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# Ethnomedicine study of medicinal plants as malaria treatments in Moi Tribe, Southwest Papua, Indonesia

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**Abstract.** *Hutami AT, Ekasari W, Rudyanto M. 2025. Ethnomedicine study of medicinal plants as malaria treatments in Moi Tribe, Southwest Papua, Indonesia. Biodiversitas 26: 1124-1134.* Moi Tribe is the indigenous tribe in Sorong District and Raja Ampat of the Southwest Papua Province, Indonesia, that still holds onto their traditional value, including maintaining their health. Living in the eastern part of Indonesia, where malaria is still prevalent, the Moi Tribe still use the traditional method to treat their illness using medicinal herbs according to the knowledge that has been passed down from their ancestor. Ethnomedicine is a study of the perception and conception of a local tribe in order to understand health, or a study to investigate the traditional medical system of a tribal community. The purpose of this study was to gain information on the use of natural products by the Moi Tribe community in Kampung Malaumkarta, Sorong District to treat malaria. The qualitative research method was employed, with in-depth interviews, purposive, and snowball sampling. The inclusion and exclusion criteria qualified 30 people as informants. The study's results indicate that, depending on the route of administration, 10 single concoctions are administered orally, while two plants are administered topically. Based on the number of citations, the most widely used traditional antimalaria plants are the stems of *tali kuning* (*Arcangelisia flava*) with 0.96 RFC (Relative Frequency of Citation) index, papaya leaf (*Carica papaya*) with 0.7 RFC, and leaf of *Orthosiphon aristatus* with 0.26 RFC. The most common mode of preparation of the herbal medicines is to boil them in two glasses of water, strain them, and drink the decoction. They usually consume a glass of the concoction twice a day until the condition improves, which typically takes two days. The topical treatments include the use of itchy leaves (*Laportea decumana*) that are rubbed onto the body part that feels sore, leaf of *Premna serratifolia* is rubbed on the forehead to relieve headaches. Most of the plants that are used by the tribe have been shown to have various pharmacological effects.

**Keywords:** Ethnomedicine, malaria, medicinal plants, Moi Tribe

## INTRODUCTION

Malaria is spread to people by the bite of a female *Anopheles* mosquito. It is caused by protozoan parasites of the genus *Plasmodium*, which include *Plasmodium falciparum, P. vivax, P. ovale, P. malariae,* and *P. knowlesi* (Dagen 2020). Efforts to control malaria, including prevention, diagnosis, and treatment have been widely carried out. However, the morbidity and mortality rates of malaria in several countries are still high. Malaria treatment was initially carried out using quinine, chloroquine, artemisinin, and its derivatives. However, after reports of resistance, malaria treatment was no longer given as a single drug but rather in combination, namely through Artemisinin-based Combination Therapy (ACT) (WHO 2023). The existence of resistance to first-line antimalarial drugs and the unsuccessful efforts to find an ideal malaria vaccine make it necessary to find an effective antimalarial drug. Efforts to find an effective antimalarial drug can be carried out through ethnomedicine studies. As unexplored natural resources, traditional knowledge of folk and ethnomedicine combined with modern technologies in screening, separation, and synthesis could be integrated to discover new drugs (Singh et al. 2020). The importance of ethnomedicine studies in the search for antimalarial drugs has been proven. Natural products have been utilized in traditional medicine for thousands of years and have played a significant role in shaping modern medical treatments (Pandey et al. 2023). Studies were conducted with phytochemical analyses and preclinical and clinical trials upon the discovery of quinine compounds from the Cinchona plant, which was used by traditional Peruvian communities in the 19th century (Dagen 2020). The quinine compounds from Chincona became a template for the synthesis of chloroquine and other aminoquinoline compounds, which are very effective antimalarial drugs. *Artemisia annua* is a Chinese herb, that is a traditional source of artemisinin and its derivatives, which become the major component of first line antimalarial treatment, the ACTs (Artemisinin-based Combination Therapies) (Soni et al. 2022).

Indonesia, in Southeast Asia, has a remarkable biodiversity of medicinal plants and diverse ethnic groups (Bhagawan et al. 2024). It is estimated that there is significant local wisdom of traditional communities related to the prevention and treatment of malaria that has not been explored, especially in malaria-endemic areas in Eastern Indonesia. The Moi Tribe is one of the tribes inhabiting the Southwest Papua Province (Sorong City, South Sorong and Raja

Ampat Regencies), which still depends on biological resources, such as forests and seas, in their life (Suaib 2017). Papua and West Papua, which has been expanded into six provinces in 2022 (West Papua, Papua, Southwest Papua, South Papua, Central Papua, and Highlands Papua) contribute to almost 94% of national malaria cases in Indonesia (Ministry of Health of the Republic of Indonesia 2022). The malaria morbidity rate is described by the Annual Parasite Incidence (API) indicator per 1,000 population, which is the proportion of positive malaria patients to the population at risk in the area with a constant of 1,000. In Sorong District, the malaria API in 2023 was recorded at 9.9% from the data collected from the Public Health Office of Sorong District in October 2024.

The Moi community in Malaumkarta Village, Sorong District, still lives based on customs. Moi people have a specific custom to take care of the forest, as the forest is their source of living. They only use non-timber forest products for subsistence and commercial purposes, such as sago (*Metroxylon sagu*), medicinal plants, vegetables, spices, and wild animals for food needs, such as wild boar and deer. The close relationship between the people and their forest minimizes the need for modern medicine, as they believe that the forest provides everything they need to live (Anna 2016). In order to keep their traditional value, they have a traditional *Kambik* education system, which regulates the social system of Moi Tribe such as marital system, division of property system, *hak ulayat* (customary right of land), agricultural system, healthcare system and clan system (Yuliana 2018). The knowledge of indigenous people regarding medicinal ingredients and treatment methods is greatly influenced by the types of diseases that often occur in their lives (Taek et al. 2018). Therefore, it can be assumed that the Moi people have long developed their own local concept of malaria and how to treat this disease. Exploration of the concept and practice of ethnomedicine of the Moi people is expected to produce knowledge about how the traditional Moi people defend themselves from malaria, so that it can be used scientifically as a strategy to support malaria eradication efforts and is expected to obtain candidate plants to be further developed as candidate antimalarial drugs.

## MATERIALS AND METHODS

### Study area

The Sorong District is located in the Province of Southwest Papua, Indonesia, with a geographical location of 1.1°S 131.51667°E. This district has an area of 13,075.28 km$^2$ and directly borders Raja Ampat District to the north, Sorong City to the west, South Sorong District to the south, and Tambrauw District and Maybrat District to the east. Sorong District consists of 30 districts and 226 villages. Malaumkarta Village, located in Makbon Sub-district, Sorong District, Indonesia has a population of 319 people and an area of 49.29 km$^2$ (BPS Kabupaten Sorong 2023; Sambo et al. 2024). This village is located on the coast of Malaumkarta with a distance of about 40 km from Sorong City. The majority of the population of Malaumkarta Village is the Moi Tribe, which is Protestant Christian.

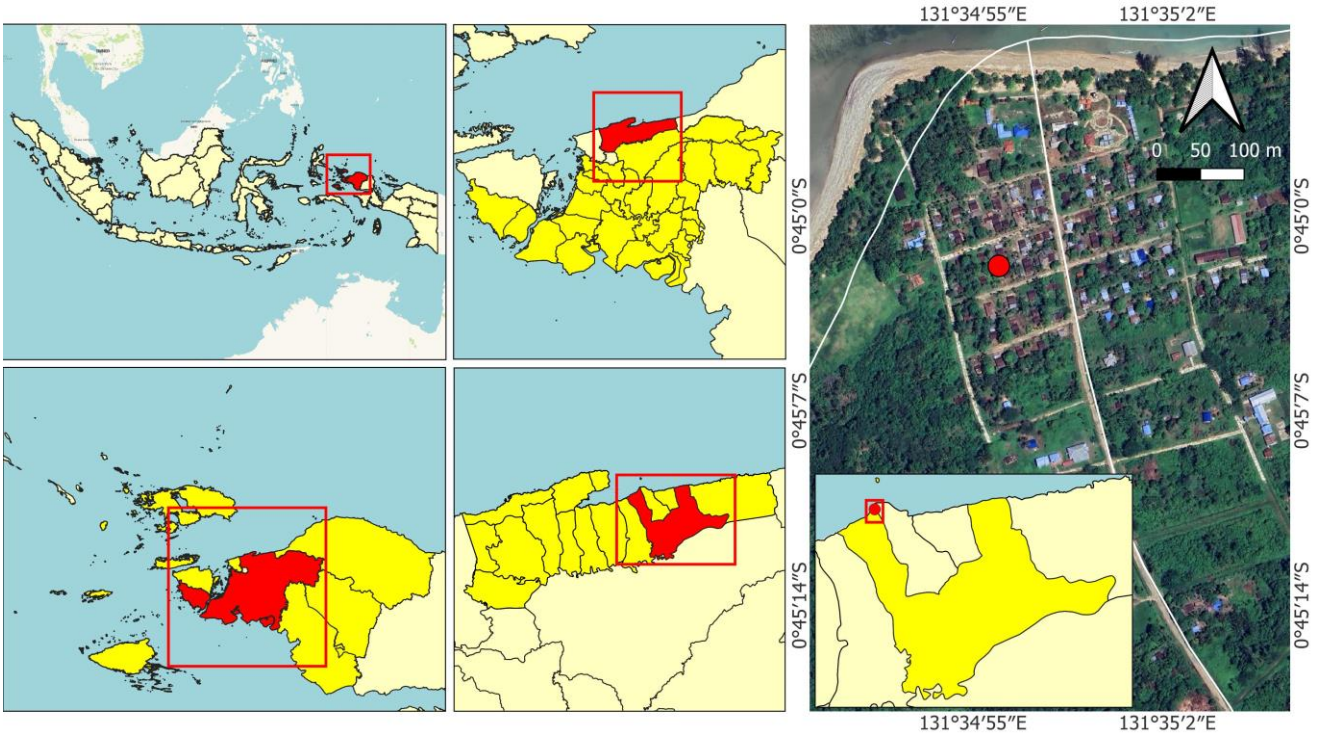


**Figure 1.** Location of the Moi Tribe in Malaumkarta Raya Village, Makbon Sub-district, Sorong District, Southwest Papua, Indonesia

**Data collection**

This research used qualitative design with purposive and snowball sampling methods to select informants. The purposive method uses several specific considerations according to the desired criteria to determine the informants to be interviewed, while the snowball method is a sample determination that starts with an informant obtained from the purposive sampling who then recommends the next informant and so on, until the number of informants collected is enough. This research has passed the ethical clearance on humans, with certificate number DP.04.03/ F.LIII.13.a./093/2024 from the Ministry of Health's Health Polytechnic of Sorong. The interviews were conducted with the people who are part of the Moi Tribe community in Kampung Malaumkarta, Sorong District, who meet the inclusion and exclusion criteria. Inclusion criteria include informants who are indigenous Moi people who have lived >5 years in Kampung Malaumkarta, are at least 18 years old, have used herbal traditional medicine to treat malaria. The exclusion criteria included informants who have cognitive disorders, have trouble in communicating, and are not willing to be interviewed.

The interviews aim to collect information from the informants, such as demographic data, the concept of health and illness, the knowledge of malaria, the prevention method of malaria, and the traditional herbal medicine to treat malaria. The demographic data encompasses factors such as age, gender, previous education, occupation, and the ethnic origin of the family. The concept of health and illness determines how a community understands, interprets, and manages disease and health based on their knowledge and traditional practices (Susanti 2023). The questions about traditional herbal medicine data cover the knowledge and practices of the Moi Tribe on traditional malaria cures including information on the local name of the plant, the plant part that is used to treat malaria, the mode of preparation and administration, dosage, and duration.

The data collection of plant specimens during the ethnomedicine exploration was assisted by the local healer. The plant specimens were photographed as a whole and in parts. Based on the field observations, interviews, and discussions with informants, the collected plant samples were identified. At first, we used a service from PlantNet (https://identify.plantnet.org/) and Plant of the World Online (https://powo.science.kew.org/) to identify the species, family, spelling, and family classification. We then used available services from UPT Laboratorium Herbal *Materia Medica Batu* to legally determine the species.

**Data analysis**

Ethnomedicinal data on the Moi Tribe's local idea of the malaria treatment system obtained from observations, field notes, and interviews were analyzed carefully and described in a table. Analysis of the number of plants used in the Moi Tribe's malaria potion was calculated as the Relative Frequency Citation (RFC) Index, because this research seeking ethnomedicinal information on one particular disease, thus the analysis was done without considering the use-category. The RFC formula is as follows (Tardío and Pardo-De-Santayana 2008):

$$RFC = \frac{FC}{N}$$

Where:
RFC : Relative Frequency of Citation
FC : Number of informants that cite the species' usage
N : Number of all informants

The RFC index, is obtained by dividing the number of informants who mention the use of the species (frequency of citation) by the number of informants that participated in this study (N). RFC values range from 0 (when no participant mentions a plant as being beneficial) to 1 when all the participants mention it as useful.

## RESULTS AND DISCUSSIONS

**Demographical data**

Thirty native people of the Moi Tribe from Malaumkarta Village, Makbon Sub-district, Sorong District, Southwest Papua Province, Indonesia who met the criteria to be informants, were interviewed to obtain ethnomedicinal data on how to treat malaria, which is shown in Table 1. Of the 30 respondents, 29 are users of traditional medicine, and one person is a traditional healer who has received *Kambik* traditional education. The user of traditional medicine obtained their knowledge from family tradition, and experience while being treated with traditional medicine and observing the practice from traditional healer. Informants consisted of more women, which shows the role of women in maintaining family health. Their main profession is farmer, which has close relationship to the nature and often fulfill their daily needs from natural source surround them. Most of the informants were in the 50-69 years age category and had empirical experience in using traditional herbal remedies.

**Table 1.** Demographical data

| Category | Sub-category | Number of informants | Percentage |
|---|---|---|---|
| Ethnic group | Moi Tribe | 30 | 100% |
| Village | Malaumkarta Raya | 30 | 100% |
| Gender | Male | 7 | 23..3% |
| | Female | 23 | 76..7% |
| Age | >60 years old | 14 | 46..6% |
| | 50-59 years old | 5 | 16..7% |
| | 40-49 years old | 5 | 16..7% |
| | 30-39 years old | 3 | 10% |
| | 20-29 years old | 3 | 10% |
| Education | Bachelor's degree | 2 | 6..7% |
| | High School | 5 | 16..7% |
| | Junior High School | 6 | 20% |
| | Elementary School | 17 | 56..6% |
| Occupation | Traditional healer | 1 | 3.3% |
| | Farmers | 17 | 56..7% |
| | Housewife | 8 | 26..7% |
| | Civil servants | 3 | 10% |
| | College students | 1 | 3..3% |

**Local concepts of Moi Tribe about malaria**

The Moi Tribe community in Malaumkarta Village has its own concept of malaria based on their knowledge, which has been passed down through generations. From Table 1, all respondents in the study are indigenous Moi people with 46.6% being over 60 years old, the majority being women (76.7%), and most having completed only elementary school (56.6%). As a result, their concept of health and illness tends to be simple. According to their view, the causes of malaria are mainly naturalistic, not personalistic. Some natural factors include bad weather, fatigue, eating less, lack of activity, and a dirty environment, which are naturalistic properties that cause the heat-cold balance in the human body to be unbalanced and make malaria infect the body (Taek et al. 2019). Apart from the naturalistic factors, some of the members of Moi Tribe community have also acknowledged that mosquito bites can spread malaria. Symptoms of malaria according to the Moi Tribe include: fever (96%), chills (18%), body pain or back pain/bone pain (51%), and chills/cold (88%). The percentage exceeds 100% because the respondents often cited more than one symptom of malaria, as this percentage is based on the citation and the number of respondents. Respondents did not know that an enlarged spleen is also a sign of severe malaria. In general, almost all respondents said that malaria is a common and harmless disease, except for tertian and tropical malaria. This local understanding greatly influences the community's perception of malaria and causes a decrease in awareness of malaria and seriousness of dealing with this disease. Based on Foster's dichotomy on the causes of disease, the cause of malaria according to the Moi people in Malaumkarta village is naturalistic and not personalistic. Factors such as fatigue, cold weather, and exposure to rain are naturalistic causes that disrupt the hot-cold balance in the human body and cause someone to get malaria.

Malaria prevention carried out by the community includes using itchy leaves when signs of feeling unwell arise (16%), staying at home during cold weather spells and at night (33%), using mosquito nets (50%), and using mosquito repellent (16%). The percentage exceeds 100% because the respondents often cited more than one way to prevent malaria, as this percentage based on the citation and the number respondents. According to the community, in ancient times when people still lived in stilt houses, to avoid mosquitoes and warm their homes, people burned twigs and dry leaves under the house to repel pests and make the house warmer. According to the community, malaria is still a feared disease, especially in cases of tertian malaria, or malaria that attacks the brain. Meanwhile, people are not worried about milder case of malaria because there are health services available. The Moi Tribe's ways to prevent malaria are effective, as most of them are meant to avoid mosquito bites that can spread malaria.

**Medicinal plants for malaria treatments of Moi Tribe in Malaumkarta Village**

Table 2 shows the herbs and medicinal plants used to relieve malaria symptoms by the Moi Tribe in Malaumkarta Village. A total of eight single herbal plant concoctions are used orally and two plants topically. The plants most widely used by the community are the stems of *tali kuning* (*Arcangelisia flava*) and papaya leaf (*Carica papaya*), and all ten plants are from different families, as shown in Table 2. These findings are in line with the finding of 2017 RISTOJA (Research on Medicinal Plants and Herbal Medicine), which stated that the five plants that are widely used in the treatment of malaria in Papua island are *Alstonia scholaris* (leaf and bark), *C. papaya* leaf, *Andrographis paniculata*, and *Physalis minima* (Budiarti et al. 2020). However, there are slight difference with the RISTOJA finding, where the Moi people used *A. flava* as the common option of malaria treatment, along with the use of some other medicinal plants. The usage of bitter plants is common in the medication of malaria, such as the stems of *A. flava, C. papaya* leaf, *A. paniculata* leaf, and *A. scholaris* bark. The Moi people believe that the consumption of bitter food and drink, such as stir-fried papaya leaves and water boiled with the stems of *A. flava*, can prevent someone from catching malaria. All of the plants are used as single formulations because they believe that combining medicinal herbs can disrupt the desired effects.

As shown in Figure 1, the areas of the plants most used to cure malaria by the Moi Tribe are the leaf (67%), followed by trunk bark (25%), and trunk (8%). The plant part used by the Moi community is mostly leaf, as it is the easiest plant part to take and utilize. The leaf also has a more diverse secondary metabolite content, is easier to harvest, and the plants can regrow leaves more quickly than the other parts. Therefore, considerable harvesting of the leaves has little to no impact on plant death (Nugroho et al. 2022).

From the results of interviews with 30 respondents, it was found that there were ten plants used for malaria treatment by the Moi Tribe in Malaumkarta Village, which can be found in Table 2. Most of the plants were boiled, and the stew was drunk. Because the taste of the boiled bark and leaves is bitter, people recommend drinking it while it is hot to reduce the bitter taste. For the use of *A. flava* stems, the respondents said that the stems can be boiled again as medicine if the boiled water is still yellow-colored.

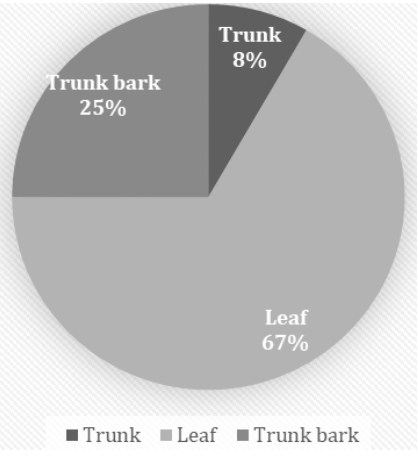


**Figure 1.** Plant parts that are used as herbal medicine to treat malaria by the Moi Tribe in Malaumkarta Village, Sorong District, Southwest Papua Province, Indonesia

**Table 2.** Medicinal plants used to treat malaria by the informants of the Moi Tribe in Malaumkarta Village, Sorong District, Southwest Papua Province, Indonesia

| Botanical name [Family] | Voucher No. | Vernacular name | RFC | Part used | Mode of preparation | Mode of administration |
|---|---|---|---|---|---|---|
| *Arcangelisia flava* (L.) Merr. [Menispermaceae] | SOQ-2401 | *Tali kuning* | 0.96 | Trunk | 2 pieces of the plant's trunk are crushed coarsely, and then boiled with 2 glasses of water, until the water is reduced by half. Strain and drink while it's hot | Drink 1 glass of the stew, twice a day until the condition improves. Usually, it takes 2 days |
| *Carica papaya* L. [Caricaceae] | SOQ-2402 | *Pepaya* | 0.7 | Leaf | 2 fresh leaves boiled with 1 glass of water and then strained | Drink 1 glass of the stew, twice a day until the condition improves, usually, it takes 2 days |
| *Orthosiphon aristatus* (Blume) Miq. [Lamiaceae] | SOQ-2403 | *Kumis kucing* | 0.26 | Leaf | 7 fresh leaves are boiled with 1 glass of water and then strained | Drink 1 glass of the stew, once a day until the condition improves. Usually it takes 2 days |
| *Andrographis paniculata* (Burm.fil.) Nees [Acanthaceae] | SOQ-2404 | *Sambiloto* | 0.10 | Leaf | One handful of fresh leaves boiled with a bowl of water and then strained | Drink 1 bowl of the stew, twice a day until the condition improves. Usually it takes 2 days |
| *Laportea decumana* (Roxb.) Wedd. [Urticaceae] | SOQ-2405 | *Daun gatal* | 0.16 | Leaf | 2-3 fresh leaves are rubbed onto the back or stomach | Once or twice a day, the leaves are used for rubbing or gentle massaging, until the condition improves |
| *Ipomoea pes-caprae* (L.) R. Br. [Convolvulaceae] | SOQ-2406 | *Kastroli* | 0.10 | Leaf | One handful of fresh leaves boiled with a bowl of water and then strained | Drink 1 bowl of the stew, twice a day until the condition improves. Usually it takes 2 days |
| *Premna serratifolia* L. [Lamiaceae] | SOQ-2407 | *Kigainas* | 0.06 | Leaf | 2-3 fresh leaves are rubbed or gently massaged on the forehead | Once or twice a day, the leaves are used for gentle massaging, until the condition improves |
| *Alstonia scholaris* (L.) R.Br. [Apocynaceae] | SOQ-2408 | *Kayu susu* | 0.03 | Trunk bark | One handful of the trunk bark scraped from the tree is squeezed with some water (not too much), until some juice is obtained to drink. | Drink half a glass, once a day for 1-2 days |
| *Syzygium malaccense* (L.) Merr. & L.M.Perry [Myrtaceae] | SOQ-2409 | *Jambu bol* | 0.03 | Trunk bark | One handful of the trunk bark scraped from the tree is squeezed with some water (not too much), until some juice is obtained to drink | Drink half a glass, once a day for 1-2 days |
| *Ficus septica* Burm.fil. [Moraceae] | SOQ-2410 | *Baulas* | 0.03 | Leaf | 2 fresh leaves boiled with 1 glass of water and then strained. | Drink 1 glass of the stew, twice a day until the condition improves. Usually it takes 2 days |

The medicinal plants mentioned by the Moi Tribe, have diverse phytochemical contents and bioactivity as shown in Table 3. *A. flava*, *C. papaya*, *A. paniculata*, *Alstonia scholaris*, and *F. septica*, have been found to have antimalarial activity in scientific publications (Mishra et al. 2009; Kubo et al. 2016; Hapsari et al. 2019; Reddy et al. 2019; Teng et al. 2019), while scientific publications for other plants regarding their antimalarial activity have not been found (La Basy et al. 2022; Tadesse and Wubneh 2017). However, these plants still have other bioactivities that help relieve malaria symptoms, such as antipyretic, analgesic, and anti-inflammatory.

The use of plants as external medicine is the itchy leaf (*Laportea decumana*) used for external medicine, mainly to relieve fatigue and aches and the leaf of *Premna serratifolia* (Figure 2.B) specifically used to relieve headaches. Itchy leaves do not seem to be antimalarial but are used to relieve malaria symptoms such as pain or aches. Itchy leaves are important plants for the Moi Tribe, they are inseparable 'provisions' when working in the garden, or traveling to the forest. *Laportea* spp. is widespread in the islands of Maluku and Papua, and is part of the Urticaceae family. Itchy leaves are widely sold in traditional markets and are recorded as being used traditionally to reduce pain, fatigue, headaches, stomachaches, and muscle pain (La Basy et al. 2022). The leaves of *P. serratifolia* are also used as an external medicine for malaria by the Moi Tribe. They are rubbed onto the forehead, to relieve headaches. In scientific publications, *Premna integrifolia* (synonymous with *Premna serratifolia* and *Premna obtusifolia*), is known as Aginimantha in the traditional Indian medicine system (Ayurveda) or Headache Tree (Mali 2016). The pharmacological activities of *Premna integrifolia* that have been reported include analgesic, antinociceptive, anti-arthritis, antibacterial, anticancer/antitumor, antioxidant, anti-inflammatory, antimicrobial, hypolipidemic, gastro-protective, and immunomodulatory activities (Mali 2016). An in vivo antimalarial test using a mouse model infected with *Plasmodium berghei* on *Premna oligotricha* leaf extract showed that there was parasitemia suppression

higher than 30% at a dose of 350 mg/kg; a compound with parasitemia suppression greater than 30% is categorized as an active antimalarial compound (Seyfe et al. 2017).

The stems of *A. flava* are a mainstay medicine for the Moi people to treat malaria, and one respondent also mentioned the use of *A. flava* as an antidiarrheal treatment. It is said that by drinking boiled stems of *A. flava* 2-3 times a day, fever due to malaria will immediately go down. *A. flava* abatement can be used fresh or dry. Drying of *A. flava* stems is done by cleaning the stems from their bark, cutting and splitting it 1 span of finger long (20 cm), after which they are dried in the sun. Water extract from *A. flava* stems has in vitro antimalarial activity with an $IC_{50}$ value of 601 ppm, while chloroquine sulfate as a positive control has activity with an $IC_{50}$ value of 916.64 ppm. It is known from the results of characterization using FTIR and GC-MS there is an active compound stigmastan (Hapsari et al. 2019).

Papaya (*C. papaya*), a plant that is widely used as a traditional medicine for malaria in Indonesia, is known to contain alkaloids, flavonoids, saponins, tannins, quinones, steroids, and triterpenes and has in vitro antimalarial activity with an $IC_{50}$ value of 0.1770 µg/mL (Abdillah et al. 2015). Papaya leaf extract has been used to treat various illnesses, such as dengue, fever, asthma, colic, beriberi and jaundice. In traditional medicine, *C. papaya* has been used as a therapeutic agent due its wound healing, anti-cancer, hypolipidemic and hypoglycemic properties (Ugbogu et al. 2023). In China, the leaves, fruits and seeds of C. papaya are used to treat stomach pains, bacterial infections, and inflammations (Zhang et al. 2022).

The leaves of *Ipomoea pes-caprae* are used as a malaria medicine by the Moi Tribe by boiling 1 handful of leaves and stems and drinking 1 glass twice a day for two days. *I. pes-caprae* (Convolvulaceae) is a halophyte plant that grows in many coastal areas in tropical and subtropical regions in Asia, America, Africa, and Australia. Traditionally, *I. pes-caprae* is widely used for medicinal purposes, such as by Australian Aborigines who use it to treat wounds, skin infections, and inflammatory pain and to overcome stings from poisonous fish, stingrays, and insects (Akinniyi et al. 2022). In India, it is widely used for bathing rituals to ward off evil spirits (Manigauha et al. 2015) and in Brazil, it is used as a traditional medicine to overcome inflammation, gastrointestinal disorders, and pain (Akinniyi et al. 2022). In an in vitro antimalarial screening, the methanol extract of *I. pes-caprae* roots has an $IC_{50}$ value of 15 µg/mL against *Plasmodium falciparum* strain 3D7 (Pothula and Kanikaram 2015).

Scrapes of *Alstonia scholaris*'s bark and *Syzygiym malaccense*'s bark are consumed by kneading them with a little water and then drinking the juice. *A. scholaris* is a plant known to have antimalarial activity and is widely used traditionally. The in vivo antimalarial activity of *A. scholaris* stems showed a decrease in parasitemia depending on the dose, namely 59% (200 mg), 66% (400 mg), and 95% (600 mg). Phytochemical screening results showed that *A. scholaris* stems contain alkaloids, saponins, phenolics, tannins, flavonoids, and terpenoids (Reddy et al. 2019). The chloroform extract of *Andrographis panniculata* has an in vitro antimalarial activity with $IC_{50}$ value of 6.36 µg/mL against 3D7 strain and 5.24 µg/mL against the K1 strain of *P. falciparum* (Dwivedi et al. 2021).

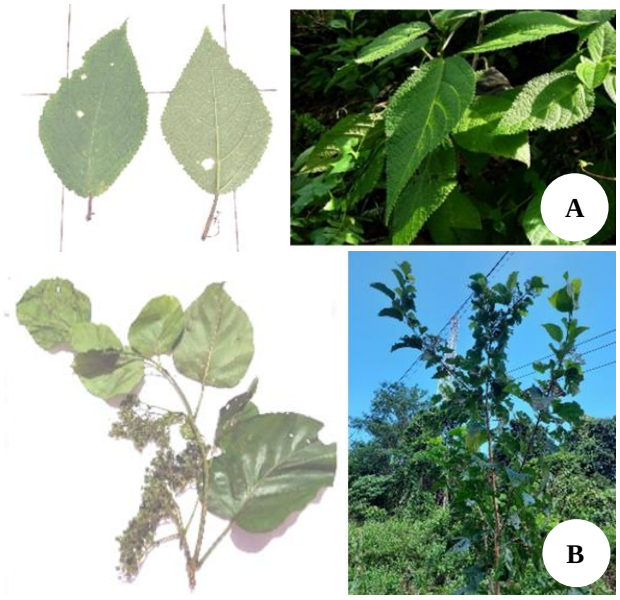


**Figure 2.** A. *Laportea decumana*; B. *Premna serratifolia*


**Figure 3.** A. *Arcangelisia flava*; B. *Syzygium malaccense*


**Figure 4.** A. *Ipomoea pes-caprae*; B. *Ficus septica*

**Table 3.** Phytochemicals constituents and bioactivity of medicinal plants used as malaria remedies by the Moi Tribe, Sorong District, Southwest Papua Province, Indonesia

| Botanical name [Family] | Vernacular name | Part | Phytochemicals | Antimalarial activity | Other bioactivity |
|---|---|---|---|---|---|
| *Arcangelisia flava* (L.) Merr. [Menispermaceae] | *Tali kuning* | Stems | Isopycnarrhine, pycnarrhine, sinapic acid, sinapaldehyde, pallidinine, 3-hydroxy-3',4',5'-trimethoxyflavone, demethyleneberberine, stepharanine, fibleucin, jatrorrhizine, berberine, docosanoid acid, N-methyltetrahydropalmatine, fissisaine, palmatine (Pratama et al. 2023) | Water extract of *A. flava* stems has $IC_{50}$ of 601 ppm (Hapsari et al. 2019). | Antibacterial, antioxidant (Maryani et al. 2013), anticancer (Keawpradub et al. 2005), cytotoxicity against WiDr colorectal cancer cells (Mutiah et al. 2020). |
| *Carica papaya* L. [Caricaceae] | *Pepaya* | Leaf | Carpaine, kaempferol 3-(2g-glucosylrutinoside), kaempferol 3-2('-rhamnosylgalactoside), kaempferol 3-rhamnosyl-1(1->2)galactose-7-rhamnoside, luteolin 7-galactosyl-(1->6)-galactoside, orientin 7-O-rhamnoside, 11-hydroxyperoxy-12,13-epoxy-9-octadecenoic acid, palmitic amide and 2-hexaprenyl-6-methoxyphenol (Soib et al. 2020) | Hexane extract of *C. papaya* leaves has $IC_{50}$ of 3,43 ± 0.41 and 1.52 ± 0,003 µg/mL against 3D7 and Dd2 strains respectively (Teng et al. 2019). Carpaine from dicloromethane leaf extract of *C. papaya* is active against 3D7 and DD2 strains with $IC_{50}$ values of 4.21 µM and 4.57 µM respectively (Teng et al. 2019). | Anti-hypertensive, antibacterial, diuretic, antifertility, antifungal and antitumor, wound healing, immunomodulation, beneficial effect on hypolipidemic and hypoglycemic effects (Sharma et al. 2020) |
| *Orthosiphon aristatus* (Blume) Miq. [Lamiaceae] | *Kumis kucing* | Leaf | Monoterpenes (camphene, limonene, β-pinene), sesquiterpenes (α-humulene, β-bourbonene, β-caryophyllene, β-elemene), diterpenes (orthosiphols A and B, orthosiphols F-I,), triterpenes, flavonoids, caffeic acid derivatives (Chai et al. 2014) | Cyranoside in O. aristatus shows a strong binding affinity to TNF Alpha, regulates immune response and inhibits inflammation associated with malaria and asthma using an in-silico approach (Zainul et al. 2023) | Anti-inflammatory, diuretic, anti-lithiatic, anti-hypertensive, antioxidant, anti-angiogenic, anti-cancer, antimicrobial, analgesic, anti-pyretic, hepatoprotective, hypoglycaemic (Chai et al. 2014) |
| *Premna serratifolia* L. [Lamiaceae] | *Kigainas* | Leaf | p-methoxy cinnamic acid, linalool, linoleic acid, β-sitosterol, luteolin, iridoid glycoside, premnien, ganiarine, ganikarine, premnazole, aphelandrine, pentacyclic terpenebetulin, caryophellen, premnenol, premnaspirodiene, clerodendrin-A, diterpenoids (Mali 2016) | No reported antimalarial activity from *P. serratifolia*. In the same genus, in vivo antimalarial test using a mouse model infected with *Plasmodium berghei* on *Premna oligotricha* leaf extract showed that there was parasitemia suppression higher than 30% at a dose of 350 mg/kg. A compound with parasitemia suppression greater than 30% is categorized as an active antimalarial compound (Seyfe et al. 2017) | The pharmacological activities of Premna integrifolia that have been reported include analgesic, antinociceptive, anti-arthritis, antibacterial, anticancer/antitumor, anti-inflammatory, antimicrobial, hypolipidemic, antioxidant, gastro-protective, and immunomodulatory activities (Mali 2016) |
| *Andrographis paniculata* (Burm.fil.) Nees [Acanthaceae] | *Sambiloto* | Herbs | Diterpenoids, 2'-oxygenated flavonoids, including andrographolide, neoandrographolide, 14-deoxy-11, 12-didehydroandrographolide, 14-deoxyandrographolide, isoandrographolide, 140deoxyandrographolide-19-β-D-glucoside, homoandrographolide, andrographolidegraphan, andrographolidegraphosterin and stigmasterol (Chao and Lin 2010) | Sambiloto (*Andrographis panniculata*) has an in vitro antimalarial activity of 7.2 µg/mL (Mishra et al. 2009) | Anti-cold, anti-hepatotoxic, anti-urothelial, and anti-hepatotoxic (Mishra et al. 2009) |

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| *Laportea decumana* (Roxb.) Wedd. [Urticaceae] | *Daun gatal* | Leaf | (2S)-4-Methyl-2-({[(3s-4s,5r)-2,3,4-trihydroxy-5-(hydroxymethyl)tetrahydro-2-furanul]methyk}amino)pentanoic acid, choline, erucamide, ethyl 40amino-2-(methylsulfanyl)-1,3-thiazole-5-carboxylate, α-Eleostearic acid, betanine, steramide, linoleic acid, Bis(2-ethylhexyl)phthalate, hexyl 2-furoate (La Basy et al. 2024) | No reported antimalarial test on *L. decumana* | Analgesic (La Basy et al. 2024), antibacterial (Simaremare et al. 2020) |
| *Ipomoea pes-caprae* (L.) R.Br. [Convolvulaceae] | *Kastroli* | Leaf | Calystegine B2, actinidols 1a and 1b, 5,7-dihydroxy-4-phenyl-2H-chromen-2-one, quercetin 3-O-galactoside, quercetin 3-O-glucoside, quercetin 3-O-acetylgalactoside, quercetin 3-O-acetylglucoside, quercetin 3-O-β-d-glucofuranoside, querceton, (-) mullein, limonene, α-terpineol, α-copaene, 8-cedren13-ol, 2-hydroxy-4,4,7-trimethyl-1 (4H)-napthalenone, E-phytol, caryophyllene oxide, α-pinene, α-amyrin,β-amyrin, , α-amyrin acetate, β-amyrin acetate,betulinic acid, glochidone, p-cymene, €-nerolidol, geranyl acetate, linalool, α-cadinol, β-caryophyllene, lanosterol, sericic acid, stigmaterol, β-sitosterol (Akinniyi et al. 2022) | The methanol extract of *I. pes-caprae* roots has an $IC_{50}$ value of 15 µg/mL against *P. falciparum* strain 3D7 in vitro (Pothula and Kanikaram 2015) | Antioxidant, anti-inflammatory, antinociceptive, antimicrobial, collagenase inhibitory, antispasmodic, anticancer, antitumor, antiproliferative, multidrug-resistance efflux-inhibiting (Akinniyi et al. 2022) |
| *Alstonia scholaris* (L.) R.Br. [Apocynaceae] | *Kayu susu* | Bark | 1-(2-hydroxuethoxy) tridecane, 1,2-benzenedicarboxylic acid, Pentadecane, 9-octadecenoic acid, 16-heptadecenal, 2-(ethoxymethyl)oxirane, non-2-en-1-ol, methyl palmitate, Spiropentane, tridecanoid acis, 1—dodecatriene, 3.5.6-tris (trimethulsilyl)cyclohexa-1,3-dien (Santhose et al. 2023) | The antimalarial activity of *A. scholaris* stems in vivo showed a decrease in parasitemia depending on the dose, namely 59% (200 mg), 66% (400 mg) and 95% (600 mg) (Reddy et al. 2019) | Antibacterial, antidiarrheal, antimutagenic, anti-inlammatory, immunomodulatory, antifertility (Santhose et al. 2023) |
| *Syzygium malaccense* (L.) Merr. & L.M.Perry [Myrtaceae] | *Jambu bol* | Bark | Flavonoids, phenols, saponins, alkaloids, quinones, steroids, tannins, terpenoids, ursolic acids, ellagic acid, 3-Omethylellagic acid, 3,3'-di-O-methylelagic acid (Pazzini et al. 2021) | No reported antimalarial test for *S. malaccense*, but in the same genus, *Syzygium guineense* shows antimalarial activity *in vivo* in a mouse model infected with *P. berghei*. *S. guineense* leaf extract showed parasitemia suppression at doses of 600 and 400 mg/kg of 59.39 and 49.09% respectively (Tadesse and Wubneh 2017) | Antidiabetic, antibacterial, antioxidant (Pazzini et al. 2021) |
| *Ficus septica* Burm.fil. [Moraceae] | *Baulas* - | Leaf, twigs | B-sitosteryl-3β-glucopyranoside-6'-O-fatty acid esters, α-amyrin fatty acid ester, β-sitosterol, stigmasterol, β-amyrin, and long chain saturated fatty alcohol from the leaves (Ragasa et al. 2016). Phenanthroindolizine alkaloids (1a,b-seco-dehydroantofine, dehydrotylophorine, dehydroantofine, tylophpridicine D) from MeOH extract of the twigs (Kubo et al. 2016) | 1a,b-seco-dehydroantofine, dehydrotylophorine displays moderate activity against 3D7 strain with IC50 value of 4.0 µM, while dehydrotylophorine, dehydroantofine, tylophpridicine D has strong antimalarial activity with IC50 0.028, 0.42 and 0.058 µM respectively (Kubo et al. 2016) | Antifungal (Sudirga et al. 2014), antimitotic, Antiproliferative (Luceñara et al. 2022) and antioxidant (Vun-Sang and Iqbal 2023) |

*Syzygium malaccense* is part of the Myrtaceae family, which is widely found in Malaysia, India, and Indonesia. The bark of *S. malaccense* is used by the Moi Tribe as a malaria medicine by scraping the bark, squeezing it with a little water, and then drinking it. The genus *Syzygium* consists of 1200-1800 species, that have many pharmacological benefits, such as for the treatment of wounds, burns, and toothaches (*S. aromaticum*), stomachaches, digestion, diarrhea (*S. cordatum* and *S. guineense*), mouth ulcers, irregular menstruation (*S. malaccense*) and so on (Uddin et al. 2022). As a malaria drug, *S. guineense* shows antimalarial activity in vivo in a mouse model infected with *P. berghei*. *S. guineense* leaf extract showed parasitemia suppression at doses of 600 and 400 mg/kg with 59.39 %and 49.09%, respectively (Tadesse and Wubneh 2017).

*Ficus septica* is part of the Moraceae family that is spread in the tropical and subtropical regions of the Western Pacific. This plant has been used in traditional medicine to treat fever, headache, gastralgia, and diseases caused by fungi and bacteria. The methanol extract of *F. septica* twigs showed significant in vitro antiplasmodial activity on the *P. falciparum* 3D7 strain with an $IC_{50}$ value of 2.0 µg/mL (Kubo et al. 2016). The Moi Tribe boils the leaves of *F. septica* in water and the resulting liquid is drunk to treat malaria.

*Orthosiphon aristatus* is a medicinal plant that is widely used in Southeast Asian countries such as Malaysia and Indonesia, and is traditionally used to treat cystitis, diabetes, rheumatism, arthritis, gout, and kidney disease. These extensive benefits can be attributed to its rich phenolic content, which includes polyphenols, diterpenes, triterpenes, lipophilic flavones, glycosides, and caffeic acid derivatives such as Rosmarinic Acid (RA). *Orthosiphon aristatus* has been reported to have α-amylase and β-glucosidase inhibitory activities, exhibit antioxidant and anti-inflammatory properties, regulate lipid metabolism, increase insulin secretion, improve insulin resistance, increase glucose absorption, increase glycolysis, and inhibit gluconeogenesis (Alshehade et al. 2023).

The Moi Tribe interviewed stated that there was no special potion to prevent malaria. When they felt symptoms of malaria were begining to appear, they consumed the same potion for the treatment of malaria or maintained their body conditions by using the leaves of *Laportea decumana*. The prevention of malaria is done by using mosquito nets, maintaining personal and environmental hygiene, and reducing outdoor activities during cold weather, rain, and at night. This is because of the understanding that malaria is caused by cold weather and mosquito bites.

In conclusion, this study has documented the traditional knowledge of the Moi Tribe in Malaumkarta Village regarding medicinal plants used to treat malaria. The findings reveal the Moi community predominantly relies on single-plant formulations, with *Arcangelisia flava* being the most cited species. The preference for boiling as a preparation method and the use of specific plants for topical applications reflect the community's practical approach to manage the symptoms. While some species such as *A. flava*, *C. papaya*, and *A. paniculata* have established antimalarial activity findings, others remain unexplored in scientific literature. Future research should focus on in vitro and in vitro antimalarial testing of these plant extracts to confirm their efficacy, safety and potential as antimalarial drug candidates. Additionally, integrating ethnomedicine with modern drug discovery efforts could contribute to sustainable malaria treatment strategies, particularly in endemic regions.

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