


Ethnomedical uses of *Cananga odorata* (Lam.) Hook. f. and Thomson in indigenous traditional medicine among Indonesia ethnic groups

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ABSTRACT

Cananga odorata, commonly known as ylang-ylang, is an evergreen perennial tropical tree belonging to the *Annonaceae* family, which is traditionally and scientifically reported to have various pharmacological activities. This indigenous medicine study was carried out to document the traditional usage of *C. odorata* for medicinal reasons by Indonesian ethnic groups. This is one of numerous initiatives aimed at preserving indigenous knowledge and medical practices maintained by the community. Data were acquired during 2015 and 2017 through in-depth interviews with selected traditional healers from each ethnic group throughout 34 Indonesian provinces, who were chosen using a purposive sampling approach based on inclusion criteria. The information gathered includes the demographic data of healers, medicinal plants used, potions, and their applications for health purposes. Following the completion of the interview with the informant, specimens of medicinal plants were collected. Data quantification was accomplished by examining the value of plant parts and doing a simple ranking analysis for multihealth purposes. This study revealed 42 traditional applications of *C. odorata* by 36 traditional healers from 28 ethnic groups in 16 provinces to overcome 18 diseases. *Cananga odorata* was primarily obtained from the woodland instead of the house garden and other environments. Skin disease was identified as the most prevalent indication of *C. odorata*, in agreement with the most commonly employed administration method, the external route. Leaves became the foremost prominent plant part utilized by healers. This study emphasized the significant role of traditional healers in healing various illnesses with *C. odorata* and the variations in *C. odorata* ethnomedical usage as a traditional remedy in Indonesia. Nonetheless, cultivating initiatives should be started as more than 60% of identified *C. odorata* has yet to be grown. The study's findings are likely to benefit various stakeholders, serve as baseline data for further studies on the efficacy and safety of *C. odorata*, and contribute to efforts for developing health products that employ *C. odorata*.

INTRODUCTION

Cananga odorata (Lam.) Hook. f. and Thomson, commonly known as ylang-ylang or perfume tree, is an evergreen perennial tropical tree (as shown in Figure 1)

belonging to the *Annonaceae* family which natively grows in Malaysia, the Philippines, Indonesia, the Islands of Madagascar, the Comoro, and Nossi Be and has been widely used for various purposes such as cosmetics, food industry, medication, and agriculture [1]. The botanical synonyms are as follows: *C. odoratum* (Lam.) Baill. ex King; *C. odoratum* (Lam.) Baill. ex King; *Unona odorata* (Lam.) Baill.; *U. odorata* (Lam.) Dunal; *Uvaria gaertneri* DC.; *Uvaria javanica* Thunb.; *Uvaria odorata* Lam [2]. While *C. odorata* is taxonomically classified as follows: Plantae (kingdom), Angiosperms (plant division), Magnoliopsida (class), Magnoliales (order), *Annonaceae*

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(family), *Cananga* (Dunal) Hool. f. and Thomson (genus), and *C. odorata* (lam.) Hook. f. and Thomson (species) [1]. The extraordinary essential oil content of the flowers makes this plant widely cultivated for commercial purposes [3]. The community's cultivation of *C. odorata* is confined to preserving plant seeds that develop naturally around the parent tree [4]. This may have an impact on the availability of these plants in nature. Apart from that, many environmental aspects have been reported to impact its growth and sustainability. Water, soil nutrients, and temperature pressure impact plant growth and the development of secondary metabolites in diverse plants [5–7]. Overharvesting due to human needs and plant product commercialization without balanced cultivation efforts are also detrimental to plant longevity [8].

Studies related to this plant were first published in Scopus in 1975, which reported the presence of hexylene glycol content in commercial volatile oils of *C. odorata* [9]. *Cananga odorata* mostly contains linalool, germacrene D, and β -caryophyllene as secondary metabolites with a chemical structure as shown in Figure 2. Linalool is considered to be responsible for the characteristic floral perfume of *C. odorata* [1].

The pharmacological activities of *C. odorata* as an antioxidant, repellent, antimicrobe, and antianxiety have been reported [10–14]. Antibiofilm, antidiabetic, antifertility, anti-melanogenesis, sedative, and relaxing effects are also found in *C. odorata* [1]. Secondary metabolites of medicinal plants have a crucial role in defining their biological actions [15]. Widespread use of *C. odorata* has traditionally been reported in various regions. Essential flower oil treated respiratory and cardiovascular disorders in North Sumatra [16]. Seeds may be used to treat fever, flowers can be used for traditional ceremonies or cultural rites, and leaves can be used to heal skin diseases and asthma [17]. Essential oil provision of *C. odorata* flowers with a dose of 30 mg/kg for 28 days showed neuropathic pain alleviation and reduced pain-related anxiety in male mice [18]. In combination with crude extracts of *Vetiveria zizanioides* and *Andrographis paniculata*, *C. odorata* demonstrated synergistic effectiveness as a repellent [12]. The findings of a sub-acute toxicity research conducted in 2023 revealed that administration of an ethanol extract of *C. odorata* flowers at a concentration of 500 mg/kg bw caused no adverse effects in the histopathology of the test rat's organs [19].

According to the Indonesia Food and Drug Supervisory Agency's Decree number 25 of 2023, natural medicines or traditional Indonesian medicines are classified into three categories: *Jamu* or traditional herbal medicines, standardized herbal medicines, and phytopharmaceuticals. *Jamu* is a natural medicine derived from traditional knowledge or Indonesian cultural heritage used for health maintenance, health improvement, illness prevention, treatment, or health recovery and more than 95% of *jamu* consumers recognize and have experienced the benefits of herbal remedies for their health [20,21]. Due to the vast diversity of Indonesian ethnic groups and local cultures, knowledge of traditional remedies in Indonesia is relatively affluent [22]. Each ethnic group has a wealth of information passed down from generation to generation [23]. Based on empirical data, the indigenous knowledge of the effectiveness of many medicinal plants has been demonstrated

to be beneficial and safe. Since ancient times, the community has used medicinal plants grown on communal property to acquire traditional medical supplies [24]. Traditional medicine usage has increased throughout time, and various factors underlie this change. Following the Ministry of Health's national basic health research, traditional medicine use in Indonesia grew by more than 44% from 2010 to 2018 [25]. The usage of traditional medicine was linked with gender, residence, age, marital status, and distance to health services [26]. Sundararajan observed that poverty is one of the significant variables affecting the desire to utilize traditional medicine in Mwanza, Tanzania [27]. Apart from price and accessibility, the type and ability of treatment possessed by healers also influence the preference of traditional medicine use [28]. Having few side effects is also a consideration when using traditional medicine [29].

The practice of employing traditional medicine is one of the indigenous traditions of Indonesian society. Indigenous cultures have traditionally created, developed, and passed down knowledge orally without any documentation over the generations. This unrecorded indigenous knowledge and expertise, inappropriate harvesting methods, commercial utilization, and extensive industrialization are all issues threatening the survival of traditional indigenous medicine [30–32]. Preserving the noble values and wisdom of traditional knowledge, applying traditional knowledge in daily life, documenting the diversity of traditional knowledge, and



Figure 1. Original photograph of *C. odorata* plants, leaves, and leaf color refers to the color categories on the RHS colour chart (growing in Indonesia's Central Java Province area).

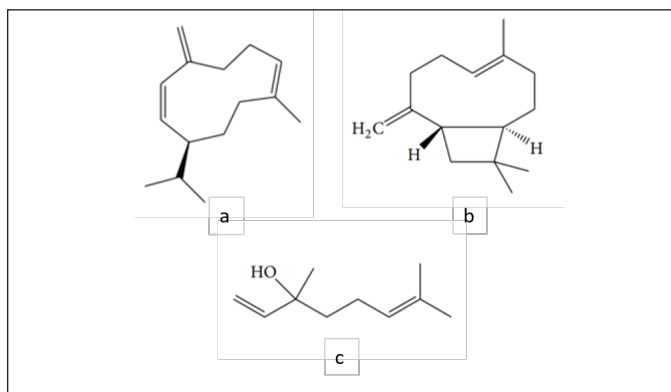


Figure 2. The chemical structures of the principal secondary metabolites of *C. odorata*, namely linalool (a), germacrene D (b), and β -caryophyllene (c).

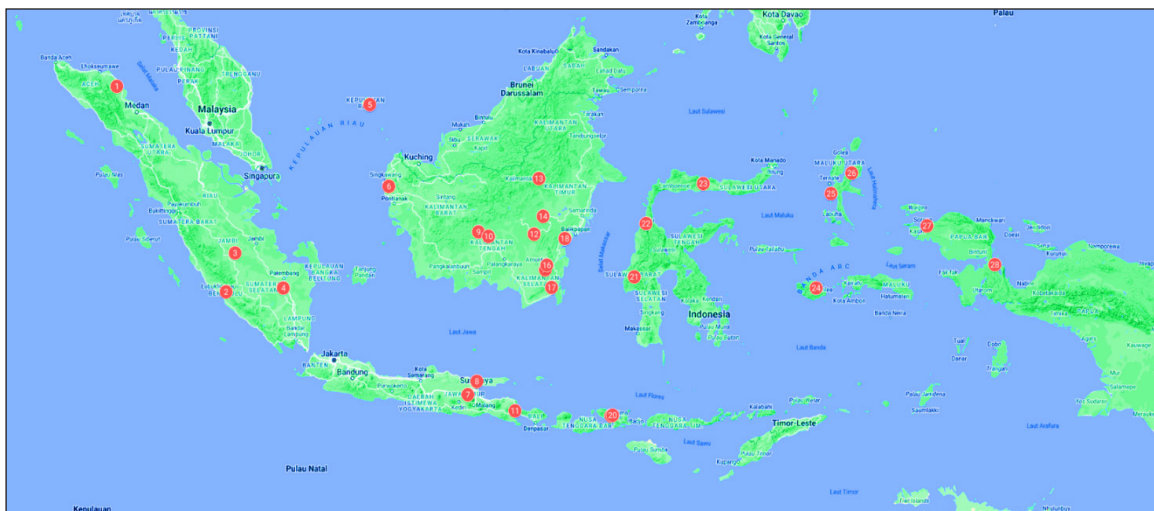


Figure 3. The location of the study area data is processed with MapSource® Garmin® mapping software). It shows ethnic groups that use *C. odorata* in concoctions: 1. Tamiang, 2. Lebak, 3. Anak Dalam, 4. Pegagan, 5. Melayu Natuna, 6. Dayak Bentian, 7. Jawa Majapahit, 8. Madura, 9. Dusun Maanyan, 10. Bakumpai, 11. Osing, 12. Dayak Tabuyan, 13. Tunjung, 14. Halok, 15. Ulu Batang Ali, 16. Pitap, 17. Pagatan, 18. Paser, 19. Kore, 20. Dompui, 21. Mamuju, 22. Dampelas, 23. Polahi, 24. Buru/Batabual, 25. Makian, 26. Tugutil, 27. Moi Pedalaman/Maibo, 28. Wamesa.

revitalizing and preserving the cultural ecosystem for any traditional knowledge and inheritance are some efforts to avoid deterioration, loss, or destruction of traditional knowledge [33]. Furthermore, no research has been performed to document the application of *C. odorata* by traditional healers in various ethnic groups in Indonesia to treat various disease indications. Thus, this study aims to discover and document indigenous traditional knowledge on the use of *C. odorata* for medical purposes by traditional healers in diverse ethnic groups in Indonesia.

MATERIALS AND METHODS

Study area

The ethnomedicine study area included 254 ethnic groups in 34 provinces of Indonesia. The identification and selection of traditional healers that employ *C. odorata* for their therapy is carried out according to all the information obtained across all ethnicities. Figure 3 depicts the ethnic group location employed *C. odorata* for healing diseases, consisting of 28 ethnic groups within 16 provinces in Indonesia.

Data collection

Data collected by the research team corresponds to the earlier publication [34,35]. Each team comprises five researchers with biology, sociology, anthropology, and health backgrounds. A total of five traditional healers on each ethnic group were chosen using a purposive sample approach based on inclusion criteria such as the healer being of native or enculturated ethnicity, having knowledge, ability, and carrying out treatment using medicinal plants, the most effective, well-known and be recognized by the community. Healers having specialized therapeutic competence in one type of ailment were excluded from this study. The researcher obtained initial information regarding the whereabouts of healers from tribal chiefs, community leaders, village offices, and other

Table 1. Demographic information of the selected traditional healers as informants.

Characteristic	Criteria	Informants (n = 36)	
		Frequency	Percentage
Gender	Male	25	69.44
	Female	11	30.56
Age (years old)	29–38	2	5.56
	39–48	3	8.33
	49–58	14	38.89
	>58	16	44.44
Main job	Housewife	1	2.78
	Civil employer	1	2.78
	Farmer	21	58.33
	Healer	11	30.56
	Other	2	5.56
Education	Illiterate	5	13.89
	Kindergarten	15	41.67
	Elementary School	10	27.78
	Junior High School	2	5.56
	Senior High School	4	11.11
Origin of knowledge	Parents	27	75.00
	Grandparents	25	69.44
	Experiences	15	41.67
	family	11	30.56
	Friends	8	22.22
	Nonformal education	8	22.22
	Formal education	0	0.00
	Other sources	8	22.22

Table 2. Informants distribution in each ethnic group and province.

Province	Ethnic groups	Informants (<i>n</i> = 36)	
		Number	Percentage
Bengkulu	Lebak	3	8.33
Aceh Special Region	Tamiang	1	2.78
Gorontalo	Polahi	1	2.78
Jambi	Anak Dalam	1	2.78
East Java	Jawa Majapahit	1	2.78
	Madura	2	5.56
	Osing	2	5.56
South Kalimantan	Pagatan	1	2.78
	Pitap	3	8.33
	Ulu Batang Ali	1	2.78
Central Kalimantan	Bakumpai	1	2.78
	Dayak Tabuyan	1	2.78
	Dusun Maanyan	1	2.78
East Kalimantan	Dayak Bentian	1	2.78
	Halok	2	5.56
	Paser	1	2.78
	Tunjung	1	2.78
Kepulauan Riau	Melayu Natuna	1	2.78
Maluku	Buru/Batabual	1	2.78
North Maluku	Makian	1	2.78
	Tugutil	1	2.78
West Nusa Tenggara	Dompu	2	5.56
	Kore	1	2.78
West Papua	Moi Pedalaman (Maibo)	1	2.78
	Wamesa	1	2.78
West Sulawesi	Mamuju	1	2.78
Central Sulawesi	Dampales	1	2.78
South Sumatra	Pegagan	1	2.78

trustworthy sources. The most well-known and highest patient number was used to determine informants among ethnic groups with more than five healers who met inclusion criteria. Data were gathered through in-depth interviews based on semi-structured questionnaires. The information gathered includes the demographic data of healers, medicinal plants used, potions, and their applications for health purposes. After the interview with the informant, medicinal plant specimens were collected and stored at the Tawangmanguensis Herbarium of Indonesia. The study received ethical approval from the Health Research Ethics Commission, National Institute of Health Research and Development, Ministry of Health of the Republic of Indonesia, with the codes LB.02.01/5.2/KE.318/2015 and LB.02.02/2/KE.107/2017. The data in this article can be accessed from the Health Development Policy Agency Indonesia at www.badankebijakan.kemkes.go.id.

Data analysis

The traditional healer's gender, age group, education levels, knowledge sources, and occupation were descriptively analyzed to determine frequencies and proportions. To cure diseases using *C. odorata*, the source of materials, plant parts, formula composition, and administration techniques used in this study were descriptively examined.

Treatable diseases (hemorrhoid, antidote, sexually transmitted disease, back pain, mental disorder, cough, obesity, fever, cosmetics, rheumatics and gout, wound healing, pre and postpartum care, other internal diseases, hypertension, stomachache, smallpox disease, and skin disease) using *C. odorata* by thirty-six traditional healers were analyzed with multi health purposes simple ranking exercise referring to previous studies [34,36].

Plant part value (PPV)

PPV was a parameter for calculating the proportion of employed plant parts. The percentage of *C. odorata* plant

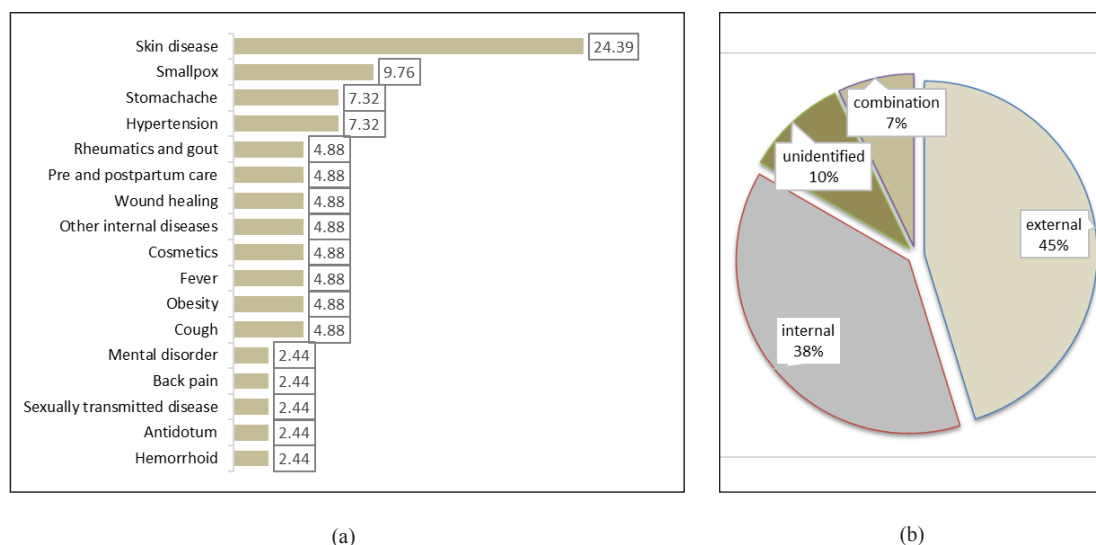


Figure 4. The percentage of treatable diseases healed by traditional healers using *C. odorata* (a) and the administration route of *C. odorata* (b).

Table 3. Multihealth purposes simple ranking of seventeen treatable diseases using *C. odorata* by thirty-six traditional healers.

Healers number	Treatable diseases*																
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-
4	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-
5	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
7	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
10	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
13	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
16	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
18	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
19	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
21	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
22	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-
23	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
25	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
27	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
31	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
34	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
35	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
36	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Score	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	4	10
Rank	5th	5th	5th	5th	5th	4th	4th	4th	4th	4th	4th	4th	3rd	3rd	3rd	2nd	1st

*Treatable disease code A (hemorrhoid), B (antidote), C (Sexually transmitted disease), D (back pain), E (mental disorder), F (cough), G (obesity), H (fever), I (cosmetics), J (rheumatics and gout), K (wound healing), L (pre and postpartum care), M (other internal disease), N (hypertension), O (stomachache), P (smallpox disease), and Q (skin disease)

organs for medication purposes by traditional healers in ethnic groups of Indonesia was determined by following the formula. PPV is the plant part utilized value, and RU is the quantity of use stated for each plant part [37].

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

RESULTS

Sociocultural profile of informants

This research included 36 traditional healers from 28 ethnic groups dispersed over 16 Indonesian provinces. Table 1 provides a brief socio-cultural profile of the informants. Almost

70% of healers are men, with the majority being over 59 years old, with a low level of education, their primary employment being farming, and practically all healers gaining traditional knowledge through grandparents and their parents. According to Table 2, the Lebak ethnic group from Bengkulu Province, as well as the Pitap ethnic group from South Kalimantan, had

the greatest number of informants who utilized *C. odorata* for traditional medicine, followed by the Madura and Osing ethnic groups from East Java and the Halok ethnic group from East Kalimantan.

Treatable diseases and administration route

Compared to other ailments, skin disease is a symptom of a medical condition frequently treated by healers leveraging *C. odorata*, as indicated by a percentage of almost 25%. As shown in Figure 4(a), some of the most uncommon symptoms are hemorrhoids, poisoning, sexual illnesses, back discomfort, and mental issues. Figure 4(b) displayed all three kinds of *C. odorata* herbs delivery routes advocated by healers, namely internally or orally, externally, and a mix of both. In contrast, the external route was the most prominent provision route, accounting for 45% of the total. Meanwhile, for multihealth purposes, a simple ranking of seventeen treatable diseases (hemorrhoid, antidote, sexually transmitted disease, back pain, mental disorder, cough, obesity, fever, cosmetics, rheumatics and gout, wound healing, pre and postpartum care, other internal diseases, hypertension, stomachache, smallpox disease, and

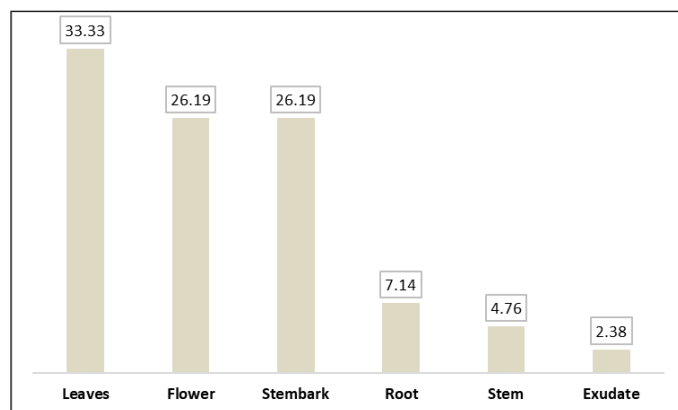


Figure 5. Plant part utilized by traditional healers.

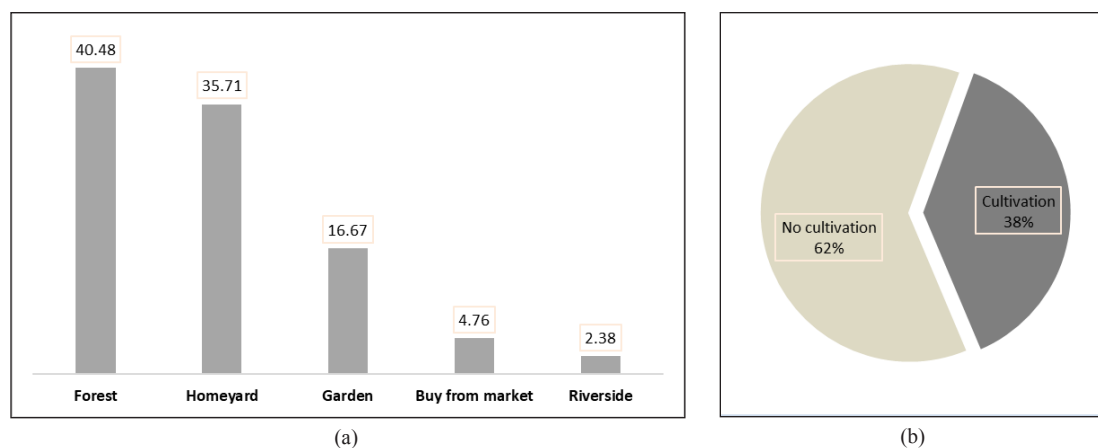


Figure 6. Medicinal plant sources (a) and cultivation efforts of *C. odorata* conducted by healers (b).

Table 4. Identified chemical composition of *C. odorata* plant parts.

Plant parts	Chemical contents	References
Oxygenated fraction of essential oil	Linalool, geraniol, geranyl acetate, <i>p</i> -methyl anisole, benzyl salicylate, benzyl benzoate, benzyl acetate, (E, E)-farnesyl acetate, cinnamyl acetate, and methyl benzoate	[1]
Hydrocarbon fraction of essential oil	Germacrene D, β -caryophyllene, γ -Murolene, and (E, E)-farnesyl acetate	[1]
Fruits	α -pinene, cananodine, myrcene, and terpinen-4-ol, cryptomeridiol 11- α -L-rhamnoside, γ -eudesmol 11- α -L-rhamnoside, γ -eudesmol	[1]
Leaves	Isosophonodin, canangone, canangaionoside, hexanol, α -pinene, myrcene, sabinene, and terpinene-4-ol, anthraquinone glycosides, flavonoids, alkaloids, tannins, trans-caryophyllene, ocimene, farnesol, α -cadinol, α -pinene, α -terpineol, camphor, copaene, linalool, eugenol,	[11,57,58]
Flowers	Isoeugenol, methyl benzoate, benzyl benzoate, geraniol, germacrene D, farnesol, farnesyl acetate, canangalignans, canangaterpenes 1-6, canangafruticoides, caryophyllene oxide, germacrene, linalool, caryophyllene, <i>p</i> -cresyl methyl ether, (E)-cinnamyl acetate, (E, E)- α -farnesene, benzyl salicylate, EE-farnesol	[1,59–62]
Chloroform extract of stem bark	Sampangine	[1]

skin disease) using *C. odorata* by thirty-six traditional healers were revealed on Table 3.

PPV

Cananga odorata plant parts are employed, especially exudate, stem, root, stembark, flower, and leaves. Leaves have been discovered as the most frequently used substance by healers for treatment, shown by a PPV of 33%, as shown in Figure 5.

Medicinal plant sources and cultivation efforts

Traditional healers obtained *C. odorata* from various places, including riverbanks, gardens, backyards, woodlands, and market purchases. More than 40% of the herbs were gathered by natural harvesting from the forest, followed by home yard, garden, market purchase, and riverfront collection [Fig. 6(a)]. According to the study findings in Figure 6(b), more than 60% of *C. odorata* gathered and utilized by healers has yet to be attempted to cultivate.

DISCUSSION

This study emphasizes the essential role of traditional healers in sustaining ethnic communities' health through medicinal plants, particularly *C. odorata*. The results acknowledged that males represent a larger proportion of healers. This is tied to various perspectives, including that males are responsible for caring for their families, that parents generally pass on their expertise and ability to the sons, and that being in the role of traditional healers elevates men's prestige in society. This is consistent with reports from Bali, Indonesia, whereby the community acknowledges and honors traditional healers [38]. They are frequently seen as the traditional moral and value code defenders [39]. In Sub-Saharan Africa, most citizens believe traditional healers are their sole choice for meeting healthcare requirements [39]. Even though they practice traditional medicine, healers in Sub-Saharan Africa are already aware of how to protect themselves against disease transmission from patients [40].

In the current study, healers over the age of 58 predominated, and roughly 14% of healers were under the age of 49, with more than 50% having a low level of formal education. Most healers obtained traditional medicine expertise and abilities from their parents (75%) and elders (68%). Inevitably, passing knowledge and treatment abilities is separate from documentation and generally occurs verbally, leaving this crucial knowledge at risk [41,42]. A person's understanding of traditional medicine increases with age [43]. This study result contradicts prior research, which found that the more a person's degree of education and understanding, the greater their usage and practice of traditional medicine [44]. Traditional medicine is unappealing to youthful generations in Mali, Africa, which is predicted to affect the future decrease of traditional healers. However, the growing education level offers prospects for collaboration with modern medical practices [45].

The study exhibited that the most significant usage of *C. odorata* is for treating skin disorders, which occupy the first rank of curable conditions with a score of 10 and a percentage

of about 25% compared to other diseases in Indonesian ethnic groups. This relates to the proportion of administration routes since external usage outnumbers internal applications and other ways by 45%. The topical route over the skin is considered an effective technique for alleviating the limitations of other internal routes [46]. Skin diseases are quite prevalent in Indonesia. Itching is the most prevalent sign of a skin illness. Severe itching can degrade one's quality of life and lead to other health problems [47]. Unhealthy behavior, hygiene, and the surroundings may give rise to the spreading of diseases, particularly skin diseases. Scabies and dermatitis are two of Indonesia's most prevalent skin-related diseases [48,49]. A lack of awareness of the many skin diseases and how to prevent them leads to someone developing acute skin illness [50]. Moreover, Indonesia is tropical, and air humidity, temperature, and sunlight contribute to skin disease cases [51]. Several investigations have found *C. odorata* to be antifungal and antibacterial. *Cananga odorata* stem bark contains the alkaloid liriodenine and sampangine, which inhibit the development of Gram-positive bacteria, yeast, and fungus. Hexane stem bark extract demonstrated efficacy against *Candida albicans* and *Propionibacterium acnes* [1,52,53].

As opposed to flower, stembark, root, stem, and exudate, leaves are the component of the *C. odorata* that healers frequently employ, and it is in tune with the outcomes of several prior investigations. This condition can be attributed to a variety of reasons, such as the plenty availability of plant leaves, the relative ease with which leaf parts can be harvested compared to other parts, collecting in large amounts not lead to plant death or damage, and multiple studies have highlighted several chemical substances (as revealed in Table 4) related to a plant's pharmacological properties are frequently discovered in the leaves.

The results of this study indicate that over 60% of the *C. odorata* utilized by healers of various ethnicities in Indonesia has yet to be farmed. Even though *C. odorata* was included in the minor concern (LC) category according to the results of the International Union for Conservation of Nature and Natural Resources Red List of Threatened Species assessment in 2019; conservation and cultivation efforts are needed to prevent this species category from increasing to the near-threatened (NT) level, which is close to qualifying or assessed to be in the endangered category shortly [54]. The preference of healers for wild harvesting from forests or other places is related to several factors, including the fact that the material is still available in large quantities in nature. Thus, it is easy to obtain, more economical, does not require sacrificing time, space, or costs to plant, and can be taken whenever needed. Aside from these benefits, natural harvesting has several drawbacks, such as uneven plant conditions and inconsistent quality and availability [55]. Meanwhile, medicinal plant cultivation will expand in areas where appropriate technology is accessible, replacements are unavailable, and costs stay considerable [56].

The limitations of this study include the fact that the emphasis of this study is confined to the use of *C. odorata* by traditional healers from a health perspective alone, and it has not studied its usage from different viewpoints, such as

economic and cultural factors from each ethnicity. Aside from that, due to time constraints and other resources, the number of informants chosen based on the inclusion criteria was restricted to five healers per ethnic group. This provides the possibility for untapped local ethnomedicine knowledge possessed by the sixth healers and others in each ethnic group, as well as information and abilities in treatment utilizing medicinal plants owned by indigenous communities other than healers that have yet to be documented. Thus, future ethnomedicine studies focusing on each ethnicity utilizing the snowball sampling approach with a broader range of informants and in-depth information are required.

CONCLUSION

This study emphasized the significant role of traditional healers in healing various illnesses with *C. odorata* and the variations in *C. odorata* ethnomedical usage as a traditional remedy in Indonesian ethnic groups. Nonetheless, cultivating initiatives should be started as more than 60% of identified *C. odorata* has yet to be grown. The study's findings are likely to benefit various stakeholders, serve as baseline data for further studies on the efficacy and safety of *C. odorata*, and contribute to efforts for developing health products that employ *C. odorata*. With diverse information and facts on the traditional usage of *C. odorata* for health purposes, supported by scientific data on various pharmacological properties and the presence of secondary metabolite substances, *C. odorata* has considerable potential to be developed as a therapeutic substance.

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AUTHOR CONTRIBUTIONS

Conceptualization, NR, YW, AR, AE; methodology, NR and RM; software, RM and IY; validation, NR, YW, AR, AE; formal analysis, NR; investigation, NR, YW; resources, NR and RM; data curation, NR; writing original draft preparation, NR, AE, AR, YW; writing, review and editing, NR, AR, AE, YW; visualization, NR; supervision, YW, AE, AR. 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 report no financial or any other conflicts of interest in this work.

ETHICAL APPROVALS

The study protocol was approved by the Health Research Ethics Commission, National Institute of Health Research and Development, Ministry of Health of the Republic of Indonesia, with the approval number LB.02.01/5.2/KE.318/2015 and LB.02.02/2/KE.107/2017.

DATA AVAILABILITY

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

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors declares that they have not used artificial intelligence (AI)-tools for writing and editing of the manuscript, and no images were manipulated using AI.

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