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Medicinal plants utilized for fitness disorders treatment by ethnic groups in Papua and West Papua Province, Indonesia

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ABSTRACT

Papua is one of Indonesia's islands with a large biological wealth, including medicinal plants. This study aimed to identify the utilization of medicinal plants by selected traditional healers who met inclusion criteria to treat fitness disorders in ethnic groups of Papua and West Papua. Data was collected through interviews, observation, and sample collection. Data quantification was done by analyzing the use value parameters, simple preference ranking exercise, multi-health purpose species rank, and the plant parts value. This study revealed 43 concoction information details and identified the use of 24 plant species distributed in 19 families among 19 healers in 10 ethnic groups in Papua and West Papua. *Cymbopogon citratus* (DC.) Stapf (12.12%) and leaves (57.35%) were determined as the most prominent species and plant parts used. *Morinda citrifolia* was identified as the species with the biggest number of other treatable diseases, with a total score of 85. The most used plant families were Myrtaceae and Poaceae, each with a percentage of 12.12%. The study showed the critical role of medicinal plants and traditional healers in community health. However, conservation efforts must be initiated immediately since almost 40% of traditional healers still harvest the available plants and make no cultivation efforts.

INTRODUCTION

A fitness disorder is any type of physical condition that significantly impacts one or more major life activities (Saebu, 2010). The World Health Organization has published public health guidelines and recommendations on physical activity and sedentary lifestyle for children, adolescents, and adults on the amount of physical activity that includes frequency, intensity, and duration as one of the preventive, promotive efforts to improve physical fitness and reduce health risks (WHO, 2016). In addition to physical activity, efforts to overcome fitness disorders can be made by utilizing traditional medicine (Imandiri *et al*., 2020).

The traditional healing system is a very common method and has been practiced in many countries since antiquity for treating physically and mentally ill people. Various things that encourage the use of traditional medicine include the lack of economic resources, relatively minimal side effects, accessibility of medical services, the high price of modern medicine, and the experience of failure in previous treatments (Junsongduang *et al*., 2020; Mahgoub, 2020).

The implementation of traditional medicine is highly dependent on the availability and richness of biodiversity in the region (Khanal *et al*., 2020). Papua is one of the islands in Indonesia that consist of two provinces, Papua and West Papua, with a large number of local ethnic groups with a large biodiversity, one of which is medicinal plants (Ananta *et al*., 2016). The existence of climate change and an increase in the earth's temperature are predicted to have an impact on the survival of various medicinal plant species and their distribution areas, especially on the island of Papua and two other large islands, namely, Java and Sulawesi (Cahyaningsih *et al*., 2021). In addition, there is a tendency for the knowledge and abilities of traditional medicine that healers possess to be better documented, causing the potential to lose indigenous knowledge (Junsongduang *et al*., 2020).

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Conducting and publishing ethnobiological research has become an important way of preserving and protecting knowledge about local medicine and other information for the next generations (Anyaoku *et al*., 2015; Pramanik, 2019; Simbiak *et al*., 2019). It is, however, crucial to conduct the study to document and inventory the wealth of local ethnomedicine knowledge, especially regarding the use of medicinal plants for the treatment of fitness disorders in Papua and West Papua ethnic groups in Indonesia.

MATERIALS AND METHODS

Study area

The study was conducted among 10 ethnic groups distributed in Papua and West Papua, as shown in Figure 1. Ethnic groups of Meyah, Inanwatam, Mey Brat, Waigeo, and Sough were located in Papua Province, while Yakai, Asmat, Ngalum, and Tobati ethnic groups administratively entered the province of West Papua. This study has obtained ethical approval from the Health Research Ethics Commission of the Health Research and Development Agency, Ministry of Health of the Republic of Indonesia.

Data collection

Data was collected in 2017 from 10 ethnic groups in Papua and West Papua. For each ethnic group, five traditional healers were selected that met various established inclusion criteria. They have both knowledge and treatment skills using medicinal plants; they are indigenous acculturated or people of the ethnic group and the most popular healer and recognized by the community. Direct interview based on a structured questionnaire among selected traditional healers was conducted in each ethnic group. Data on demography, sources of knowledge and healer's skill, vernacular plant names, plant origin, plant part used, plant habitat, treated disease, symptoms of the disease, herbs used, the dosage used, preparation method, and the administration route were obtained by the questionnaire as the tool. After the interview with the healer was over, species specimens were observed and collected. The collected specimens were identified and preserved by the Herbarium Tawangmanguensis of the Medicinal Plant and Traditional Medicine Research and Development Center.

Data analysis

The data from this study were reported and stored in the Data Management Laboratory of the National Institutes of Health Research and Development. The data request follows the standard procedure of the Data Management Laboratory. Data were quantified by analyzing the use value (UV) parameters, simple preference ranking exercise, multi-health purpose species rank, and the plant parts value.

Use value

To measure the value of each medicinal plant species used by traditional healers to treat physical disorders in Papua and West Papua ethnic groups.

$$UVs = \Sigma\ UVis / ni$$

where UVs is the use value, UV is the citation number for each species, and ni is the total number of respondents interviewed (Ayyanar and Ignacimuthu, 2011).

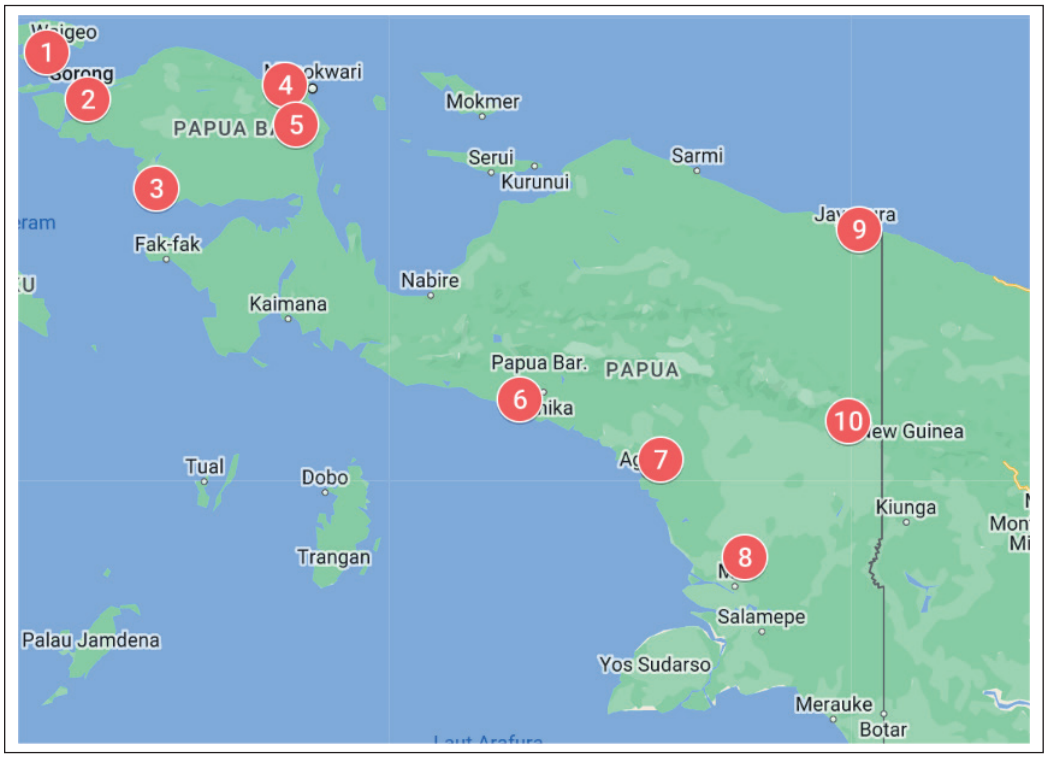

Figure 1. The ethnic group location of the study processed with MapSource ®Garmin® mapping software: (1) Waigeo, (2) Mey Brat, (3) Inanwatam, (4) Meyah, (5) Sough, (6) Sumber Baba, (7) Asmat, (8) Yakai, (9) Tobati, and (10) Ngalum.

Plant part value (PPV)

To quantify the plant part (leaves, stem, root, fruit, stembark, and tubers) used percentage for physical disorders by traditional healers, the following equation was used.

$$PPV\ (\%) = (\Sigma RU\ (plant\ part) / \Sigma RU) \times 100$$

where PPV is described as the plant parts used to value and RU is the usage amount quoted for each plant part (Ayyanar and Ignacimuthu, 2011).

Species and multi-health purpose ranking exercise

Species ranking exercise was directed to grade the most picked medicinal plant for a specific illness symptom and disease. In this study, the rank exercise was based on citation numbers by informants (Alemneh, 2021). The bigger the citation number of the species, the better the rank. Other than for physical disorders, multi-health purposes were also determined to provide data on the use diversity of cited species for health purposes.

RESULTS

Demographic data of informants

This current study data demonstrated that from a total of 19 selected traditional healers having knowledge and skill in utilizing medicinal plants for curing illness, specifically for physical disorders in Papua and West Papua ethnic groups, the percentage of women with a main profession as traditional healers was greater than that of men, as shown in Table 1.

The selected traditional healers were dominated by generations with an age range of 40–60 years (78.95%), with the main livelihood as farmers (52.63%) and with low levels of education.

Table 1. Demographic Information of the Selected Traditional Healers.

Criteria	Specification	Frequency	Percentage
Gender	Male	8	42.11
	Female	11	57.89
Age	30–40	2	10.53
	41–50	8	42.11
	51–60	7	36.84
	>61	2	10.53
Ethnic group	Asmat	1	5.26
	Inanwatam	2	10.53
	Mey brat	2	10.53
	Meyah	1	5.26
	Ngalum	3	15.79
	Sough	4	21.05
	Sumber baba	1	5.26
	Tobati	2	10.53
	Waigeo	1	5.26
	Yakai	2	10.53
Main Job	Civil employer	2	10.53
	Ethnic leader	1	5.26
	Farmer	10	52.63
	Healer	2	10.53
	Housewife	4	21.05
Education	Illiterate	5	26.32
	Kindergarten	3	15.79
	Elementary School	4	21.05
	Junior High School	3	15.79
	Senior High School	3	15.79
	University	1	5.26

UV and medicinal plants utilized

The highest UV reported in this study was 0.21, and the lowest was 0.05. Each plant is equipped with various information, including the local name, plant family, plant part used, potion dose, disease symptoms, route of administration, and toxicity data obtained from previous studies (Table 2). As many as 24 species of medicinal plants were identified, complete with their toxicity profiles and identified secondary metabolites (Table 3), belonging to 19 plant families that traditional healers have used to treat physical disorders.

The most frequently used species for overcoming physical disorder by traditional healers in Papua and West Papua was lemongrass (*Cymbopogon citratus*), with the highest UV and use the percentage of 0.21% and 12.12%, as demonstrated in Table 2 and Figure 2. One of the specific medicinal plants inventoried in this study was red fruit (*Pandanus conoideus* Lam.), as shown in Table 2. The traditional healers utilized this species belonging to the Pandanaceae family to overcome physical disorders with specific symptoms. The body is quickly tired by boiling the ingredients with water and drinking it once a day after being filtered and chilled. This species is an indigenous Papuan plant and has been reported to contain various medicinal compounds, showed no toxicological effect among experimental rats, and has been widely used by local communities for multiple purposes, for health purposes, nutritional sources, and other reasons (Wismandanu *et al*., 2016). Figure 3 illustrates that Myrtaceae and Poaceae were recognized as the most utilized plant family by traditional healers from 19 plant families determined in this current study, followed by the families of Compositae, Annonaceae, and other families.

Plant part value

Leaves were indicated to be the most widely harvested and utilized plant parts by traditional healers in Papua and West Papua ethnic groups compared to other parts such as stem, root, fruit, stembark, and tubers, as shown by PPV for more than 75% as revealed in Figure 4. The study results showed that the level of concern for traditional healers for the survival of medicinal plant species was quite high, as indicated by the cultivation efforts that have been carried out by more than 60% of healers (Fig. 5).

Species and multi-health purpose ranking exercise

Morinda citrifolia was recognized as the first rank species with the biggest number of other treatable diseases with a total score of 85, followed by *Psidium guajava, Annona muricata, Citrus aurantifolia*, and other species with a score of 76, 46, and 17, respectively (Table 4). While *C. citratus* was identified as the first rank species reported to overcome physical disorders based

Table 2. Medicinal plants utilized for treating physical disorders in Papua and West Papua, Indonesia.

Species	Vernacular name	Plant part	UV	Potion dose	Disease symptoms	Administration route	Toxicity data
A. calamus L.	Biridago, daun suangi	Leaves	0.05	Once a day	Body aches, tired, weak	Inhalation	Methanolic crude extract showed toxicity against the secondary instar of *Spodoptera litura* larvae (Wiwattanawanichakun *et al*., 2022)
Alyxia reinwardtii Blume	Adakoch	Leaves	0.05	Once a day	Easily tired	Internal	High dose of the ethanolic extract caused moderately toxic in mice (Sundari *et al*., 2012)
A. muricata L.	Duraro, sirsak, turan	Leaves	0.16	Once a day	Tired, lethargic, weak, tired tone, body aches	External	A high dose (5 g/kg BW) of the extract could cause kidney damage in Swiss Albino Mice (Arthur *et al*., 2011)
Boerhavia sp. Cf.	Yamen	Leaves	0.05	Others	As a vitamin enhancer	Internal	The crude methanolic extract showed a cytotoxic effect on BSLT (Rahman *et al*., 2014)
Callicarpa dichotoma (Lour.) K.Koch	Smeisana	Leaves	0.05	Once a day	Tired, cannot go far	Internal	*Callicarpa* sp. of 5 mg/ml had a cytotoxic effect on HepG2 cells (Cai *et al*., 2014)
Citrus aurantiifolia (Christm.) Swingle	Jeruk nipis	Leaves	0.05	Once a day	Decreased endurance, weakness, easy to get sick	External	Essential oil of *C. aurantifolia* showed no acute toxicity but caused mild subchronic toxicity (Adokoh *et al*., 2019)
C. esculenta (L.) Schott	Keladi, talas	Bulbs	0.05	Once a day	Body tired quickly	Internal	An aqueous leaf extract dose of 800 mg/kg revealed an adverse effect on the lungs of rats in a subacute toxicity study (Nyonseu Nzebang *et al*., 2018)
C. massoy (Oken) Kosterm.	Misoy	Bark	0.05	Once a day	Decreased endurance, weakness, easy to get sick	External	Bark chloroform extract showed a cytotoxic effect on the MCF-7 cell line with IC_{50} values of 9.14 µg/ml (Widiyastuti *et al*., 2018)
C. citratus (DC.) Stapf	Jakah, sereh, sereh wangi	Stem, leaves	0.21	Three times a day	Tired, not sweating, decreased endurance, weak, easy to get sick	External	Butanolic and aqueous extracts possess cytotoxic properties on *Escherichia coli* (Fuentes-León *et al*., 2017)
Cymbopogon nardus (L.) Rendle	Sereh wangi	Leaves	0.05	Once a day	Body aches, tired, weak	Inhalation	Ethanol extract of root and stem extract showed no toxic effect based on BSLT (Nurcholis *et al*., 2019)
Drimys piperita Hook.f.	Aqua mambri, kayu aquai	Stem	0.05	Once a day	Weak, not strong enough to walk far	Internal and external	Not yet available
Maesa sp. Cf.	Adagalogoch	Leaves	0.05	Once a day	Easily tired	Internal	Dichloromethane and methanol extract from leaf and bark showed a cytotoxic effect on the VeroE6 cell line (Timothy *et al*., 2018)
Melastomastrum sp.	Boric	Leaves	0.05	Once a day	Weak, not strong enough to walk far	Internal	Aqueous root extract up to a dose of 2 g/kg did not cause any acute toxicity signs against Swiss Albino mice (Ukwubile *et al*., 2019)
M. denhamii (Seem.) T.G.Hartley	Puring Papua	Leaves	0.05	Once a day	Decreased endurance, weakness, easy to get sick	External	Acetophenone contained in *Melicope* sp. showed moderate cytotoxic activity on the human ovarian cancer cell line A2780 with IC_{50} values of 30.0 µM (Le *et al*., 2021)
M. citrifolia L.	Grego, mengkudu, meri	Leaves	0.11	Once a day	Body aches, tired, weak	Inhalation	A dose of 2000 mg/kg BW showed no mortality or adverse effect on mice (Nagarjuna *et al*., 2015)
Murdannia nudiflora (L.) Brenan	Kakpik	Leaves	0.05	lainnya	Skinny and yellowish body	Internal	An acute toxicity study of *Murdannia* sp. up to a dose of 5 g/kg showed no signs of mortality (Sulaiman *et al*., 2021)
Ocimum basilicum L.	Cim	Root	0.05	Once a day	The body gets tired quickly and gets sick easily	Not stated	Aqueous extracts at a concentration of 10–1,000 µg/ml did not show toxicity signs (Nadeem *et al*., 2022)

Continued

Species	Vernacular name	Plant part	UV	Potion dose	Disease symptoms	Administration route	Toxicity data
Pandanus amaryllifolius Roxb.	Daun ponda, ponda	Leaves	0.05	Two times a day	limp body	Internal	Ethyl acetate extract exhibits a toxic effect based on BSLT with IC_{50} of 288.4 ppm (Sukandar *et al*., 2017)
Pandanus conoideus Lam.	Auwyat, buah merah	Fruit	0.05	Once a day	Body tired quickly	Internal	Red fruit oil of a dose of 5 g/kg caused no significant change in AST and ALT levels of SD rats (Wismandanu *et al*., 2016)
Pluchea indica (L.) Less.	Beluntas	Leaves	0.11	Once or two times a day	Body aches, tired, weak	Internal	n-Hexane leaf extract demonstrated toxicity based on BSLT with IC_{50} of 57.45 ppm (Ratu *et al*., 2019)
P. guajava L.	Giawas, jambu biji	Leaves	0.16	Once a day	Body tired, tired	Inhalation	Aqueous leaf extract of a dose of 500 mg/kg was practically nontoxic among experimental rats (Yusuf and Ocheje, 2019)
Syzygium aqueum (Burm.f.) Alston	Jambu air	Leaves	0.05	Once a day	Decreased endurance, weakness, easy to get sick	External	Leaf extract up to a dose of 1,024 µg/ml had no toxicity effect on the Vero cell line (Insanu *et al*., 2017)
Theobroma cacao L.	Coklat, kakao	Leaves	0.05	Two times a day	Weak body, pale face	Internal	Unsweetened natural cocoa up to a dose of 9 g/kg did not induce congenital malformation and genotoxic effect against Wistar rats (Asiedu-Gyekye *et al*., 2021)
Vernonia amygdalina Delile	no name	Leaves	0.05	Three times a day	Decreased endurance, weakness, easy to get sick	Internal	Leaf methanol extract showed no toxic effect on male and female experimental rats (Abebe and Gebru, 2015)
Weinmannia sp. Cf.	Metgebin	Leaves	0.05	Once a day	Easily tired	Internal	Not yet available

Table 3. Identified secondary metabolites of recorded medicinal plant species.

Species	Identified secondary metabolites
A. calamus L.	Asarone, n-hexadecanoic acid, 9, 15–octadecadienoic acid, methyl ester, (z,z)– and 9,12–octadecadienoic acid (Elshikh *et al*., 2022)
A. reinwardtii Blume	Oumarin, scopoletin, (+)–pinoresinol, zhebeiresinol (Rao *et al*., 2012)
A. muricata L.	Octadecanoic acid, isocomene, quercetin (Olasehinde and Afolabi, 2022)
Boerhavia sp. Cf.	Punarnavine, rotenoids (Gaur *et al*., 2022)
C. dichotoma (Lour.) K.Koch	Echinacoside, poliumoside, isoacteoside, acacetin-diglucuronide (Kim *et al*., 2022)
C. aurantiifolia (Christm.) Swingle	Coumarin, three cinnamic acids. polymethoxyflavones (Fayek *et al*., 2019)
C. esculenta (L.) Schott	Stigmasterol, nonacosane, cyanidin 3-glucoside (tuber) (Prajapati *et al*., 2011)
C. massoy (Oken) Kosterm.	C-8, C-10, C-12, C-14 massoia lactone (Graf and Stappen, 2022)
C. citratus (DC.) Stapf	Methylheptenone, furfurol, isopulegol, p-coumaric acid (Oladeji *et al*., 2019b)
C. nardus (L.) Rendle	Citronellal, geraniol, nerol, elemol, citral (Bayala *et al*., 2020)
D. piperita Hook.f.	Terpenoid, flavonoid, alkaloid, and saponin (Zakariyah *et al*., 2018)
Maesa sp. Cf.	Terpenoids, tannins, saponins, flavonoids, and alkaloids (Tekalign *et al*., 2022)
Melastomastrum sp.	Tannins, flavonoids, saponins, alkaloids, and cardiac glycosides (Ighere *et al*., 2019)
M. denhamii (Seem.) T.G.Hartley	Zierone, a-Gurjunene, Melicodenine I, bergapten, isoevodionol methyl ether, isoevodionol, ternatin (George *et al*., 2017, 2015)
M. citrifolia L.	Damnacanthal, scopoletin, kaempferol, rutin, quercetin, asperulosidic acid, asperuloside, citrifolinoside A (Almeida *et al*., 2019)
M. nudiflora (L.) Brenan	Alkaloid, tannin, saponin, flavonoid (Huq, 2015)
O. basilicum L.	Chicoric acid, farnesene, β-cadinene, menthyl acetate, germacrene, α-bisabolol, δ-gurjunene, δ-cadinene, neoisomenthol, guaiene, pulegone (Shahrajabian *et al*., 2020)
P. amaryllifolius Roxb.	kaempferol, naringin, catechin, caffeic acid, myricetin, luteolin, quercetin, pandanin, norpandamarilactonine-A,-B, pandamerilactones (Bhuyan and Sonowal, 2021)

Continued

Species	Identified secondary metabolites
P. conoideus Lam.	Oleic acid, 1,3-dimethyl-benzene, N–glycyl-alanine (Rohman *et al*., 2012)
P. indica (L.) Less.	3–*O*-caffeoylquinic acid, 3,4–*O*-dicaffeoylquinic acid (Vongsak *et al*., 2018)
P. guajava L.	Guajaverin, guavinoside, guavin B, quercetin, naringenin, esculin, quercetin (Bulugahapitiya *et al*., 2021)
S. aqueum (Burm.f.) Alston	Phloretin, myrigalone, samarangenins, myricetin-3-O-rhamnoside (Aung *et al*., 2020)
T. cacao L.	Eucalyptol, naphthalene, eugenol, and D-limonene (Mustanir *et al*., 2020)
V. amygdalina Delile	Vernolide, hydroxyvernolide, 3′-deoxyvernodalol, vernodalol, vernomygdin, vernolepin, vernoniosides (Ugbogu *et al*., 2021)
Weinmannia sp. Cf.	Isoastilbin, neoisoastilbin, neoastilbin (Barrientos *et al*., 2020)

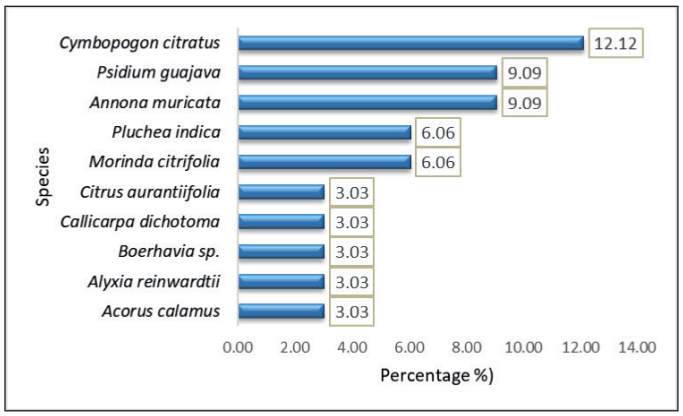

Figure 2. The most prominent species utilized.

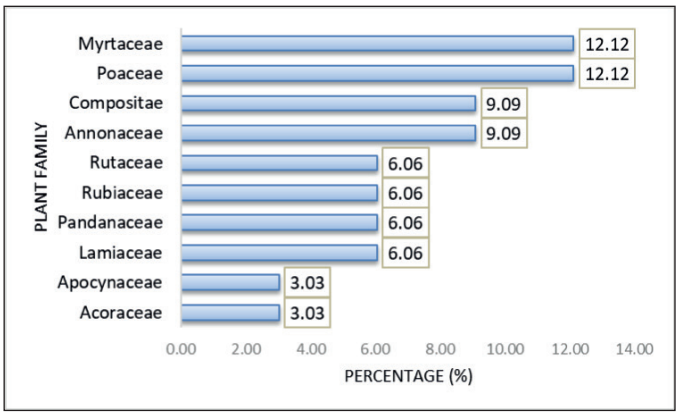

Figure 3. The most cited plant families identified.

on citation number by informants in Papua and West Papua by multi-health ranking exercise with a total score of 4 (Table 5).

DISCUSSION

The crucial role of indigenous traditional healers and medicinal plants in dealing with health problems in society, especially in Papua and West Papua, Indonesia, is evident from the results of this study. The percentage of women who primarily work as traditional healers is greater than men in this study is in line with a previous study that stated that for women, the healing profession has a positive impact on improving their status and the status of women in society (Cabré, 2008; Popper-Giveon and Al-Krenawi, 2010). The role of women in medicine and healing has been proven throughout history, from the ancient world to the present, although in different forms (Jefferson *et al*., 2015). Another study stated that many men lost their prestige when they became traditional healers, while many women benefited in this regard (Bakker, 1992). However, this is not the case in Thailand, where traditional Thai medicine and healers are very important in Thai society, so men always crave these positions (Junsongduang *et al*., 2020). Conditions in which most of the traditional healers are more than 40 years old are also reported by Shuaib *et al*. (2021), whereas 51% of healers were between the ages of 30 and 50 years, with an illiterate level of 36% in Tahsil, Pakistan. Most people with the knowledge and skills to perform traditional medicine are elderly (Cheikhyoussef *et al*., 2011). It is stated that the people get older, their knowledge of medicinal plants expands (Srithi *et al*., 2009).

UV is a parameter that quantitatively indicates the relative importance of a plant species to a population (Sharif *et al*., 2022). *Cymbopogon citratus* has the highest UV. *Cymbopogon citratus* is also recorded as the first rank species reported to treat physical disorders based on citation number by simple ranking exercise with a total score of 4. Plant species with higher UV and use total score indicate that the species is likely to grow in abundance in the area, found mostly by local communities, and known to benefit local people for health purposes (Shuaib *et al*., 2021). Many previous studies have reported the phytoconstituents, such as citral, nerol, geraniol, citronellal, terpinolene, geranyl acetate, and terpinol, and pharmacological activities of *C. citratus*, including the analgesic, diuretic, carminative, galactagogue, antidepressant, antimicrobial, antipyretic, antiseptic, astringent, bactericidal, sedative and tonic effects (Majewska *et al*., 2019; Narayan and Maheshwari, 2017; Oladeji *et al*., 2019a; Olorunnisola *et al*., 2014; Shah *et al*., 2011). As a tonic and to treat a physical disorder, *C. citratus* works to improve health by enhancing the work of the respiratory, digestive, nervous, and excretory systems and facilitating the absorption of nutrients into the body, thereby providing strength and boosting the immune system (Narayan and Maheshwari, 2017).

Apart from treating physical disorders, recorded species were also used to treat other diseases. *Morinda citrifolia* was identified as the species with the biggest number of other treatable diseases, with a total score of 85. It showed that the utilization rate of this species for health purposes was the highest compared to other species and allowed the overharvesting of materials from nature, which can trigger its extinction. Based on The International Union for Conservation of Nature's Red List of Threatened Species, no

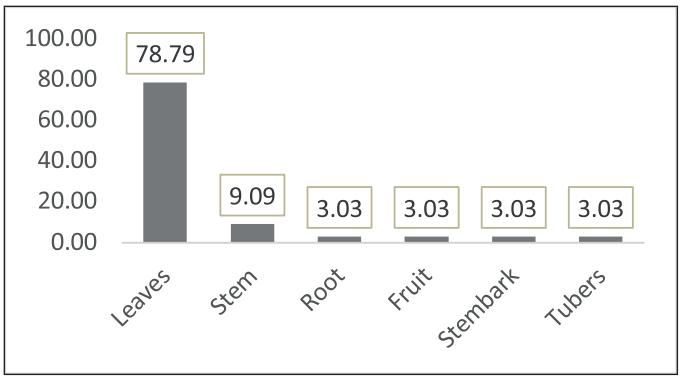

Figure 4. Plant parts used by traditional healers.

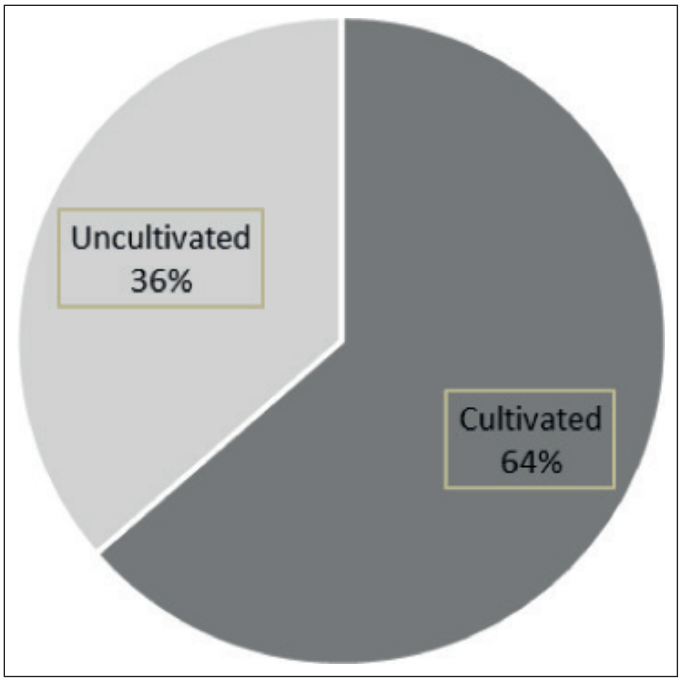

Figure 5. Cultivation status of utilized medicinal plants.

endangerment status of *M. citrifolia* is found, but out of a total of 24 documented species in this current study, there are five species with a status of Least Concern (LC), namely, *A. muricata* L., *P. guajava* L., *Acorus calamus* L., *Colocasia esculenta* (L.) Schott, and *Melicope denhamii* (Seem.) T.G. Hartley; a species (*Cryptocarya massoy* (Oken) Kosterm.) with Extinct (E) status; a species, *Weinmannia* sp. Cf, with near threatened status. The only threat reported to *C. massoy* is the continuous harvesting of its bark for its high demand in the perfumery market due to its sweet fragrance. This is in accordance with the conditions in Papua and West Papua ethnic groups, whereas from this current study results, it is known that the species part used for health purposes is also the bark; moreover, 40% of the informants still conducted no cultivation effort (Fig. 5).

Myrtaceae and Poaceae were recognized as the most utilized plant families by traditional healers from a total of 19 plant families determined in this current study. Poaceae was reported to have the largest number of species in the Rongkong ethnic group (Mustofa *et al*., 2020). Ahmad *et al*. (2022) reported that the Myrtaceae family, which consists of 140 genera and about 3,500–5,800 species, is the most well-known essential oil-producing plant in the community and is widely used for medical and commercial purposes (Ahmad *et al*., 2022). Moreover, about 1,800 plant species belonging to the genus *Syzygium* in this family have been widely used in traditional medicine systems in Asian countries, including Indonesia (Uddin *et al*., 2022). Meanwhile, the Poaceae family, which comprises 119 genera and 1,482 described species, is also reported to have been used by indigenous people and native communities in Asian countries, specifically to treat certain diseases and ailments.

Compared to other plant parts, leaves are the most harvested and utilized parts by traditional healers in Papua and West Papua. This is in accordance with several previous studies that reported leaves as the most frequently used part (Mustofa *et al*., 2020; Nisa *et al*., 2022; Radha *et al*., 2021; Rahmawati *et al*., 2020; Sharif *et al*., 2022; Subba *et al*., 2022). Compared to other plant parts, leaves are generally available in more significant quantities in a plant, so leaf harvesting is considered safer and does

Table 4. Ranking of 9 plant species by 19 informants based on other treatable diseases' numbers.

Other treatable diseases besides physical disorders	Medicinal plant species								
	M. citrifolia	*P. guajava*	*A. muricata*	*C. aurantiifolia*	*C. nardus*	*A. calamus*	*P. indica*	*C. esculenta*	*S. aqueum*
Cough	2	6	1	3	1	1	0	0	1
Antiinflammation	7	0	0	0	0	0	0	0	0
Dysentery	2	0	1	1	0	0	0	0	0
Smallpox	2	0	1	0	0	0	1	0	0
Bone pain	4	0	0	0	1	0	1	1	0
Hypertension	2	0	4	0	0	0	0	0	0
Fever	5	2	3	0	0	1	0	0	0
Common flu	0	0	0	0	0	1	0	0	0
Diuretics	1	0	0	0	0	0	0	0	0
Fertility disorders	0	1	0	0	0	0	0	0	0
Goiter	0	0	1	0	0	0	0	0	0

Continued

Other treatable diseases besides physical disorders	Medicinal plant species								
	M. citrifolia	*P. guajava*	*A. muricata*	*C. aurantiifolia*	*C. nardus*	*A. calamus*	*P. indica*	*C. esculenta*	*S. aqueum*
Anthelmintic	1	1	1	0	1	0	0	0	0
Muscle cramps	1	0	0	0	0	0	0	0	0
Antidiabetic	0	1	1	0	0	0	0	0	0
Antianemia	1	0	0	0	0	0	0	0	0
Wound healing	1	0	1	3	1	0	1	2	0
Magical healing and spiritual properties	0	0	0	0	0	1	0	1	0
Malaria	7	2	1	1	0	0	1	0	0
Diarrhea	1	37	7	1	0	0	0	3	1
Sore throat	0	1	0	0	0	0	0	0	0
Myalgia	5	0	1	1	0	0	1	0	0
Laxative	1	2	0	1	0	0	0	0	0
Antiobesity	0	0	0	0	0	2	0	0	0
Antidotum	1	0	0	1	0	0	0	1	0
Sexually transmitted diseases	1	1	0	0	0	0	0	0	0
Neonatal care	2	1	1	0	1	1	1	0	0
Expectant mother care	0	0	1	0	0	0	0	0	0
Cosmetics	1	0	1	0	0	0	0	0	0
Pre- and postpartum care	5	2	0	1	2	2	2	0	2
Feminine care	0	0	2	0	1	0	0	0	0
Rheumatics and gout	3	0	6	0	1	0	0	0	0
Dental and oral care	0	0	0	1	5	0	0	0	0
Headache	0	0	0	1	0	0	0	0	0
Skin disease	1	1	0	0	0	0	1	0	1
Stomachache	3	17	2	0	0	1	0	0	0
Ear disease	0	0	0	0	0	1	0	0	0
Asthma	1	0	1	2	0	0	0	0	0
Stroke	4	0	0	0	0	0	0	0	0
Tuberculosis	1	0	1	0	0	0	0	0	0
Tumor	5	0	5	0	0	0	0	0	0
Appendicitis	3	0	0	0	0	0	0	1	0
Hemorrhoids	1	0	1	0	0	0	0	0	0
Miscellaneous	0	1	0	0	0	0	0	0	0
Other internal diseases	10	0	2	0	1	1	1	0	1
Score	85	76	46	17	15	12	10	9	6
Rank	First	Second	Third	Fourth	Fifth	Sixth	Seventh	Eighth	Ninth

Table 5. Ranking of 9 plant species by 19 informants based on other treatable diseases' numbers.

Medicinal plants for physical disorders	Informants labeled by A to S																		Score	Rank
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	
C. citratus	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	4	First
P. guajava	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	Second
A. muricata	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	Third
P. indica	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	Fourth
M. citrifolia	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	Fifth

not have a negative impact on plant survival (Rabgyal and Pelden, 2021). Furthermore, the leaves also contain various bioactive components, such as flavonoids, alkaloids, phenols, and saponins, which are predicted to be responsible for their pharmacological activities (Friday *et al*., 2011).

The concern levels of traditional healers about the survival of medicinal plant species are quite high, as indicated by the cultivation efforts that have been carried out by more than 60% of healers. This is in accordance with a previous study reported by Ungirwalu *et al*. (2017) that examined whether local knowledge regarding sustainable use and the traditional concept of forest resources conservation have been established in Papua, but this traditional wisdom is less exposed in the scientific literature (Ungirwalu *et al*., 2017). However, the initiation of cultivation needs to be carried out considering that almost 40% of healers still treat their patients using medicinal plants by collecting and harvesting existing plants without cultivating them. Moreover, local communities in Papua tend to use the forest for their daily needs (Sundari *et al*., 2020). Thus, a close synergy between local communities and their environment is expected to contribute positively to sustainable biodiversity resource management (Ungirwalu *et al*., 2017).

CONCLUSION

This study demonstrated that the study area has plenty of medicinal plants to treat ailments specifically for physical disorders. As many as 43 concoction information details and 24 plant species distributed in 19 families among 19 healers in 10 ethnic groups in Papua and West Papua were documented. *Cymbopogon citratus* (DC.) Stapf (12.12%) and leaves (57.35%) were determined as the most prominent species and plant parts used. *Morinda citrifolia* was identified as the species with the biggest number of other treatable diseases, with a total score of 85. The most used plant families were Myrtaceae and Poaceae, each with a percentage of 12.12%. This showed the important role of both medicinal plants and traditional healers in community health. Since almost 40% of traditional healers still harvested the available plants and practiced no cultivation, conservation efforts need to be started immediately to prevent the extinction of these medicinal plants.

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AUTHOR CONTRIBUTIONS

NR, DS, SH, IYMS, DSu, HW, RM, and YW were responsible for the conceptualization, preparation of the original draft, and review and editing of the manuscript; NR and RM contributed to the methodology and data curation; RM and IYMS were responsible for the software; HW, NR, and DS validated the data; NR, DSu, and IYMS conducted the formal analysis; SH conducted the investigation; NR and DS were responsible for the resources; NR was responsible for the visualization; YW, HW, and SH supervised the study. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

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CONFLICTS OF INTEREST

The authors declared no conflicts of interest.

ETHICAL APPROVALS

This study has obtained ethical approval with the number of LB.02.02/2/KE.107/2017 from the Health Research Ethics Commission of the Health Research and Development Agency, Ministry of Health of the Republic of Indonesia.

DATA AVAILABILITY

All data generated and analyzed are included in this research article.

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