



## Original Article

# Ethnomedicine of Tetun ethnic people in West Timor Indonesia; philosophy and practice in the treatment of malaria

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## ARTICLE INFO

## Article history:

Received 13 March 2019

Received in revised form 22 May 2019

Accepted 24 May 2019

Available online 4 June 2019

## Keywords:

Ethnomedicine

Local knowledge

Malaria

Tetun ethnic

West Timor

## ABSTRACT

**Background:** Interactions between humans and diseases for a long time have encourage people to construct concepts related to the disease and create strategies to prevent and treat the disease. The aim of this study is to document philosophy and practice of ethnomedicine of Tetun ethnic people in the prevention and treatment of malaria.

**Methods:** This research was a field study using ethnobotany and anthropology approaches. It was conducted among the Tetun people who settled in the Belu and Malaka districts from April to December 2017. A total of 94 informants consists of public healer, home healer and traditional medicine users were involved in semi-structured interviews and discussions.

**Results:** Tetun ethnic has local knowledge that malaria is caused by naturalistic factors that affect the hot–cold balance in the body. Prevention and treatment of malaria are intended to maintain and restore the hot–cold balance in the body. They use various local medicinal plants for the treatment of malaria, by drinking, bathing, massage, inhalation and cataplasm. Plants used have been proven scientifically to have pharmacological activity as true antimalarials and/or indirect antimalarials.

**Conclusion:** Ethnomedicine practice of Tetun people on malaria is proven to contain scientific truth, although it is built on the basis of concepts that are different or even contrary to the true etiology of malaria.

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## 1. Background

The World Health Organization (WHO) defines ethnomedicine or traditional medicine as a sum total of knowledge, skills and practices based on theories, beliefs and experiences of different cultural customs used in health care, disease prevention and increased physical and mental performance, which have been used for generations from one generation to the next.<sup>1</sup> Ethnomedicine is a term imposed on pre-scientific medical systems which have been passed down from generation to generation.<sup>2</sup> Ethnomedicine in practice include traditional medical systems such as Traditional Chinese Medicine, Indian Ayurveda, Arabic Unani, traditional medicine of Egypt, Africa, America and the Mediterranean, and various other

forms of original medicine. Traditional medicine has long been popular in developing countries, and now rapidly spreading also in industrialized countries. It was estimated that up to the last decade, about 80% of the world's population especially in developing countries, still relied on traditional medicinal systems.<sup>3</sup>

Every community in a certain area has its local knowledge and wisdom in utilizing plants, animals, and minerals to support their life. Using of these natural materials vary according to place of residence, ethnicity, age, sex, original beliefs, religion, relationships with other community groups and the availability of natural resources.<sup>4–7</sup> Generally, indigenous communities use plants, animals, and minerals to fulfill their needs of food and medicine. Using of these natural resources as medicine is based on common belief that diseases that occur in a region can be treated with natural medicine originating from the region.<sup>8</sup> The knowledge on medicinal properties of various natural resources was strongly influenced by the types of diseases that often occur in their own lives.<sup>9</sup>

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Most researchers in the world realize that isolated tribes have a variety of wisdom, knowledge and experience which are of great significance to humans in modern society. Research for new drug discovery is often based on an ethnomedical approach, and then followed by phytochemical screening, isolation of active compound(s), and development of new drug(s). This approach is felt to be more efficient compared to the random screening. In addition, various ethnomedicine studies can be a valuable contribution in the effort to rediscover drugs for old diseases that are still not fully eradicated. They are also a way to get new approaches or strategies in providing more effective treatment for diseases or health care.<sup>10</sup>

Interactions between humans and diseases for a long time have encourage people to construct concepts related to the disease and ways to prevent and treat it. Malaria is an example of ancient disease that has not been fully eradicated until this time. Some old manuscripts of more than 6000 years ago in Egypt and China, and in 1600 bc in India showed that malaria was a disease that has been suffered by humans since ancient times. And, there is evidence that traditional antimalarials have been used in almost all traditional medicine cultures. Ethnomedicine studies showed that people from various parts of the world have various drug formulas to treat malaria.<sup>11</sup>

Tetun ethnic is one of the indigenous ethnic groups in Timor island, Indonesia.<sup>12</sup> Based on historical records, Timor island has long been attacked by various dangerous diseases such as malaria and cholera. Reports of Dutch missionaries showed that Timorese people in 1800s suffered from malaria which caused many deaths.<sup>13,14</sup> Until this time, some parts of Timor such as Belu and Malaka districts are still endemic areas of malaria.<sup>15</sup> As previously stated, malaria, which has been faced by people all over the world since ancient times, has forced them to create concept and ways to prevent and treat it. Therefore, it should be assumed that Tetun ethnic people has also had their own concept (local knowledge or philosophy) about malaria and methods for prevent and treat the disease. In-depth study of ethnomedicine of this ethnic is expected to generate a knowledge about the strengths and weaknesses of their philosophy and practice in defending against malaria. This knowledge then can be incorporated with the existing conventional malaria eradication programs to make them more culturally acceptable and effective.<sup>16</sup>

## 2. Methods

### 2.1. Study site

This research was carried out in Belu and Malaka districts in West Timor (Indonesia) located at 9°15' S–9°34' S and 124°40' E–124°54' E. Belu and Malaka are two of Indonesian territories that border directly with the Republic Democratic Timor Leste (RDTL). In these areas, approximately 80% of the total of population is Tetun ethnic people that scattered in almost all of the sub-district of Belu and Malaka.<sup>17</sup>

### 2.2. Selection of the informants

Searching of the informant(s) to be interviewed was conducted according to purposive and snowball approaches. Firstly, we asked local people to mention one (or some) person(s) who having good knowledge or experiences in traditional medicine. After the interview with a person, then we asked this informant to recommend the other person(s) to be the next informant(s).

The person who is selected to be an informant must meet the criteria: (1) indigenous people of Tetun ethnic; (2) has experience in using traditional medicine, i.e., traditional healer, patient, or family member of patient; and (3) got knowledge about traditional

**Table 1**  
Demographic Profile of the Informants (N=94)

Biodata	Group of informants	No. of informant n (%)
Gender	Man	43 (44.7)
	Woman	51 (55.3)
Age	<40 years old	4 (4.3)
	41–60 years old	37 (39.4)
	>60 years old	53 (56.4)
Education level	Illiterate	38 (40.43)
	Primary level	25 (26.60)
	Secondary level	10 (10.63)
	High education levels	21 (22.34)
Language mastery	Tetun (local language)	44 (46.81)
	Tetun and Indonesian	50 (53.19)
Main profession	Farmer	77 (81.91)
	Employee and retired employee	17 (18.09)

medicine from medical practices by parents or traditional healers in their home/village, not from schools, training, books or mass media.

### 2.3. Data collection

The field study was conducted for 9 months, from April 2017 to December 2017. Data was collected by observation, one-on-one interviews, and group discussion. Interviews were conducted with a semi-structured questionnaire, which was intended to collect biodata of the informants and their local knowledge about malaria and its causes, methods for the treatment of malaria, and medicinal plants used for prevention and treatment of malaria.

Interviews were conducted in Tetun and Indonesian languages. Several interviews were audio- and video-recorded. In addition to interviews, we make several short field trips with informants and local guides in order to search, document and collect plant specimens. On-the-spot observations and several discussions were conducted to completing and cross-checked the interviews data.

### 2.4. Data analysis

All of collected field notes, interview, discussion and observation records were organized and typed neatly, and then analyzed to obtain the following data: (1) local concept about malaria and its causes, (2) methods for prevention and treatment of malaria, (3) plants used for prevention and treatment of malaria, and their claimed effects. Analysis of these aspects was carried out qualitatively with more depth to construct a conclusion about philosophy and practices of ethnomedicine in the prevention and treatment of malaria. Confirmation of plant species was carried out by matching the local name of each plant with its scientific name in local reference<sup>18</sup> and also by specimen identification by specialists of the Indonesian Institute of Sciences-Bogor Botanic Garden.

## 3. Results

### 3.1. The informants

A total of 94 informants (43 men and 51 women) were involved in this study. Demographic profiles of the informants are listed in Table 1. According to their competency in traditional medicine, we classified them into three categories: (1) public healer namely *dok* or *makdok*, who provides traditional medical services for public, (2) home healer, who is only treat the sick family members, and (3) traditional medicine users. The public traditional healers here only provide medical practice if a community member is sick and ask for helping. Their main profession is farmer.

Some informants claimed to have obtained their knowledge and skill of traditional medicine through family tradition, experience of observing and then imitating the medication practices of the

**Table 2**  
Local Concepts of Tetun Ethnic People About Malaria Disease

Local concepts	No. of informant n (%) <sup>a</sup>		
Local term for malaria	<i>Moras isin manas</i> (hot body illness)	86 (91.49)	
Symptoms and signs of malaria	<i>Isin manas</i> (fever)	94 (100)	
	<i>Kiki</i> (shivering)	22 (23.40)	
	<i>Kok bubu</i> (splenomegally)	17 (18.09)	
	<i>Ulun moras</i> (headache, dizzy)	11 (11.70)	
	<i>Ain-liman sin</i> (muscle and joint pain)	10 (10.64)	
	<i>Manas-malirin</i> (intermittent fever)	5 (5.32)	
	<i>Oin nakmutis, matan modok</i> (pale, yellow eyes)	3 (3.19)	
	<i>Kabun moras</i> (diarrhea)	2 (2.13)	
	Causes of malaria	<i>Ha-hemu midar</i> (sweet foods and drinks)	61 (64.89)
		<i>Son udan</i> (chilled)	54 (57.45)
<i>Son loro</i> (sunburn, overheating)		31 (32.98)	
<i>Kole</i> (fatigue)		21 (22.34)	
<i>Horak</i> (disease in the body)		9 (9.57)	
<i>Buan, ema nalo</i> (magic, sorcery)		4 (4.26)	
<i>Susuk</i> (mosquito)		3 (3.19)	
<i>Ha-hemu malirin</i> (cold foods and drinks)		2 (2.13)	
<i>Toba la too</i> (lack of sleep)		2 (2.13)	
Inadequate post natal care		1 (1.06)	
<i>Hemu tua</i> (drink alcohol)		1 (1.06)	
<i>Ha manas</i> (spicy food)		1 (1.06)	
<i>Ha minan, boran</i> (oily or fatty food)		1 (1.06)	
Irregular eating		1 (1.06)	
Methods for malaria prevention		<i>Luli, haleu</i> (abstinence)	34 (36.17)
		<i>Hemu ai tahan</i> (drink medicinal herbs)	8 (8.51)
		<i>Ha-hemu moruk</i> (bitter food and drink)	7 (7.45)
	<i>Drink tua moruk</i>	2 (2.13)	
	<i>Suas uma</i> (repel mosquitoes with smoke)	2 (2.13)	
	Using bed net when sleep	1 (1.06)	
Methods for malaria treatment	<i>Hemu ai tahan</i> (drink medicinal herbs)	80 (62.77)	
	<i>Sa'u, hakoruk</i> (massage using medicinal herbs)	59 (52.13)	
	<i>Haris</i> (bath using medicinal herbs)	49 (85.11)	
	<i>Sunu kok</i> (burning waist using coals)	15 (2.13)	
	<i>Taka kok</i> (cataplasm)	14 (15.20)	
	<i>Horut</i> (inhale the vapor of medicinal herbs decoction)	2 (15.96)	

<sup>a</sup> Note: Each informant could provide more than one answer, so the total percentage of each category may be more than 100%.

traditional healers in the village, and experience of sick in the past and treated using traditional medicine. Some informants got their knowledge of traditional medicine through dreams and visions.

### 3.2. Local concept of Tetun ethnic people about malaria

The symptoms, signs and causes of malaria, methods of prevention and treatment of malaria according to local knowledge of Tetun people are listed in Table 2. Tetun people identify malaria as *moras isin manas* (sick of hot body) with primary signs and symptoms are high fever, shivering, intermitten fever, headache, muscle and joint pain, pale, yellow eyes, and abdominal pain and/or diarrhea. Tetun people assumed that malaria is a common, mild and not serious disease. Many informants assumed that severe headache and splenomegally that associated with fever are other diseases.

Tetun people consider sweet foods or drinks such as sugar cane, ripe bananas, young coconut water and young corn are considered the main causes of malaria. The other main causes are long time in rain or watery and cold place, long working under the hot sun, fatigue and the presence of other disease in the body. All of these factors are believed to disturb the hot-cold balance in the body. Some informants confirmed that knowledge about mosquito as malaria transmitter is new, introduced by the Catholic missionaries from Netherland and Germany.

Sweet foods and beverages are believed to cause *kok*, which is a spleen disorder. Furthermore, *kok* will increase the temperature of the body and cause someone to become *isin manas* (malaria). Tetun people also considered long time exposed to cold water, rain and moisture can cause malaria. Being long in such a cold environment causes someone to easily had *malirin tama* (“cold entering

the body”). This condition forces the body to produce an excessive heat, and as a result, fever is raised; and they consider it malaria.

For the Tetun ethnic people, the best way to prevent malaria is *luli* or *hale'u*, that is avoiding things which are believed to be the causes of malaria. Therefore, avoid or reduce consumption of sweet foods and drinks, not often get wet or long under hot sun, and not too tired are considered the best ways to avoid malaria. Drinking/eating bitter herbs to restore body fitness were also considered effective for malaria prevention. A traditional fogging namely *suas uma*, that is, burning aromatic plants such as wood of sandalwood and whole plant of basil to produce aromatic smoke was also considered effective to reduce malaria attack.

The treatment of malaria in ethnomedicine of Tetun ethnic people consists of herbal and non-herbal methods that applied for external and internal medications. External herbal treatment including methods of *haris* (bath), *sa'u* or *hakoruk* (massage), and *taka kok* (attaching medicine to the swollen spleen; cataplasm). Internal herbal treatment including *hemu ai tahan* (drinking plant decoction), and *horut* (inhaling hot vapor of boiled medicinal plant). It is also known an external non-herbal method called *sunu kok*, that is, burning the waist using coconut shell coal, which is believed to be effective in reducing the swollen spleen and fever.

*Sa'u* or *hakoruk* (massage) using medicinal herbs is the most recommended method for treating people with malaria. According to most traditional healers, if a patient is sorted with medicinal plants until having sweat and the body temperature decrease to normal, so the patient is considered to have recovered. For malaria that already severe, which also cause headaches, vomiting, diarrhea and swollen spleen, traditional healers also combine two or more methods to treat it, for example, massage and drinking herbal concoction. This

**Table 3**  
Plants Used by Tetun Ethnic People for Prevention and Treatment of Malaria

Plants'scientific name	Plants' part used	Mode of preparation	Mode of application
<i>Acorus calamus</i> L.	Rhizome	Paste	Massage
<i>Allium cepa</i> L.	Bulb	Paste	Massage
<i>Alstonia scholaris</i> (L.) R.Br. <sup>a</sup>	Stem bark	Decoction	Drink
<i>Alstonia spectabilis</i> R.Br. <sup>a</sup>	Stem bark	Decoction	Drink
<i>Annona muricata</i> L.	Leaves	Boil	Inhalation
<i>Annona reticulata</i> L.	Leaves	Boil	Inhalation
<i>Blumea balsamifera</i> (L.) DC.	Leaves	Boil	Bath
<i>Brucea javanica</i> (L.) Merr.	Leaves	Boil	Inhalation
<i>Calotropis gigantea</i> (L.) R. Br.	Leaves	Paste	Massage
<i>Carica papaya</i> L. <sup>a</sup>	Leaves	Decoction	Drink
<i>Cleome rutidosperma</i> DC.	Whole plant	Decoction	Drink
<i>Crimum asiaticum</i> L.	Leaves, bulb	Paste	Massage
<i>Drynaria quercifolia</i> (L.) J. Smith.	Tuber	Paste	Massage
<i>Ficus hispida</i> L.f.	Leaves	Paste	Cataplasm
<i>Garuga floribunda</i> Decne.	Leaves	Paste	Massage
<i>Jatropha curcas</i> L.	Stem bark	Paste	Massage
<i>Melia azedarach</i> L. <sup>a</sup>	Stem bark, leaves	Decoction	Drink
<i>Melicope latifolia</i> (DC.) T.G. Hartley	Leaves	Boil	Bath
<i>Momordica charantia</i> L. <sup>a</sup>	Leaves, fruit	Juice, decoction	Drink
<i>Moringa oleifera</i> Lam.	Root	Paste	Cataplasm
<i>Ocimum</i> sp.	Leaves	Paste	Massage
<i>Physalis angulata</i> L.	Whole plant	Decoction	Drink
<i>Psidium guajava</i> L.	Leaves	Boil	Bath
<i>Ruta graveolens</i> L.	Leaves	Paste	Massage
<i>Strychnos ligustrina</i> Blume <sup>a</sup>	Wood, stem bark	Decoction, infusion	Drink
<i>Tamarindus indica</i> L.	Leaves	Boil	Bath

<sup>a</sup> Note: Plants indicated with this letter are used for both prevention and treatment of malaria, while the others are only for treatment.

combination is considered to provide a better and faster healing effect.

### 3.3. Plants used for prevention and treatment of malaria

We recorded a total of 96 species of plants used by Tetun people in their various recipes for prevention and treatment of malaria.<sup>19</sup> Some plants of high frequency of citation are listed in Table 3. Bitter plants such as *Carica papaya*, *Momordica charantia*, *Melia azedarach*, *Alstonia scholaris*, *Alstonia spectabilis* and *Strychnos ligustrina* are well-known medicinal plants for Tetun people, used in drinking formula for both prevention and treatment of malaria. Tetun people believe that consumption of bitter food or drink (for example decoction of flowers, leaves and young fruit of *C. papaya* or young fruit of *M. charantia*) can prevent someone from malaria attacks. Some informants also believed that drinking *tua moruk* – a traditional drink made by soaking the stem bark of *A. scholaris*, *A. spectabilis* or *S. ligustrina* in the fresh tapped palm sap – is effective in preventing someone from malaria attack. Tetun people believe that bitter plants have antimalarial property because of their opposite taste to sweet foods and drinks those are considered the main cause of malaria. Therefore, plants with very bitter taste such as *S. ligustrina*, *C. papaya*, *A. scholaris* and *M. charantia* are considered good antimalarials.

In the treatment of malaria, *Garuga floribunda*, *Jatropha curcas*, *Acorus calamus*, *Allium cepa*, *Drynaria quercifolia*, *Ocimum* sp. and *Ruta graveolens* were common for massage use. *Tamarindus indica*, *Psidium guajava*, *Melicope latifolia* and *Blumea balsamifera* were widely used for bathing. *Brucea javanica*, *Annona muricata* and *Annona reticulata* were often boiled in water to produce vapor for inhalation treatment. Pastes of *Moringa oleifera* root and *Ficus hispida* leaves were used as cataplasm to reduce the swollen spleen.

Some plants used in the treatment of malaria were classified as cold or hot plants. *J. curcas*, *G. floribunda*, *Calotropis gigantea*, *Cleome rutidosperma*, *T. indica*, *D. quercifolia*, *Crimum asiaticum* and *F. hispida* are some of cold plants, while *A. calamus*, *A. cepa*, *R. graveolens*, *Ocimum* sp., *M. latifolia*, and *B. balsamifera* are considered hot plants. People assumed that cold plant can absorb excess heat from the

body so that temperature of the body decrease to normal again; while hot plant increase body temperature and stimulate the body to produce sweat, so after that, temperature of the body decrease to normal again.

In the practice of traditional treatment of malaria, recovery status of patient is determined only by assessing the patient's clinical/physical changes. If a patient has not fever and shivering anymore, the swelling of the spleen has subsided, and the appetite has improved, then the patient is declared to have recovered; especially if the patient is able to get up and move and work without feeling any discomfort. The traditional healers believed that medicinal plants they recommended have the effect of curing malaria, although for this claim, no laboratory test had been conducted to prove it.

## 4. Discussion

In the local concept of Tetun people, the causes of malaria are naturalistic things, not personalistic.<sup>20</sup> Factors such as sweet foods, cold rain/water, hot sun, fatigue, the presence of other disease in the body are naturalistic properties that cause heat–cold balance in the human body to be disrupted, and then cause malaria. Many Tetun people do not consider mosquito as carrier of malaria, causing them to have low awareness of the threat of mosquitoes. This may be one of the causes of the still high endemic of malaria in Belu and Malaka until this time.<sup>21</sup>

In modern understanding, local concept about the causes of malaria according to Tetun people is incorrect. But some scientific reviews may justify the prevention and treatment of malaria they have done based on their local concept. For example, the metabolism of glucose derived from sweet foods produces energy for cells, including *Plasmodium*,<sup>22</sup> so, eating lots of sweet foods is thought to cause a person becomes more susceptible to malaria, or aggravate the disease in an infected person.<sup>23</sup> Therefore, based on this scientific explanation, although sweet food is indeed not a cause of malaria, but it can be accepted as one of the factors that contribute to increasing susceptibility to malaria attacks. Another example, Tetun ethnic people considered long time in



cold or watery place as factors triggering malaria. In scientific view, watery areas such as rice fields and ponds the main habitat for malaria mosquitoes, *Anopheles*.<sup>22</sup> Therefore, long working in such areas causes a high frequency of contact between human and mosquitoes; people are bitten more often by mosquitoes. This will greatly facilitate someone suffering from malaria. In modern explanation, factors as long working in cold place, long time under the hot sun, fatigue and the presence of other diseases in the body can cause decreasing of the immunity, thus, the person becomes more susceptible to attack of diseases.<sup>24</sup>

Traditional treatment of malaria in ethnomedicine of Tetun ethnic people consists of a set of simple treatment methods that are primarily intended to treat fever. The implementation of various methods of treatment is based on the belief that these methods can help the body to maintain or to restore the hot–cold balance that is disturbed due to the influence of naturalistic factors that originate from the environment. It seems that Tetun ethnic people also adheres to the theory of cold-hot balance as in the Yin-Yang theory in Traditional Chinese Medicine.<sup>25</sup>

Tetun people classifies plants especially those used for massage and bathing as cold and hot plants. Plants that work by absorbing excess heat from the body of malaria sufferers are said to be cold, while the others that work to reduce heat by forcing the body to produce sweat are said to be hot. Cold plants such as *D. quercifolia* and *C. asiaticum* generally have high water content in their tubers, so they are quite effective as head absorber. On the other hand, hot plants such as *Acorus calamaus*, *R. graveolens* and *Ocimum* sp. are generally contain essential oils that have a hot or spicy taste. Some constituents of essential oils such as linalool, methyl cavicol, thymol, eugenol, ocimen, limonen, geraniol, cineol, estragol and caryophyllene from *Ocimum* sp. are known to have various pharmacological activities, including antimalarial activity.<sup>26</sup>

The results of this research showed that Tetun people believed that bitter-tasted plants such as *S. ligustrina*, *A. scholaris*, *A. spectabilis*, *C. papaya*, *M. charantia* and *Melia azedarach* are good for prevention and treatment of malaria. Several studies have reported that these plants contain a lot of bitter alkaloid compounds. These alkaloids together with other natural compounds from groups of flavonoids, terpenoids, coumarins, quassinoids, etc. has been shown to show various pharmacological activities related to malaria, i.e., antiplasmodial, antipyretic, analgesic, antiinflammatory and immunostimulant.<sup>27–37</sup> From other publications on antimalarial plants in Indonesia, it was found that several plants used by Tetun ethnic people in the treatment of malaria were also used for the same purpose by people in some other regions in Indonesia. For example, *A. scholaris*, *B. balsamifera*, *B. javanica*, *C. papaya*, *Andrographis paniculata*, *A. muricata*, *Morinda citrifolia*, *M. charantia*, *Phyllanthus niruri*, *P. guajava*, *S. ligustrina* and *Swietenia macrophylla* are also used as antimalarials by traditional people in Java and Sumatra.<sup>32,38</sup> However, the use of *C. rutidosperma*, *Physalis angulata* and *Fatoua pilosa* in the treatment of malaria did not appear to exist in other ethnic groups in Indonesia. Similarly, it has not even found any reports about usage of *Neosomitra podagrifolia* as traditional antimalarial anywhere.

The overall results of the research and discussion above can be summarized as follows: The practice of ethnomedicine for the prevention and treatment of malaria by Tetun ethnic people is an implementation of the philosophy which was compiled by their ancestors regarding malaria. Various methods of prevention and treatment of malaria were developed to maintain or to restore the hot–cold balance in the body. Many of the plants used in the traditional prevention and treatment of malaria by Tetun ethnic people have been scientifically proven to have pharmacological activities related to malaria, i.e., antiplasmodial, antipyretic, analgesic, anti-inflammatory or immunostimulant.

In conclusion, a long time interaction between some previous generations of Tetun ethnic people and malaria have encouraged this community to formulate concepts as their philosophy or local knowledge about the disease. This local knowledge was then becomes a guidance for them to establish strategies for prevention and treatment of malaria. The results of this study also indicate that ethnomedicine is a scientific truth. The results of this study showed that the practice of ethnomedicine of an ethnic group is scientifically proven, although it is built on a concept that was totally different or even contrary to the true etiology of the disease.

### Conflict of interest

The authors declare no conflict of interests.

### Funding

Research and Community Service, Ministry of Research, Technology and Higher Education, Republic of Indonesia (Research Contract No. 0668/K8/KM/2018).

### Ethical statement

To guarantee the ethics and legality of human involvement in this study, all field research designs have been approved by the Government of the Province of East Nusa Tenggara (No. 070/535/DPM-PTSP/2017 and No. 070/535/DPM-PTSP/2017, dated February 28, 2017), the Government of Malaka District (No. 070/150/IV/2017, dated March 3, 2017) and the Government of Belu District (No. BKBK-070/75/III/2017, dated March 29, 2017).

### Data availability

The data of this article is available for free download at <https://doi.org/10.13140/RG.2.2.14822.06724>.

### Acknowledgement

We are very grateful to all the informants who shared their valuable knowledge with us. Thank you to the Directorate of Research and Community Service, Ministry of Research, Technology and Higher Education, Republic of Indonesia for financial support with Research Contract No. 0668/K8/KM/2018. We also thank to the government of Malaka and Belu districts who have given permission to conduct this research in these areas.

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