cancer and is sold at exorbitant prices in many big cities, for example, Tokyo, Japan, where it is believed to have supernatural powers when combined with the aphrodisiac root of the Ginseng plant (*Panax ginseng*) (Lam et al. 2020). Other concerns have been raised about the quality control of these plant medicines that may have varied strengths and toxic potencies depending on several factors, for example, soil composition, altitude, drying, and processing methods. In some cases, while maintaining proper nutrition, sanitation and hygiene are important for maintaining health, they may be neglected in developing countries due to limited economic and social support. In regions facing the neglected tropical diseases, the alternative option of herbal supplements might be considered the only choice when modern medicines are not available. While infectious diseases by microorganisms can be reduced by the usage of effective antibiotic therapy and plant medicines that have anti-microbial properties, in both cases, the proper preparation, handling, and prescription are needed to safeguard these vulnerable people from dangerous drug interactions and counterindications.

The current main focus regarding discovery of novel compounds shifted to a combination between a high-throughout screening and computational-molecular modelling (Young et al. 2002). Nevertheless, dissemination of ethnomedical knowledge from traditional healers still remains a flowerous method to investigate phytochemical compounds for developments of novel drug discovery (Ram and Kumari 2001; Martin and Ernst 2003; Buenz et al. 2005). In rural areas, the healthcare is often controlled by traditional healers called "*dukun*". They have ethnomedical knowledge for treatments of various ailments. However, the traditional plants are only known by their local names, while the bioactive compounds and the scientific potential effects are poorly understood.

Objectives

Species identification is essential to plan for further research on chemical constituents and conduct species cultivation in the future. This study aims to collect ethnomedicinal data from traditional healers regarding common medicinal plant-based remedies for infectious diseases such as diarrhea, dysentery, wounds, and stomachache. In addition, this study also expects to protect the natural resources and human sources of valuable ethnobotanical knowledge. The researchers expects to document traditional healers' methods to prepare the biological activities of medicinal plants in the remote areas of Sumatera. By far, there have been few studies discussing the traditional medicinal ethnobotany.

METHODOLOGY

Study Area

Kuantan Singingi is a district of Riau province in Sumatera Island, Indonesia (Fig. 1). This area is located 0°02 03 North and 101°552 03 East. Kuantan Singingi has an area of 7,656.03 km^2 with a population of 321,216 people comprising 164,769 men and 156,447 women. Kuantan Singingi has been divided into 15 subdistricts, namely, Hulu Kuantan, Kuantan Mudik, Gunung Toar, Kuantan Tengah, Sentajo Raya, Benai, Pangean, Singingi Hilir, Singingi, Kuantan Hilir, Cerenti, Inuman, Logas Tanah Darat, Kuantan Hilir Seberang, and Pucuk Rantau. Based on its geographical location, Kuantan Singingi is surrounded in the north by Kampar and Pelalawan district, in the south by the Jambi province, in the west by the West Sumatera Province and in the east by the Indragiri Hulu district. The study area in this ethnomedicinal study includes Gunung, Seberang Gunung, Toar, Petapahan, Koto Gunung, and Teluk Beringin as shown in Figure 1. Indonesia has the dry and rainy season. During the rainy one, flooding occurs around some particular districts, and hence it affects the water quality around coastal and river areas. During the dry season, drought turns to be common issue in almost every area in Indonesia. When the rainfall mean is under the normal rate while the temperature is increasing, there must be the increasing threat of drought periods. In some regions of Riau province, it is hard for people to catch some freshwater due to the drought periods that also limits the yield of crops. Drought in Indonesia is a big nightmare that might cause failure in planting and harvesting.

Data Collection

The ethnobotanical data were collected by interviews of six traditional healers in their home

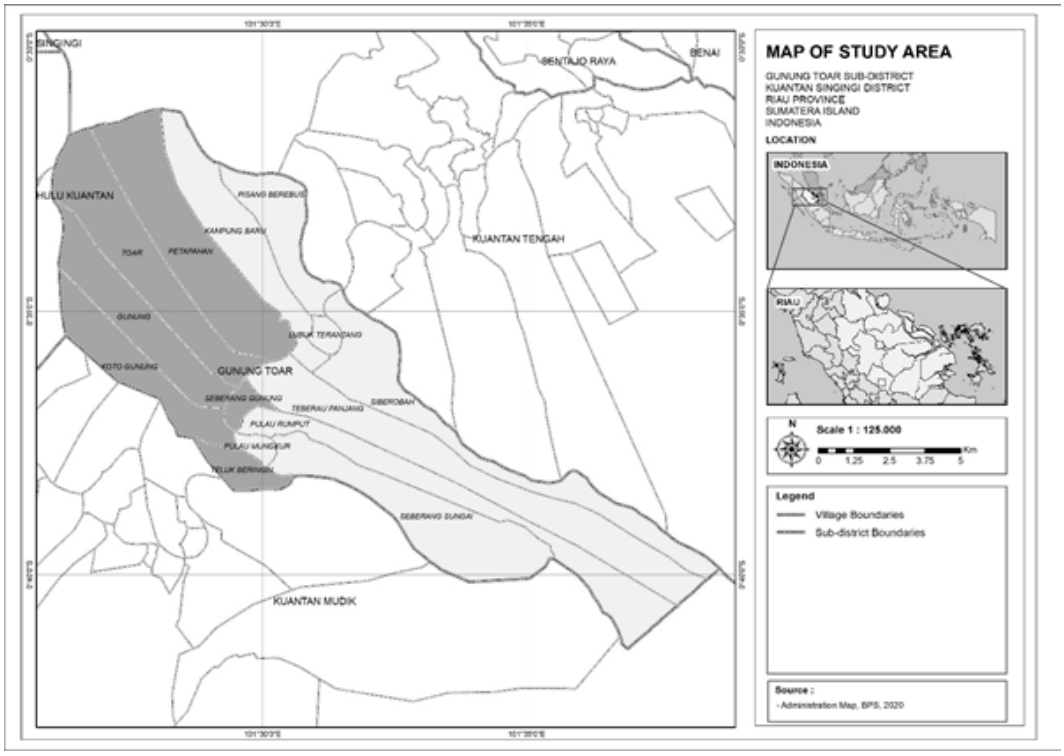

Fig. 1. Map of the study area showing the location ofvillages
Source: Using ArcGis 10.4.1 created by the researcher

during June 2018 in six villages in Kuantan Singingi district, Riau province, Indonesia. These regions are located alongside the Kuantan river of Kuantan Singingi district were selected for the field investigations. In strengthening the researchers' field observations and intensive literature search findings through data triangulation, further ethnomedicinal surveys were conducted to collect and confirm the botanical data via interviews with traditional healers of each area in the study. The local healers were demanded for their consent to share their knowledge only for the purpose of this study. Data were obtained through semi-structured interviews with six traditional healers (local inhabitants with various occupations) as guided by Martin (1995) and Cotton (1996). The interviews comprised of two parts. First, the respondents' demographic profiles; name, age, gender, education background, how they obtained the traditional medicinal knowledge, occupations, and their duration of. Second was about the information about herbal therapy used by traditional healers to cure people in Kuantan Singingi district associated with infection diseases (diarrhea, dysentery, stomachache and wounds). The ethnomedicinal data collection was conducted by delivering the questions:

1. What plants are used to cure infection diseases such as wounds, diarrhea, dysentery and stomachache?
2. What is the local name of plants, what parts are used, what methods of preparation are involed, dosage, and methods of administration.

The responses are generated to get a short description of how the local people used those medicinal plants. The research team that visited the study field area comprised of the researchers and two trained interviewers who were familiar with the local setting and the local languages. Each interview session lasted from 1 hour to 2.5 hours. Similar questions were given to each informant to get a compilation of indigenous ethnobotanical knowledge. Information was collected in their local language (Malay language). The research team analysed the interview contents and conducted a community study simultaneously with local healers. The collected information was re-checked to the available literature regarding medicinal plants and ethnobotany worldwide, particularly in Indonesia. The medicinal plants' scientific names were verified through online sources; International Plant Name Index (IPNI: http:// www. ipni.org) and www.the plantlist.com. All specimens' identification was confirmed by botanists in the Department of Pharmaceutical Biology, Universitas Gadjah Mada, Indonesia, and catalogued into storage for future research.

Data Analysis

The data that were obtained were analysed using qualitative-quantitative methods. The qualitative analysis was conducted by grouping plants based on families, parts used, habit, preparation mode, and administration mode using the descriptive statistics. Further, the data were arranged in tables for analysis employing Microsoft Excel 2013. Data of investigations of the traditional healers were presented in a table with six categories, which were background information of traditional healers, number of medicinal plants used to treat infectious disease, partly used, the growth form, mode of preparation and mode of administration. Quantitative analysis of the data were administered with Friedman's Fidelity Level (FL), which is the percentage of respondents claiming the certain plant species use for specific healing processes, and represent the people's preference for a particular plant species in a certain medicinal process (Friedman et al. 1986). It was calculated using the following equation:

$$FL\ (\%) = \left(\frac{Ip}{Iu}\right) \times 100$$

Where,

Ip is the amount of respondents claiming the use of a plant species for a particular disease curing, and Iu is the overall number of respondents stating that plants are medicines for any disease.

RESULTS

Profile of Traditional Healers

The ethnomedical survey was initiated by obtaining personal data about traditional healers. The data of traditional healers, regarding their gender, age, education level and occupations, are shown in Table 1. All six traditional healers belong to Malay people and lived in Kuantan Singingi district. They comprised five men (83.33%) and one woman (16.67%) and were between the

ages of 50 and 89. Five of them are farmers (83.33%) and the other one is an herbalist (16.67%). The gathered information was processed and analysed in order to collect the data in these aspects, especially the plants used for the treatment of infective diseases such as diarrhea, dysentery, stomachache, and wound.

Table 1: The background information of traditional healers in this study

	Amount	*Percent*
Gender		
Male	5	83.33
Female	1	16.67
Age		
50-59	1	16.67
60-69	2	33.33
70-79	1	16.67
80-89	2	33.33
Education level		
Elementary school	6	100
Occupation		
Farmer	5	83.33
Herbalist	1	16.67

The range of age of informants started from 50 years old as the local healers mostly are elder people. They have practiced herbal therapy from medicinal plants for a long time for around an average 20 years. The knowledge about medicinal plants they have gained from their parents and have continued the ethnobotanical tradition from generation to generation. Between one local healer and others they are not always following the same recipe to cure particular ailments, but each of them have specific knowledge to cure and to give the recipe to the patients.

Medicinal Plant of the Study Area

The overall 44 medicinal plant species that belong 23 families and 33 genera were utilised by the native people of the Kuantan Singingi district to treat infection-related diseases, including wounds, diarrhea, dysentery, and stomachache. Zingiberaceae was the most utilised family with eight plant species (20.0%), followed by Euphorbiaceae, Rutaceae, Musaceae, and Solanaceae-with 3 species each (6.6%), Crassulaceae, Liliaceae, Clussiaceae, Asteraceae, Lamiaceae, Cucurbitaceae, Myrtaceae with two species each (4.4%) and the others have one species (Table 2).

The documentation of ethnomedicinal plants including local name, scientific name, family name,

Table 2: Medicinal plant species in each family used in this study

S. No.	*Family*	*Number of plants*	*Species*
1	Zingiberaceae	8	*Curcuma longa L., Kaempferia galanga, Alpinia galanga, Zingiber zerumbet, Curcuma amada, Curcuma aeruginosa, Zingiber cassumunar*
2	Myrtaceae	2	*Psidium guajava, Rhodamnia cinerea*
3	Euphorbiaceae	3	*Jatropha multifida, Manihot esculenta,*
4	Clussiaceae	2	*Garcinia atroviridis, Garcinia xanthochymus*
5	Cucurbitaceae	2	*Benincasa hispida, Lagenaria siceraria*
6	Solanaceae	3	*Solanum torvum, Solanum melongena, Physalis minima*
7	Lamiaceae	2	*Solenostemon scutellarioides, Coleus amboinicus L.*
8	Asteraceae	2	*Elephantopus scaber, Ageraratum conyzoides*
9	Liliaceae	2	*Allium sativum, Allium cepa*
10	Musaceae	3	*Musa paradisiaca, Musa sapientum L., Musa balbisiana*
11	Rutaceae	3	*Citrus aurantifolia, Citrus hystrix, Citrus medica*
12	Crassulaceae	2	*Bryophyllum pinnatum, Kalanchoe pinnata*
13	Poaceae	1	*Cymbopogon citratus*
14	Melastomataceae	1	*Melastoma malabathricum*
15	Myristicaceae	1	*Myristica fragrans*
16	Verbanaceae	1	*Peronema canescens*
17	Lythraceae	1	*Lawsonia inermis*
18	Fabaceae	1	*Tamarindus indica*
19	Acanthaceae	1	*Andrographis paniculata*
20	Moringaceae	1	*Moringa oleifera*
21	Athyriaceae	1	*Diplazium esculentum*
22	Marrattiaceae	1	*Angiopteris evecta*
23	Caricaceaea	1	*Carica papaya*

part used, habit, preparation and administration methods and medical uses is represented in Table 3.

Table 3 shows the types of infectious diseases, including dysentery, diarrhea, stomachache, and wounds. The highest number of species was documented for the treatment of dysentery (n=26, 59.09%), followed by stomachache (n= 13, 29.54%), wounds (n=9, 20.45%) and diarrhea (n=4, 9.09%). Diarrhea is an infection disease infected by several bacteria such as *Vibrio cholera*, *Clostridium difficile*, *Escherichia coli*, rotavirus, norovirus, and Shigella species (Hodges and Gill 2010). The medicinal plants used for diarrhea were *Myristica fragrans*, *Curcuma longa*, *Benincasa hispida*, and *Lagenaria siceracia*. They were divided into three families, two plants of Cucurbitaceae and one from Zingiberaceae, and the other one of the Myristicaceae family. For dysentery, there are 18 plant species used. They belong to ten families, including Zingiberaceae, Poaceae, Myrtaceae, Clussiaceae, Fabaceae, Cucurbitaceae, Solanaceae, Liliaceae, Musaceae, and Rutaceae.

This study discovers ten medicinal plants used for stomachache disease treatment, which are *Curcuma longa*, *Alpinia galanga*, *Zingiber zerumbet*, *Andrographis paniculata*, *Solenostemon scutellarioides*, *Elephantopus scaber*, *Coleus amboinicus*, *Ageratum conyzoides*, *Moringa oleifera*, *Diplazium esculentum*, *Angiopteris evecta*, *Bryophyllum pinnatum*, and *Kalanchoe pinnata*. The medicinal plants belong to seven families involving three plants of Crassulaceae, two plants of Lamiaceae and Asteraceae, followed by one plant of Acanthaceae, Moringaceae, Crassulaceae, Marattiaceae, Zingiberaceae. Wound infection and bleeding resulted from accidents are common in the Indonesian work environment and are the most concern, especially in rural areas. The treatment of wound healing has also involved several types of medicinal plants. In this case, it discovers nine plant species, including *Jatropha multifida, Melastoma malabathricum, Manihot esculenta, Rhodamnia cinerea, Peronema canescens, Lawsonia inermis, Allium sativum, Allium cepa,* and *Carica papaya*. These plants include members from six families, such as two plants of Euphorbiaceae and each plant of Melastomataceae, Myrtaceae, Verbenaceae, Lytrhaceae, and Caricaceae.

Fidelity Level

Fidelity level indicates the ratio of informants that use a botanical remedy and reveals the medicinal plants for which the ailment had FL values in this study that varied from fifty percent to one hundred percent. Most these remedies were used in a single ailment category with multiple traditional healers. The fidelity level is significant to know the most effective ailment for the specific plant. In this study, the FL value varied from fifty percent to one hundred percent. The results revealed 37 plant species of one hundred percent which were mostly used in only one ailment category involving several respondents with no consideration about plants that were only reported once for more accuracy. Generally, one hundred FL values for a particular plant is indicating that all the use-reports stated same methods in utilising the plants for treatments (Srithi et al. 2009; Chaachouay et al. 2019). The result means that the healers in the Kuantan Singingi district tend to use one particular plant species for only one ailment. There are 37 plant species highly cited for infective diseases and these must undergo further investigation related to to earn more authenticity and efficacy, based on previous studies' recommendation.

The Growth Form of Medicinal Plants

The growth form analysis of medicinal plants exhibited four habits (growth forms). The herbs earned the biggest proportion that is showed by 25 species (56.82%), followed by trees represented by 11 species (25.00%), shrubs represented by 6 species (13.64%), and two species (4.54%) of climber (Table 4).

Table 4: Percent of growth form of medicinal plants used to treat infectious ailment in the study area

Growth form	*Number of plants*	*Percent*
Herb	25	56.82
Climber	2	4.54
Shrub	6	13.64
Tree	11	25.00

The result in Table 4 showed that herbs were the most represented growth forms of medicinal plants and followed by trees. Similar findings re-

Table 3: List of the traditional medicinal plants used for healing of infectious diseases

S. No.	Local name	Scientific name	Family name	Part used	Habit	Prep. methods	Adm. methods	Med. uses	FL (%)
1	Kunyit	*Curcuma longa* L.	Zingiberaceae	Rhizome	Herb	Infusion	Oral	DT,ST, DR	75
2	Serai	*Cymbopogon citratus*	Poaceae	Stem	Herb	Infusion	Oral	DT	100
3	Jambu biji	*Psidium guajava*	Myrtaceae	Leaves	Tree	Decoction	Oral	DT	100
4	Kencur	*Kaempferia galanga*	Zingiberaceae	Rhizome	Herb	Infusion	Oral	DT	100
5	Betadin	*Jatropha multifida*	Euphorbiaceae	Leaves	Herb	Pounded	Topical	WN	100
6	Senduduk	*Melastoma malabathricum*	Melatomataceae	Leaves	Herb	Pounded	Topical	WN	100
7	Singkong	*Manihot esculenta*	Euphorbiaceae	Leaves	Herb	Pounded	Topical	WN	100
8	Mampuyan	*Rhodamnia cinerea*	Myrtaceae	Leaves	Tree	Pounded	Topical	WN	100
9	Pala	*Myristica fragrans*	Myristicaceae	Fruit	Tree	Infusion	Oral	DR	100
10	Sungkai	*Peronema canescens*	Verbenaceae	Leaves	Tree	Pounded	Topical	WN	100
11	Inai	*Lawsonia inermis*	Lytrhaceae	Leaves	Herb	Pounded	Topical	WN	100
12	Asam gelugur	*Garcinia atroviridis*	Clusiaceae	Fruit	Tree	Decoction	Oral	DT	100
13	Asam jawa	*Tamarindus indica*	Fabaceae	Fruit	Tree	Decoction	Oral	DT	100
14	Asam kandis	*Garcinia xanthochymus*	Clusiaceae	Fruit	Tree	Decoction	Oral	DT	100
15	Lengkuas	*Alpinia galanga*	Zingiberaceae	Rhizome	Herb	Infusion	Oral	DT, ST	66.67
16	Lempuyang	*Zingiber zerumbet*	Zingiberaceae	Rhizome	Herb	Infusion	Oral	DT, ST	50
17	Kunyit	*Curcuma longa* L.	Zingiberaceae	Flower	Herb	Infusion	Oral	DT	100
18	Kundur	*Benincasa hispida*	Cucurbitaceae	Leaves	Climber	Decoction	Oral	DT, DR	50
19	Labu air	*Lagenaria siceraria*	Cucurbitaceae	Leaves	Climber	Decoction	Oral	DR, DT	50
20	Terung pipik	*Solanum torvum*	Solanaceae	Leaves	Shrub	Juice	Oral	DT	100
21	Terung makan	*Solanum melongena*	Solaceae	Leaves	Shrub	Juice	Oral	DT	100
22	Sambiloto	*Andrographis paniculata*	Acanthaceae	Leaves	Shrub	Pounded	Topical	ST	100
23	Piladang	*Solenostemon scutellarioides*	Lamiaceae	Leaves	Herb	Pounded	Topical	ST	100
24	Bangun-bangun	*Coleus amboinicus* L.	Lamiaceae	Leaves	Herb	Pounded	Topical	ST	100
25	Tutup bumi	*Elephantopus scaber*	Asteraceae	Leaves	Herb	Pounded	Topical	ST	100
26	Rumput cik babi	*Ageratum conyzoides*	Asteraceae	Leaves	Shrub	Pounded	Topical	ST	100
27	Bilang-bilang	*Moringa oleifera*	Moringaceae	Leaves	Shrub	Pounded	Topical	ST	100
28	Bawang putih	*Allium sativum*	Liliaceae	Bulb	Herb	Pounded	Topical	DT, WN	66.67
29	Bawang merah	*Allium cepa*	Liliaceae	Bulb	Herb	Pounded	Topical	DT,WN	66.67
30	Pisang buai	*Musa paradisiaca*	Musaceae	Root	Herb	Decoction	Oral	DT	100
31	Pisang manis	*Musa sapientum* L.	Musaceae	Root	Herb	Decoction	Oral	DT	100
32	Pisang talun	*Musa balbisiana*	Musaceae	Root	Herb	Decoction	Oral	DT	100
33	Jeruk nipis	*Citrus aurantifolia*	Rutaceae	Root	Tree	Decoction	Oral	DT	100
34	Jeruk sundai	*Citrus hystrix*	Rutaceae	Root	Tree	Decoction	Oral	DT	100
35	Jeruk mentimun	*Citrus medica*	Rutaceae	Root	Tree	Decoction	Oral	DT	100
36	Ciplukan	*Physalis minima*	Solanaceae	Root	Shrub	Decoction	Oral	DT	100
37	Paku gulai	*Diplazium esculentum*	Athyriaceae	Leaves	Herb	Pounded	Topical	ST	100
38	Paku gajah	*Angiopteris evecta*	Marrattiaceae	Leaves	Herb	Pounded	Topical	ST	100
39	Setawar	*Bryophyllum pinnatum*	Crassulaceae	Leaves	Herb	Pounded	Topical	ST	100
40	Sedingin	*Kalanchoe pinnata*	Crassulaceae	Leaves	Herb	Pounded	Topical	ST	100
41	Kunyit temu	*Curcuma amada*	Zingibearceae	Rhizome	Herb	Infusion	Oral	DT	100
42	Kunyit eghang	*Curcuma aeruginosa*	Zingibearceae	Rhizome	Herb	Infusion	Oral	DT	100
43	Kunyit bolai	*Zingiber cassumunar*	Zingibearceae	Rhizome	Herb	Infusion	Oral	DT	100
44	Pepaya	*Carica papaya*	Caricaceae	Root	Tree	Pounded	Topical	WN	100

DT: dysentery, DR: diarrhea, ST: stomachache, WN: wound, prep: preparation, adm: administration, med: medicinal, FL: Fidelity Level

garding the usage of growth form of medicinal plants were reported by Gebreyes and Melesse (2016) in Southern Ethiopia that revealed herbs (43.0%) as the most dominant growth, followed by shrubs (21.0%). Abidullah et al. (2019) also described herbs (44.0%) and tree (37.0%) as the most highly used plant parts. However, another finding conducted by Boadu and Asase (2017) revealed that tree (45.9%) and herbs (24.5%) were the most frequently life form of medicinal plant categories.

Part of Medicinal Plants Used

The traditional healers in the study area manage to use different parts of the medicinal plants for their traditional concoctions, such as root, rhizome, leaves, fruit, bulb and flower. The most used parts of plants are leaf (47.73%) with 21 species, followed by root (18.20%) with 8 species, rhizome (15.90%) with 7 species, fruit (9.09%) with 4 species, bulb (4.54%) with 2 species while stem and flower have one species each (2.27%) (Table 5).

Table 5: Percent parts of medicinal plants used in the study area

Part used	*Number of plants*	*Percent*
Leaf	21	47.73
Rhizome	7	15.90
Root	8	18.20
Bulb	2	4.54
Fruit	4	9.09
Flower	1	2.27
Stem	1	2.27

Leaves and roots are the most used parts of a plant for medicinal study in the study area. The finding that mentiones leaves as the most contributor of medicinal plants is in line with several previous ethnopharmacological studies (Chaachouay et al. 2019; Dapar et al. 2020). The similar results showed that the leaf was the most plant part used as reported by Gebreyes and Melesse (2016). They found leaves and roots were the most widely used plant parts (at 41.0% and 26.0%, respectively). The most recent studies conducted by Kola et al. (2020) also mentioned leaves (31.1%) and roots (34.8%) as the most used plant part of medicinal plants.

Method of Preparation and Their Application as Herbal Medicines

In facilitating the administration of the active chemical compounds of the plants, a couples of preparation modes were employed, such as infusion, decoction, pounded, and juice. The most dominantly used preparation is pounded (43.20%), involving 19 species, followed by decoction (27.27%) with 12 species, infusion (25.00%) with 11 species and juice (4.54%) with 2 species as represented in Table 6. Some plants are also used as a mixture of several medicinal plants to increase the effects of the therapy. Pounded is the most used preparation methods due to the simplicity and for curing the wounds, then it is only needed to paste the pounded medicinal plants to the surface of the wound. Several studies reported decoctions (40.0%) and powder (37.6%) as the major route administration used (Kola et al. 2020). Abidullah et al.(2019) reported that juice and powder (22.0% each) were the most dominantly used preparations while Jima and Megersa (2018) reported crushing (38.5%) and pounding (18.8%). Routes of administrations varies depending on the disease and material used.

Table 6: Percent of mode of preparation of medicinal plants

Method of preparation	*Number of plants*	*Percent*
Infusion	11	25.00
Pounded	19	43.20
Decoction	12	27.27
Juice	2	4.54

In this study, the modes of administration include topical with 19 plant species (43.18%) and oral with 25 plant species (56.81%). Most recipes are composed twice or three-times a day. The recipes are consumed until healing, for one or two months, depending on the disease and other factors. Oral is the most common route of administration and most widely used, as it is comfortable and most acceptable for the patients. A similar finding of using oral as a major route administration (47.0%) was reported by Gebreyes and Melesse (2016), while Jima and Megersa (2018) reported the usage of oral (37.5%) and external application (13.5%) for healing ailments. Another study by Kola et al.(2020) also found oral and topical routes as the main administration methods for the delivery of herbal remedies.

Some medicinal plants that are used for traditional therapy in the Kuantan Singingi district are the leaves of *Melastoma malabathricum* and *Jatropha multifida* for wound healing (Fig. 2). More-

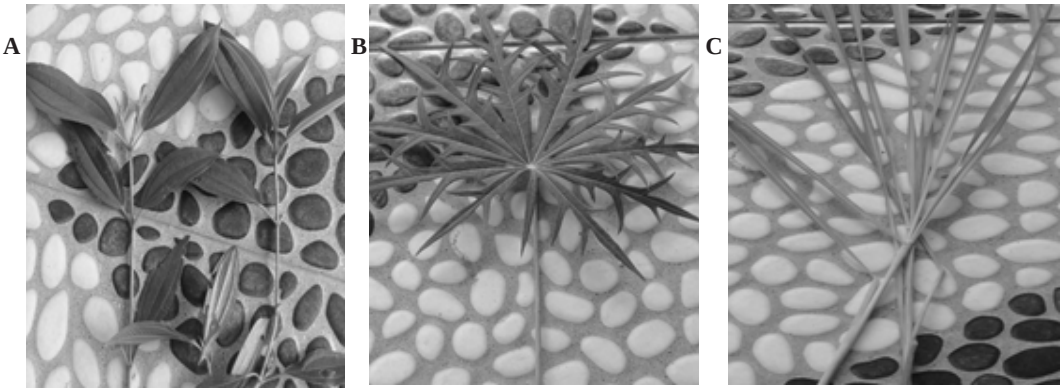

Fig. 2. The leaves of *Melastoma malabathricum* (A) and *Jatropha multifida* (B), the stem of *Cymbopogon citratus*
Source: Photos taken by researchers

over, the stem of *Cymbopogon citratus* is used for healing of dysentery.

For wound healing, the leaves of *Melastoma malabathricum* and *Jatropha multifida* are often chewed, pounded, and applied as topicalemollientson wounds or cuts to stop bleeding and accelerate the wound healing. The biological activity of the *M. malabathricum* leaf extract showed excellent properties with no microbe infection for wound healing test (Nurdiana and Marziana 2013) and had a value of MIC_{50} 0.1 mg/mL against Methicillin-resistant *Staphylococcus aureus* for antibacterial assay (Mayasari et al. 2021). The decoction of the stems of *Cymbopogon citratus*is traditionally used to treat dysentery, and water extracts of boiled leaves are consumed orally three times a day.

DISCUSSION

Most knowledge about traditional medicinal plants has been recorded in ancient texts and many of them pass on through the ages from generation to generation within families by word of mouth. Presently, the areas of the rainforest in and around Riau are threatened by conversion to *sawet* plantations for palm oil production in the current development plan of the national and regional government. This ethnobotanical knowledge could be extinc as conventional allopathic medicine approaches such as surgery, chemotherapy, and radiotherapy are hugely promoted to the exclusion of complementary-alternative medicine (CAM). Medicinal plants embrace a holistic approach to preventing and treating numerous diseases. In therapeutic applications, the use of herbs is a major and most essential approach in traditional therapy (Che et al. 2017). Traditionally, several herbs are mixed to achieve a synergistic combination therapy. The herbal prescriptions that traditional healers normally compose involve several different traditional plant ingredients to make a multi-medicinal formula. Each prescription is made up of one or more primary herbs that are responsible for the main therapeutic effects. It is believed that a combination of several medicinal plants would increase the medicinal effects of therapy. Other herbs are added for a secondary purpose such as enhancing the primary herbs effects, harmonising the properties of the ingredients, reducing side effects, or improving the palatability of prescriptions. The most common preparation method of the mixture and individual herbal medicine is boiled in the water to make a decoction and taken orally twice or three times a day. For wound healing and cut healing, other forms are available for topical or suppository applications and as a pounded poultice to paste to the cut.

A time of day, a medicine will be consumed in each treatment, usually around once up to three times a day. The times is commonly arranged by morning, noon, and night. The diagnosis from the traditional healers will be the concern to prescribe the total number of days for the treatment. Dosage is adjusted for each age-based patient,

especially infants, children, pregnant women, the elderly, and people with another medical history. In general, the treatments need about three-day up to a-week of medication. However, some of them are potentially used longer as needed.

The traditional healers from six villages collected the parts of medicinal plant from fresh plant materials, directly from the forest or garden. The collection time of the medicinal plants species is suggested in the early morning. They believe at this time the plants are still fresh and good to use for treatment. The fresh medicinal plant is more effective in treatment since the aromatic and volatile contents are not lost compared to the dried forms. Similarly, other studies reported by Cheikhyoussef et al. (2011) revealed that freshly harvested plant parts tend to be dominant in the remedies preparations, with dry and fresh (50.0%), followed by fresh (30.0%) and then dry (20.0%). This may indicate the dependency of local people on freshly available plant materials because they are easily accessible. This can strongly affect the diversity and existence of medicinally valuable plants if fresh plant materials are harvested and used directly without replacement (Gebreyes and Melesse 2016). Similar findings reported that the sources of medicinal plants varied from wild (81.0%) to cultivated (12.0%) (Zougagh et al. 2019). Dapar et al.(2020) reported collection sites mostly in the wild (57.0%), while some were from the collections within the community village (7.2%) and the house (4.8%).

Flowers and stems were reported as the least used parts of the plants. The regular use of leaves does not mean the others plant parts have fewer chemical components. It is known that all the parts of plants contain active elements. Further, leaves are the photosynthesis root and so they contain secondary metabolites, which are responsible for biological activities. Leaves are more frequently used as compared to other plant parts due to their easy harvesting, simplicity in preparation, and easy availability instead to flower and fruits where their availability depends on the season.

The effect of seasonal changes on the formation of plants' secondary metabolites is influenced by responses to a variety of season-specific pathogens (Figueiredo et al. 2008). Seasonal changes expose plants to accelerated temperate levels (extreme levels) that affects to the phytochemical compounds and to the volatile compounds at most (Usano-Alemany et al. 2014). Determination of the seasonal effect on medicinal plants provides knowledge about the time or season of harvest of individual plant species that afford optimum concentration of bioactive ingredients (Kale 2010).

The metabolic processes leading to accumulation and production of secondary metabolite of bioactive constituents are basically controlled by the physiological age of the plant and environmental conditions (Wahba et al. 2017). Seasonal change is one of factors influencing the phytochemical compositions of medicinal plants. Seasons' effect on medicinal plants had been studied by Gololo et al. (2016), specifically on medicinal plants that were collected during different seasons and found that several phytochemical compounds, including alkaloids and tannins were found to have high content during cold season (autumn and winter), whereas flavonoids were found to have higher contents during the warm season (spring and summer).

An expert said that "the harvest time of plant material is also a factor that can influence the efficacy, but this is often overlooked despite tales from traditional healers that some herbs are more effective when harvested at specific times of the year" (Hussain et al. 2010). Francis et al. (2021) reported that extract plants harvested in the dry season showed enhanced antifungal activity compared to extracts of medicinal plants harvested in rainy seasons. For example, Barman and Dkhar (2020)studied the diversity of endophytic microorganisms in host plants, which were reported to be affected by season changes. Seasons are also influential factors in the colonisation capacity of the endophytic antibacterial community, according to Barman and Dkhar (2020). Another research conducted by Sgarbossa et al. (2019) studied the effect of seasons and irrigation on the chemical composition of *Aloysia triphylla* essential oil.

Seasonal fluctuations are periodical series. They affect the availability of active principles in medicinal plants. Therefore, therapeutic efficacy is also influenced. The medicinal plants reveal a particular variation in active ingredients among different seasons. These changes are attributed to variations in environmental variables, that is, rainfall and temperature (Soni et al. 2015). The climate change has mainly impacted to the Indonesian biodiversity. It also led to the changing of the precipitation patterns and altered seasonality which can alter water availability (that is, prolonged

droughts and more intense flooding). In the end, it could impact the Indonesia's biodiversity, including species distribution, reproduction timings and phenology of plants (Case et al. 2007).

The increasing trend in medicinal plants and their economic potency is an integral eco-movement approach to gain greener lifestyle and economics. The plants' potency to become curative medicine is the spirit of the eco-movement. The medicinal plants will remain significant as priceless drug sources and lead compounds. Because of the increasing trend on these significant natural sources, all related parties need to give more attention to the sustainability of the medicinal plants. Within prior few decades, a significant portion of all deforestation in Indonesia happened in Sumatera, an island seen for its biodiversity-rich forests that are home to more than 15,000 plant species (The World Bank 2021). People are facing serious consequences due to the deforestation. It might turn to be habitat loss majorly caused by climate change for massive-illegal-agricultural expansion. That is why, no wonder if many species are facing extinction issues worldwide. In so many hotspots, the deforestation impacts are even felt more, where the global endemic species are in there in high concentrations. In addition to climate change, the use of herbarium collections used for investigations, including the prevention of population extinction of environmentally sensitive plants within the conservation priorities for endangered habitats. One excellent example in America is the Living Collection that is maintained in Dawes Arboretum, Ohio, USA. It is recognised as one of only 30 arboreta with worldwide accreditation level IV (the highest level) by Arbnet, which has recently expanded to include botanical collections in Vietnam, India and Australia (Official Home Page of The Dawes Arboretum 2021).

The issue of climate change is seen as the most threatening challenges to the earth life, including the medicinal plants. Some factors that might affect the endemic population of medicinal plants are overharvesting, climate change, habitat destruction, and natural pollinator rejection, resulted from insecticides use. Advanced investigation or research related to endangered endemic medicinal plants under the climate change isuue is urgent to formulate local community-based strategies for conserving and cultivating medicinal plants employing the traditional indigenous knowledge, which might mitigate the climate change impacts (Khanum 2017).

The specific plants that have been used for several ailments are *Curcuma longa* for dysentery, diarrhea, and stomachache, *Alpinia galanga, Zingiber zerumbet* for dysentery, and stomachache, *Benincasa hispida,* and *Lagenaria siceraria* for dysentery and diarrhea, and *Allium sativum* and *Allium cepa* for dysentery and wound. They belong to the Zingiberaceae, Cucurbitaceae and Liliaceae families. The plants of the genus *Zingiber* (Family Zingiberaceae) are widely used as medicinal plants in the traditional healing system. The use of Zingibrecaeae family plants as traditional medicine has been explored in Central Sulawesi Indonesia, and found around 24 plant species (Pitopang et al. 2019). Phytochemical substances of genus Zingiber rhizome consist of monoterpene and sesquiterpene hydrocarbons. Further, the sesquiterpene hydrocarbons cover β-zingiberene, ar-curcumene, β-bisabolene, and β-sesquiphellandrene. Those medicines help battle against microorganisms as anti-infective agents (Sharifi-Rad et al. 2017).

The turmeric rhizome (*Curcuma longa*) has been traditionally used to treat diseases such as gastritis, diarrhea, and stomachache, due to its antioxidant, antibacterial, anti-inflammatory, antiviral, and antifungal characteristics. *C. longa* has the active substance called Curcumin that is an effective antimicrobial against some species and strains of bacteria with MIC 31.25 μg/mL against *Streptococcus pyrogens*, 62.5 μg/mL against *Pseudomonas aeruginosa,* and 250 μg/mL against methicillin-sensitive *S. aureus* (Adamczak et al. 2020). The rhizome of *C. longa* consists of phenolic compounds, such as curcumin, curcuminoid, demethoxycurcumin, bisdemethoxycurcumin, and other volatile oils (Filho et al. 2020). The investigations of acute toxicity of turmeric formulation with curcuminoid essential oil complex, were performed in rats and mice. The results revealed no symptom of toxicity or mortality in any of the animals at the maximum recommended dose level of 5,000 mg/kg body weight. Another finding about the toxicity of *C. longa* was found by Kamsu et al. (2019) that evaluated the acute and subchronic toxicity of *C. longa* extract in Wistar albino rats. It found that no mortality or abnormality was recorded in female rats at the single dose of

50,000 mg/kg body weight, and the doses 30 mg/kg dose of the extract can be safe for the treatment. In contrast, some herbal treatments have proven to be very harmful and even fatal. One of the cases is the orellanus syndrome involving the consumption of poisonous mushrooms containing the toxin and orellanin (*Cortinarius speciosissimus*, *C. orellanus*, *C. orellanoides*, etc.), which were mistakenly ingested as a medicinal remedy according to Esposito et al. (2015).

The ethnic biodiversity in Indonesia has resulted in various cultures, traditions and local wisdom (Diliarosta et al. 2021). One of the local wisdoms is the medicinal plants use according to the traditional knowledge for various diseases. By far, the bioactive compounds and the efficacy of various plants have not fully been known. Most people in the villages where this study was conducted agree that there are no side effects of medicinal plants. Further, the medicinal plants are easy to find and affordable in term of price. On the other hand, however, natural resources are potential to have some harmful compositions. The harmful composition might be cumulated as secondary mobilities, that might cause dangerous side effects. Thus, the plants should be harvested responsibly and the long-term administration should be avoided to generate patients' health and well-being optimally (Tangjitman et al. 2015).

CONCLUSION

The medicinal plants are value adds for their content and chemical composition. The increased popularity of CAM worldwide emphasises the need for further research on both the ethnobotanical legacy and the potential toxicity. The ethnomedicinal studies reveal that the study area has high biodiversity with high variations of the medicinal plants for healing infectious diseases by traditional healers. The findings of this explorative survey emphasize the significance of the traditional healing method preservation and documentation used for controlling disease. The preservation and documentation are then used to investigate future scientific research and to determine their efficacy and safety on based on the ethnotherapeutic applications used by the village folks in Kuantan Singingi district, Riau province, Indonesia. The rich history of medicinal plants shows that the traditional knowledge is potential and crucial in the development of derivation process of natural resources as medicines for infective diseases. The population of medicinal plants might be threatened by environmental factors, including deforestation in Sumatera affected by climate changes, changing temperature, and the disruption of commercial relationships combined with anthropogenic habitat fragmentation that impedes natural migration. Hence, indigenous knowledge and medicinal plants need protection to save them from imminent extinction. The local knowledge about medicinal plants provided by the traditional healers is protected and complies with international law regarding ethical concerns and 'Intellectual Property Rights (IPR). An institutional review board approved the protocol of the study based on adherence to the protection protocols for human subjects as stated in the World Medical Association (WMA) Declaration of Helsinki of 1964 and all subsequent amendments.

RECOMMENDATIONS

The researchers, furthermore, recommend actions including chemically profiling, with pharmacology as well as toxicity tests of the medicinal plants such as *Curcuma longa*, *Alpinia galanga*, *Zingiber zerumbet*, *Benincasa hispida*, *Lagenaria siceraria*, *Allium sativum*, and *Allium cepa* mentioned by healers to heal several infectious diseases, conservation and local cultivation of those significant medicinal plants, continuous harvesters training, and commercial material certification, traditional knowledge preservation, raw material quality supervision as the efforts in mitigating climate change impacts.

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