

Ethnopharmacology study of medicinal plants utilization for antidiarrheal remedies by Tengger tribe in Tosari District, Indonesia

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ABSTRACT

Tengger is one of the tribes in East Java Province, Indonesia practising traditional medicine by using mantras and medicinal plants. A disease with a high incidence rate and widely treated with medicinal plants in Indonesia, including in Tosari District, Pasuruan Regency, is diarrhoea. To conserve traditional medicine, mainly the utilization of medicinal plants as anti-diarrhoea agents, it is necessary to develop a database that keeps up with technological advances. The study aimed to determine medicinal plants utilization for antidiarrheal remedies by the Tengger tribe in four villages of Tosari District, Pasuruan Regency, namely Wonokitri, Tosari, Ngadiwono, and Podokoyo. The study employed the snowball sampling method, which involved conducting semi-structured interviews. The result showed nine medicinal plants for traditional antidiarrheal remedies, with Musaceae (23%) as the most widely used plant family. Most informants used immature plant (56.25%) and fruits (89.58%). In addition, most plants were administered orally (98%) without specific compounding methods (76%). The value of Factor of the informant's consensus (Fic) of plants used for diarrhoea was 0.74. The highest Fidelity Level (FL) and Choice Value (CV) were obtained from *Elaeocarpus longifolius* Blume at 69% and 2.4, respectively. Based on the findings of the study, *E. longifolius* has the potential to be further investigated for development in antidiarrheal treatment.

Keywords: antidiarrheal remedies, tengger tribe, factor of the informant's consensus, fidelity level, choice value

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INTRODUCTION

Diarrhoea is defined as an alteration in the shape and consistency of faeces from soft to liquid, accompanied by an increase in bowel movements frequency, occurring at least three times within 24 hours (Hemalatha & Laloo, 2011). Clinically, diarrhoea is frequently caused by infection (bacterial, viral, or parasitic infestation), malabsorption, allergies, poisoning, and immunodeficiency. The main causes of diarrhoea are infection and poisoning (Sari, 2018). Diarrhoea is an endemic disease in Indonesia, occasionally accompanied by mortality. The Riskesdas report in 2018 confirmed that the highest prevalence of diarrhoea in Indonesia occurred in the 1-4 years age group at 11.5%. The prevalence of diarrhoea in East Java was 6.5%, with the prevalence of diarrhoea in toddlers being 9.9% (Kemenkes RI, 2019).

Though using a rehydration solution does not reduce the incidence of diarrhoea, over 90% of dehydration associated with diarrhoea is effectively accomplished with an oral rehydration solution. Meanwhile, antibiotics are only indicated for bloody diarrhoea or cholera (Agtini & Puspandari, 2027). Over the past few decades, there has been a worldwide movement towards back to nature. In all types of traditional medicine, the diversity of plants is utilized to treat and prevent various diseases (Jaradat et al., 2017). Based on the Riskesdas Report in 2018, it is known that the treatment of diarrhoea in toddlers using medicinal plants in East Java was 7.5%, especially in the 24-35 months age group, namely 13.6% (Kemenkes RI, 2019).

The utilization of medicinal plants is an essential component of traditional medicine found within the customs and traditions of a country's population, particularly in developing nations (Amiri & Joharchi, 2012). One of the traditional remedy cultures in Indonesia existed in the Tengger tribe. The tribe has a unique therapeutic culture, namely traditional medicine and mantras passed down through generations. Around 98 types of traditional medicinal plants were used by the Tenggerese community (Batoro, 2012).

The Tengger tribe is located around the Tengger Mountains, East Java Province, Indonesia, which comprise four regencies: Probolinggo, Pasuruan, Malang, and Lumajang (Putri et al., 2022). Most Tenggerese community in Pasuruan lives in Tosari District (Sutarto, 2007). The total area of Tosari District is 9,214.753 hectares. Moreover, the district comprises eight villages: Wonokitri, Tosari, Ngadiwono, Podokoyo, Mororejo, Sedaeng, Baledono, and Kandangan (Galba et al., 1989). However, due to an alteration in value orientation, most Tenggerese community in Tosari District only inhabit four villages: Wonokitri, Tosari, Ngadiwono, and Podokoyo (Sutarto, 2007). According to the epidemiological report on the top 20 diseases in Tosari District by Tosari PHC, public health center (*Puskemas*), the incidence of diarrhoea has decreased over the years. In 2013, there were 533 cases; in 2014, there were 408 cases; and in 2015 there were 321 cases. Nevertheless, in 2016, the incidence of diarrhoea in Tosari District increased to a total of 471 cases. Due to the common use of traditional medicine by the Tengger tribe, it is necessary to conduct an inventory of medicinal plants commonly employed to alleviate diarrhoea symptoms by the Tenggerese community located in four villages of Tosari District.

MATERIALS AND METHOD

Study area

This research was preceded by a preliminary survey followed by data collection in Wonokitri, Tosari, Ngadiwono, and Podokoyo Villages, located in Tosari District, Pasuruan Regency, East Java Province, Indonesia at an altitude range of 1681-2597, 887-2599, 1099-2198, and 1820-2488 m above sea level, respectively. The researchers obtained authorization from the National Unity and Politics Agency (*Bakesbangpol*) of Pasuruan Regency (No. 072/559/424.104/SUR/RES/2017) to perform the study.

Population and sample

The population of the study was the Tenggerese community in Wonokitri, Tosari, Ngadiwono, and Podokoyo Villages. The sample consisted of the Tenggerese community in the four villages who met inclusion criteria, namely being native descendants of the Tengger tribe aged over 17 years, living in the four villages, possessing traditional Tengger treatment knowledge and using medicinal plants to treat

diarrhoea. The exclusion criteria of the study were those who used modern medicine and used plants which were not cured of diarrhoea.

Data collection

The study was a cross-sectional research using a combination of qualitative and quantitative methods. Qualitative study was performed through semi-structured interviews using open-ended questions, respondent investigation, observation, and identification. Plants with medicinal properties were identified by their scientific names at Faculty of Mathematics and Natural Sciences, University of Jember. Quantitative data was presented by measuring Fic, FL, and CV. The determination of the sample was performed using snowball sampling method, which is a sampling technique that begins by selecting a small group and asking them to identify their acquaintances. These acquaintances then nominate further acquaintances, forming a snowball (Nasir et al., 2011).

Data Analysis

Data analysis employed in the study is a quantitative descriptive analysis using the Fic, FL, and CV analytical methods. The method was used as a reference for assessing the potential medicinal plants for use as antidiarrheal agents.

Factor analysis of informant consensus (Fic)

Data analysis of Fic aims to demonstrate the consistency of information obtained from informants regarding the most effective medicinal plants in treating specific diseases. Fic value is low (close to 0) when plants are selected randomly or when informants do not provide information on the species utilization in treating diarrhoea. A high Fic value (close to 1) is obtained when there are well-defined selection criteria established by the community and/or when informants exchange information on the use of the species in treating diarrhoea. Fic is determined by applying the subsequent formula (Karaköse et al., 2019):

$$Fic = \frac{Nur - Nt}{Nur - 1} \dots \dots \dots (1)$$

Nur represents the number of informants who possess knowledge about and utilize the plant species for their antidiarrheal properties, while Nt denotes the count of plant species that are employed as antidiarrheals.

Fidelity Level (FL)

FL analysis enables the determination of the number of informants who affirm employing a particular plant for equal primary treatment purposes. FL is characterized as the proportion of informants who assert that a particular plant species is used to treat diarrhoea. The formula for determining FL is as follows (Khan et al., 2014):

$$FL = \frac{Ip}{Iu} \times 100 \dots \dots \dots (2)$$

Ip represents the count of informants who reported using the plant species to treat diarrhoea, whereas Iu represents the total number of informants.

Choice Value (CV)

Analysis of CV aims to determine the number of plant species utilized as antidiarrheal drugs. CV value is classified from 0 to 100, with a score of 100 indicating a species used as an alternative treatment for specific diseases. CV is determined using the subsequent formula (Jaradat et al., 2017):

$$cv = \frac{Pcs}{Sc} \dots\dots\dots(3)$$

Pcs is the number of informants who mention a specific plant species for diarrhoea treatment, and Sc represents the total number of plant species claimed for treating diarrhoea by informants.

RESULT AND DISCUSSION

Characteristics of informants

The local knowledge of using plants as diarrhoea remedies is still widely recognized among the Tenggerese community in Tosari District, Pasuruan Regency. Each village in Tosari District has one traditional shaman and one traditional birth attendant. They use mantras when treating sick people. Meanwhile, plants are utilized as intermediaries for medicinal purposes. This study collected data from 32 informants by interviews in four villages of Tosari Districts. The characteristics of the informants are listed in [Table 1](#). Most informants are ordinary people (75%) from Wonokitri Village (28%) and Tosari Village (28%) with male gender (59.4%). There are more male informants since men were more easily met than women when visiting the Tengger tribe area. Most informants were between 40 and 49 years old (37.5%). Most respondents graduated from primary education (53.1%) and identified as Hindu (59.4%). Those with higher educational backgrounds had less knowledge about medicinal plants utilization since, in order to pursue higher education, the Tenggerese community had to leave their inhabitation. When the Tenggerese community leaves their habitation, they could encounter the impact of urban living. A possible effect is that they have been used to apply modern medical treatments for diarrhoea. The original religion of the Tengger tribe is Hindu. Therefore, the Hindu community still adhere to the indigenous healing practices of the Tengger tribe and have faith in them.

Table 1. Characteristics of informants from four villages in Tosari district

Characteristics of informants		Number of informants	Percentage
Village	Wonokitri	9	28
	Tosari	9	28
	Ngadiwono	8	25
	Podokoyo	6	19
Social status	Traditional shaman	4	12.5
	Traditional birth attendant	4	12.5
Gender	Ordinary people	24	75
	Male	19	59.4
	Female	13	40.6
Age	40-49 years old	12	37.5
	50-59 years old	6	18.8
	60-69 years old	11	34.4
	70-79 years old	2	6.3
	80-89 years old	1	3.1
Education	Not graduated from elementary school	4	12.5
	Graduated from elementary school	17	53.1
	Graduated from junior high school	3	9.4
Religion	Graduated from senior high school	8	25
	Hindu	19	59.4
	Islam	13	40.6

Inventory of medicinal plants used by the Tengger tribe

Based on the information obtained from the informants, there are nine plants for compounding traditional recipes of the Tengger tribe as listed in [Table 2](#). All plants were easily obtained in

nearby yards or forests. The duration of treatment for diarrhoea using herbal remedies often lasts 1-2 days. In previous research, only six plants were found as antidiarrheal remedies by the Tengger tribe, namely *Elaeocarpus longifolius* Blume, *Rubus rosaefolius* Sm., *Centella asiatica* (L.) Urb., *Musa paradisiaca* L., *Areca catechu* L., and *Psidium guajava* L. (Arifin, 2012). Other study stated *Annona squamosa* L., *Coriandrum sativum* L., *Alyxia reinwardtii* Blume, *Colocasia esculenta* (L.) Schott, *Ananas comosus* (L.) Merr., *Casuarina junghuhniana* Miq., *Elaeocarpus longifolius* Blume, *Ocimum citriodorum* Vis., *Psidium guajava* L., *Cymbopogon citratus* (DC.) Stapf, *Rubus rosaefolius* Sm., *Physalis angulata* L. for antidiarrheal treatment of the Tengger tribe (Bhagawan et al., 2023).

Table 2. Medicinal plants utilized by the Tengger tribe for antidiarrheal treatment

Family	Species	Local name	Plant parts	Age of plants	Compounding method	Routes of administration
Acoraceae	<i>Acorus calamus</i> L.	Dringu	Leaves	Immature	Pounded	Topical
Apiaceae	<i>Centella asiatica</i> (L.) Urb.	Calingan	Fruits	Immature, mature	Raw	Oral
Elaeocarpaceae	<i>Elaeocarpus longifolius</i> Blume	Jambu wer	Fruits	Immature, mature	Raw, squeezed	Oral
Lauraceae	<i>Litsea cubebae</i> (Lour.) Pers.	Krangean	Leaves	Immature	Decoction	Oral
Musaceae	<i>Musa balbisiana</i> Colla	Pisang klutuk	Fruits	Immature	Raw, squeezed	Oral
Musaceae	<i>Musa paradisiaca</i> L.	Pisang raja	Fruits	Immature, mature	Raw, roasted	Oral
Piperaceae	<i>Piper betle</i> L.	Sirih	Leaves	Immature	Decoction	Oral
Rosaceae	<i>Rubus rosaefolius</i> Sm.	Grunggung	Fruits	Mature	Raw	Oral
Zingiberaceae	<i>Curcuma longa</i> L.	Kunir	Rhizomes	Mature	Squeezed	Oral

Based on the data collection conducted, it is known that Musaceae (23%) is the plant family most commonly used in the treatment of diarrhoea by the Tengger tribe (Table 3). Informants recommended several plants that have differences in the age of the plant parts used. Table 3 compares the age of plant parts used as antidiarrheal remedies, with 56.25% utilizing immature plants and 43.75% using mature plants. This study also revealed that the parts of plants utilized in diarrhoea treatment by the Tengger tribe are fruits (89.58%), leaves (6.25%), and rhizomes (4.17%). Immature fruits were preferred more than other plant parts due to their high astringent properties (Kusuma & Zaky, 2005).

As shown in Table 4, most medicinal plants were used without any specific compounding methods (raw ingredients) (76%). The other methods of preparation used by Tengger tribe for diarrhoea treatment involved squeezed (16%), decoction (4%), roasted (2%), and pounded (2%). Some informants stated that the absence of complex and time-consuming compounding procedures made it easier and more practical. These compounding method were commonly known by the Tenggerese community as reported in the previous study (Bhagawan et al., 2023).

Table 3. Family of plants, age of plant parts, and plant parts of medicinal plants utilized by the Tengger tribe for antidiarrheal treatment

Family	Species	Utilization of family	Age of plant parts		Plant parts		
			Immature	Mature	Fruits	Leaves	Rhizomes
Acoraceae	<i>Acorus calamus</i> L.	1	1	-	-	1	-
Apiaceae	<i>Centella asiatica</i> (L.) Urb.	1	-	3	5	-	-
Elaeocarpaceae	<i>Elaeocarpus longifolius</i> Blume	1	12	10	12	-	-
Lauraceae	<i>Litsea cubebae</i> (Lour.) Pers.	1	1	-	-	1	-
Musaceae	<i>Musa balbisiana</i> Colla	2	5	-	5	-	-
	<i>Musa paradisiaca</i> L.		2	1	5	-	-
Piperaceae	<i>Piper betle</i> L.	1	1	-	-	1	-
Rosaceae	<i>Rubus rosaefolius</i> Sm.	1	5	5	16	-	-
Zingiberaceae	<i>Curcuma longa</i> L.	1	-	2	-	-	2

Table 4. Compounding methods and administration routes of medicinal plants utilized by the Tengger tribe for antidiarrheal treatment

Species	Compounding methods					Administration routes	
	Raw	Squeezed	Decoction	Roasted	Pounded	Oral	Topical
<i>Acorus calamus</i> L.	-	-	-	-	1	-	1
<i>Centella asiatica</i> (L.) Urb.	5	-	-	-	-	7	-
<i>Elaeocarpus longifolius</i> Blume	10	1	-	-	-	12	-
<i>Litsea cubebae</i> (Lour.) Pers.	-	-	1	-	-	-	-
<i>Musa balbisiana</i> Colla	5	2	-	-	-	7	-
<i>Musa paradisiaca</i> L.	5	-	-	1	-	7	-
<i>Piper betle</i> L.	-	-	1	-	-	-	-
<i>Rubus rosaefolius</i> Sm.	13	-	-	-	-	16	-
<i>Curcuma longa</i> L.	-	5	-	-	-	-	-

Table 4 also shows that most traditional medicine usage for antidiarrheal purposes was administered orally (98%). In addition, antidiarrheal plants were also used topically (2%), meaning they were applied to the abdomen of diarrhoea patients. The use of traditional medicine orally was frequently performed individually due to the easy accessibility of the plants. According to information from the Tenggerese community, the oral administration of medicinal plants was believed to promote the healing process of diarrhoea. This method was also employed by the Tenggerese community in other regions to treat diarrhoea (Arifin, 2012; Bhagawan et al., 2023).

Determination of Fic, FL, and CV

The obtained data is quantitatively calculated using the parameters of Fic, FL, and CV for data analysis. Fic value indicates the consistency of information obtained from informants regarding the effectiveness of medicinal plants in treating specific diseases (Karaköse et al., 2019). In this study, Fic value is 0.74, indicating a high level of consistency in the information provided by the informants.

FL value is used to determine the percentage of informants claiming to utilize a plant for the equal main purpose (Khan et al., 2014). Table 5 shows that the highest FL value is obtained for *E. longifolius* (69%), indicating that most informants used this plant as an antidiarrheal treatment. Meanwhile, the lowest value of 3% is obtained for *A. calamus*, *P. betle*, and *L. cubebae*. This indicates that the three plants were not widely used for antidiarrheal remedies by the Tengger tribe community in the four villages.

Table 5. FL and CV value of medicinal plants utilized by the Tengger tribe as antidiarrheal remedies

Plants name	FL (%)	CV
<i>Elaeocarpus longifolius</i> Blume	69	2.4
<i>Rubus rosaefolius</i> Sm.	30	1.1
<i>Musa balbisiana</i> Colla	10	0.6
<i>Centella asiatica</i> (L.) Urb.	9	0.3
<i>Musa paradisiaca</i> L.	9	0.3
<i>Curcuma longa</i> L.	6	0.2
<i>Acorus calamus</i> L.	3	0.1
<i>Piper betle</i> L.	3	0.1
<i>Litsea cubebae</i> (Lour.) Pers.	3	0.1

CV value determines the number of plant species that are relatively used as antidiarrheal agents (Jaradat et al., 2017). The study exhibited that the highest CV value is found in *E. longifolius*, which is 2.4 (Table 5). The value indicates that *E. longifolius* was the most commonly used plant by the Tenggerese community in the four villages as an antidiarrheal. Meanwhile, the lowest CV value of 0.1 was obtained from *A. calamus*, *P. betle*, and *L. cubebae*, indicating that these three plant species were not widely used as antidiarrheal agents. Based on FL and CV values, it is known that the plant most commonly used by the Tengger tribe in the four villages of Tosari District as an antidiarrheal is *E. longifolius*.

A previous study reported that *E. longifolius* had high Species Use Value (SUV) and Fidelity Level (FL) values and contained 25 chemical contents, with peonidin, D-phenylalanine-benzoxazole, 6-shogaol, and piperine as major constituents. The plant also showed antibacterial activity against *Staphylococcus aureus* and *Shigella dysenteriae* (Bhagawan et al., 2023). Peonidin is known to have antibacterial (Jeyaraj et al., 2023), antiinflammation, and antioxidant activity (Bonetti et al., 2017). D-phenylalanine-benzoxazole showed antibacterial activity against *Mycobacterium tuberculosis* (Pepi et al., 2022, 2023). 6-shogaol had antimicrobial, antioxidant (Ghasemzadeh et al., 2018), antiinflammation (Deb et al., 2019), antibiofilm, and antivirulence activity (Lee et al., 2018). In addition, piperine exhibited antimicrobial activity against *Staphylococcus aureus*, *Salmonella* sp., *Proteus mirabilis*, and *Candida albicans* (Alves et al., 2022). The active ingredient was also known for its antidiarrheal activity (Bajad et al., 2001; Satitsri et al., 2023).

CONCLUSION

The Tenggerese community living in the villages of Wonokitri, Tosari, Ngadiwono, and Podokoyo still used herbal remedies for treating diarrhoea. Based on the results of the 32 informants interviewed, most were men between 40 and 49 years old. They included traditional shamans, traditional birth attendants, and ordinary people. Most of them had completed elementary school and identified as Hindu.

From the nine plants mentioned by those interviewed, it is evident that most informants utilized immature plants, specifically consuming raw fruit orally. In addition, this study demonstrated that *E. longifolius* exhibits promising potential for developing diarrhoea treatment due to its high FL and CV values.

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