MEDICINAL PLANT KNOWLEDGE OF THE TEMUAN TRIBE IN KAMPUNG ORANG ASLI HULU KEMENSAH, AMPANG, SELANGOR AND THE EVALUATION OF ANTI-INFLAMMATORY PROPERTIES OF THREE SELECTED PLANTS

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ABSTRACT

Indigenous people possess their own knowledge on the usage of medicinal plants articulated by word of mouth between generations. If this knowledge is not documented, it will be lost in time. Thus, this study attempts to document plants that have therapeutic values to the indigenous Temuan tribe of Kampung Orang Asli Hulu Kemensah, Selangor. Fourteen villagers comprising an equal number of males and females ranging from 20 - 80 years old were interviewed for this study. Data for this study were collected using a set of questions whereby the name of the plant, treatment conditions, plant part used, method of preparation, and method of application were recorded. The anti-inflammatory activity of selected medicinal plant species was also evaluated using the inhibition of protein denaturation method. A total of 45 medicinal plant species from 32 families were documented. The majority of these medicinal plants belong to the families Fabaceae and Zingiberaceae. *Cinnamomum javanicum* is used as a treatment for the highest number of ailments and conditions followed by *Curcuma longa*. Meanwhile, *Homalomena sagittifolia* is the most commonly used medicinal plant species by Temuan in Kampung Orang Asli Hulu Kemensah. Apart from that, *Cratoxylum formosum* is the medicinal plant with the highest number of parts used among all the medicinal plants recorded. A total of 36 different ailments or health conditions were recorded where asthma, jaundice, wound, hypertension and diabetes were the most common. The most frequently used parts of the medicinal plants were roots and leaves with 17 and 14 species, respectively. A total of 23 species of medicinal plants are processed by decoction before application. Oral intake was the most common

method of medicinal plant administration observed with 30 species. *Cinnamomum javanicum, Clidemia hirta* and *Zingiber montanum* were selected for anti-inflammatory analysis. The potency in inhibiting the protein denaturation was calculated in the following order: ethanol extract of *C. javanicum* (48.00 ± 4.00%) > water extract of *C. javanicum* (45.33 ± 3.53%) > water extract of *Z. montanum* (37.4 ± 3.13%) > ethanol extract of *C. hirta* (37.06 ± 4.04%) > ethanol extract of *Z. montanum* (34.27 ± 0.00%) > water extract of *C. hirta* (30.07 ± 8.07%). These findings could act as the baseline for exploring new anti-inflammatory medication using the traditional knowledge of indigenous people.

PENGETAHUAN TUMBUHAN UBATAN SUKU TEMUAN DI KAMPUNG ORANG ASLI HULU KEMENSAH, AMPANG, SELANGOR DAN PENILAIAN SIFAT ANTI-INFLAMMATORI BAGI TIGA TUMBUHAN TERPILIH.

ABSTRAK

Orang asli mempunyai pengetahuan mereka tersendiri mengenai penggunaan tumbuhan ubatan yang dipindahkan mulut ke mulut antara generasi. Jika pengetahuan ini tidak didokumenkan, ia akan hilang ditelan masa. Justeru, kajian ini cuba mendokumentasikan tumbuh-tumbuhan yang mempunyai nilai terapeutik kepada suku Temuan asli dari Orang Asli Kampung Hulu Kemensah, Selangor. Empat belas penduduk kampung terdiri daripada lelaki dan wanita dengan bilangan yang sama, dalam lingkungan 20 - 80 tahun ditemubual untuk kajian ini. Maklumat dikumpulkan melalui borang soal selidik di mana nama tumbuhan ubatan, penyakit dan keadaan yang dirawat, bahagian tumbuhan yang digunakan, kaedah penyediaan dan cara penggunaan dicatat. Aktiviti anti-inflamasi spesies tumbuhan ubatan terpilih juga dinilai menggunakan kaedah perencatan denaturasi protein. Sebanyak 45 spesies tumbuhan ubatan dari 32 famili didokumentasikan. Sebilangan besar tumbuhan ubatan ini tergolong dalam keluarga Fabaceae dan Zingiberaceae. *Cinnamomum javanicum* digunakan sebagai rawatan untuk jumlah penyakit dan keadaan tertinggi diikuti *Curcuma longa. Homalomena sagittifolia* merupakan spesies tumbuhan ubatan yang paling biasa digunakan masyarakat Temuan di Kampung Orang Asli Hulu Kemensah. Sementara itu, *Cratoxylum formosum* adalah tumbuhan ubatan dengan jumlah bahagian yang paling tinggi digunakan di antara semua tanaman ubatan yang dicatat. Sebanyak 36 penyakit atau keadaan kesihatan yang berbeza dicatat dimana asma, penyakit kuning, luka, darah tinggi dan diabetes adalah yang paling kerap dirawat. Bahagian tumbuhan ubatan yang paling kerap digunakan adalah akar dan daun masing-masing dengan 17 dan 14 spesies. Sebanyak 23 spesies tumbuhan ubatan diproses dengan merebus

sebelum digunakan. Pengambilan oral adalah kaedah penggunaan tumbuhan ubatan yang paling biasa dengan 30 spesies. *Cinnamomum javanicum*, *Clidemia hirta* dan *Zingiber montanum* dipilih untuk analisis anti-radang. Potensi dalam merencat denaturasi protein dikira mengikut urutan berikut: ekstrak etanol *C. javanicum* (48.00 ± 4.00%)> ekstrak akueus *C. javanicum* (45.33 ± 3.53%)> ekstrak akueus *Z. montanum* (37.4 ± 3.13 %)> ekstrak etanol *C. hirta* (37.06 ± 4.04%)> ekstrak etanol *Z. montanum* (34.27 ± 0.00%)> ekstrak akueus *C. hirta* (30.07 ± 8.07%). Penemuan ini boleh digunakan sebagai asas bagi meneroka ubat anti-radang baru dengan menggunakan pengetahuan tradisional orang asli.

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LIST OF ABBREVIATIONS

BSA	:	bovine serum albumin
COX	:	cyclooxygenases
DMPBD	:	Compound D {(E) -4- (3, 4 – dimethoxyphenyl) but-3-en-2-ol}
DMSO	:	Dimethyl Sulfoxide
JAKOA	:	Department of Orang Asli Development
LPS	:	lipopolysaccharide
MoNRE	:	Ministry of Natural Resources and Environment
NCCIH	:	National Centre for Complementary and Integrative Health
NO	:	nitric oxide
NSAIDS	:	Non-steroidal anti-inflammatory drugs
TCM	:	Traditional Chinese medicine
WHO	:	World Health Organisation
WIPO	:	World Intellectual Property Organisation

LIST OF APPENDICES

CHAPTER 1: INTRODUCTION

Plant-based or herbal medicines have been traditionally used to treat various diseases, bringing significant attention towards global health debates. Development in natural products has recognised the diversity of secondary metabolites found in these plants and their potential in the pharmaceutical industry (Mitra *et al*., 2007). For example, 80% of African populations use some form of traditional herbal medicine leading the worldwide annual market for these products to approach USD 60 billion (WHO Bulletin, 2008). In recent decades, research on medicinal plants for health benefits has increased worldwide, including in Malaysia. The relationship between medicinal plants and traditional knowledge goes back decades ago through the indigenous community. Indigenous people live in harmony with nature and possess their own knowledge and traditions on medicinal plants (Dahare & Jain, 2010).

Folk medicine is popular among indigenous people as they have been utilising medicinal plants for generations and continue practising until today. However, the traditional knowledge of these medicinal plants among indigenous people is only verbally transferred between generations. Lack of documentation of these valuable medicinal plants may cause the information about the medicinal plants to be lost over time. Hence, the traditional knowledge on the usage of plants should be recorded before it is lost due to modernisation (Ong *et al*., 2011b). Researchers must take fast action to document this traditional knowledge about medicinal plants and their applications.

The indigenous people in Malaysia can be categorised into three major groups, which are Negrito, Senoi and Proto-Malay (JAKOA, 2019). Temuan tribe falls under the Proto-Malay group. Temuan tribe is among the most knowledgeable tribes in natural utilisation for medicinal purposes (Azliza *et al*., 2012). Considering the importance of

traditional knowledge and the struggle of the indigenous community to sustain their culture in the face of modernisation, it is an urgent need to document the practices of traditional medicine among the indigenous community.

This study focused on the medicinal plants used by the Temuan community in Kampung Orang Asli Hulu Kemensah, Selangor. Data on traditional knowledge and usage of medicinal plants were collected by conducting field trips to observe, participate and converse with the natives. This study also evaluated the anti-inflammatory potential of selected medicinal plants used by the Temuan community. This study is important to conserve ethnomedicinal knowledge of the Temuan community, which is at risk to be forgotten due to modernisation. This project was performed based on the following objectives:

1. To document the medicinal plants and their use by the Temuan community in Kampung Orang Asli Hulu Kemensah, Selangor.

2. To evaluate the anti-inflammatory activity of selected medicinal plant species.

CHAPTER 2: LITERATURE REVIEW

2.1 Indigenous people in Malaysia

According to the Department of Orang Asli Development (JAKOA), indigenous people or locally known as *Orang Asli* can be classified into three major groups, namely Negrito, Senoi and Proto-Malay. Each group is further divided into sub-groups. For example, Negrito is divided into Kensiu, Kintak, Lanoh, Jahai, Mendriq and Bateq tribes. Senoi is made up of Temiar, Semai, Semoq Beri, Jah Hut, Mah Meri and Che Wong tribes. Meanwhile, Proto-Malay comprises the Kuala, Kanaq, Seletar, Jakun, Semelai and Temuan tribes.

2.1.1 Temuan Tribe

The Temuan people are distributed in Selangor, Melaka, Pahang, Muar, Johor and Negeri Sembilan (JAKOA, 2020). The Temuans are known locally as *'Orang Bukit'* (*bukit* is the Malay word of hill) since they reside in jungle areas near the hillside. They utilise the natural resources from their surrounding for food and medicinal purposes; thus, they are among the most knowledgeable tribes on natural resources utilisation, especially for medicinal purposes (Azliza *et al*., 2012). The traditional medicine knowledge within the Temuan tribe is feared to be lost in time if the younger generation does not continue practising to preserve the tribes' heritage. Key information on medicinal plants is often forgotten with the passing of elders due to a lack of knowledge and interest among the younger generation towards medicinal plants (Samuel *et al*., 2010). Thus, it is of great importance to document the traditional medicine knowledge from the Temuan tribe.

2.2 Traditional medicine

The World Health Organisation (WHO) defines traditional medicine as the total of knowledge, skills, and practices based on the theories, beliefs, and experiences of various cultures, whether explicable or not, used to maintain health and to prevent, diagnose, ameliorate, or treat physical and mental illnesses (WHO, 2020). Abbott (2014) stated that traditional medicine is one of the complementary and alternative medicines. Complementary and alternative medicine is defined as a health care system, practice and product other than allopathic medicine. Allopathic medicine is known as Western medicine, conventional medicine or biomedicine, which is the predominant medicine in the developed world (Abbott, 2014). The most commonly practised traditional medicine include traditional Indian medicine (Ayurveda), Chinese medicine (TCM) and Arabic medicine (Unani).

The 56th world health assembly in Geneva 2003 reported that traditional, complementary, or alternative medicine has many good benefits and that traditional medicine and its practitioners play a crucial role in treating chronic diseases and enhancing the quality of life of those suffering from minor illnesses or other incurable diseases (WHO, 2003). According to Singh (2015), UNESCO highly observed that traditional medicine and medicinal plants are involved in the maintenance of good health in most developing countries. Singh (2015) also noted that "medicinal plants are the "backbone" of traditional medicine", referring that more than 3.3 billion people in less developed countries use medicinal plants regularly. Traditional medicine is very important for health care; thus, it is crucial to document the knowledge of this traditional medicine.

2.3 Documenting of traditional knowledge

2.3.1 Definition

The National Biodiversity Policy 2016-2025 defines traditional knowledge as a cumulative body of knowledge, innovations and practices of indigenous and local communities passed down orally through generations and other forms of cultural transmission, such as practice or collective experience (MoNRE, 2016). Traditional knowledge can take the form of folklore, cultural values and beliefs, songs, stories, customary laws and practices (MoNRE, 2016).

Traditional knowledge is defined by Abbott (2014) as the knowledge obtained from intellectual activities in a traditional context, which includes the know-how, skills, practices and innovation encompassing medicinal knowledge, scientific knowledge, agriculture knowledge, ecological knowledge and technical knowledge. Traditional knowledge or indigenous knowledge covers a broad spectrum ranging from art to agriculture, including traditional medicine. It exists among indigenous or local communities and has been orally passed down through generations. Mosango (2010) describes traditional knowledge as the total practices and knowledge established on observations and past experiences, which is used and held by a community.

Documentation of traditional knowledge is one of the strategies to protect traditional knowledge. In a publication by the World Intellectual Property Organisation (WIPO) (2017), documentation of traditional knowledge has been defined as a process of identifying, collecting, organising, registering or recording traditional knowledge in some ways to dynamically preserve, manage, use, disseminate and/or protect traditional knowledge with specific goals in mind. Traditional knowledge can be in the form of an indigenous language or foreign, either using modern (digital) or more classical

technologies (written). Traditional knowledge documentation can be done in many methods such as through written registries and files, images, audio, and video (WIPO, 2017). In this study, the traditional knowledge of the Temuan tribe on medicinal plants in Kampung Orang Asli Hulu Kemensah was documented.

2.3.2 Role of documenting the traditional knowledge

2.3.2.1 Preserve knowledge and improve the usage of medicinal plants

The World Intellectual Property Organisation reported (2001) that the need for documentation is urgent, as countries have been said to be at risk of losing their traditional knowledge that is usually held by older people (WIPO, 2001). Some of this knowledge was not passed down to the younger generation due to a lack of interest from this generation (WIPO, 2001). According to Ong *et al*. (2011d), the younger generation is less interested to learn and use certain plants owing to personal choice, changes in culture, and the laborious process of preparing certain food products.

Many plants are directly used to improve public health including for curing ailments and diseases. Vishwanathan (2018) claimed that roasted and powdered cumin seeds (Cuminum cyminum) taken with buttermilk are effective in digestion-related disorders of the stomach, black peppercorns (Piper nigrum) added as a spice to hot soups is suitable to relieve chest congestion in colds, and dry ginger (Zingiber officinale) powder taken with a small amount of jaggery and clarified butter (ghee) provides relief from joint pain due to rheumatoid arthritis. Documenting the traditional knowledge will conserve the knowledge and usage of medicinal plants for generations and ensure they will not be forgotten over time.

2.3.2.2 Intellectual Property rights and protection from biopiracy

Intellectual property rights are the legal protections given to individuals or organisations over their creative endeavours and award the creator exclusive rights over the use of his/her creation or discovery for a certain period (Hansen & Van Fleet, 2003). Documentation is important to obtain intellectual property protection and help traditional medicinal knowledge holders to commercialise traditional medical products or services. Documentation of traditional medicinal knowledge may also aid investment and innovations of traditional medicine (Abbott, 2014).

Documentation of traditional knowledge is also important to prevent biopiracy. Biopiracy is the exploitation and appropriation of biological and genetic resources and/or associated traditional medicinal knowledge by unauthorised parties without the approval, consent to, or adequate compensation for their holders (Timmermans, 2003). For example, in 1995, two researchers at the University of Mississippi Medical Centre were granted a US patent on the use of turmeric in wound healing. After a re-examination was requested by the Council of Scientific and Industrial Research (CSIR) of India, supported with ancient Sanskrit text and a publication in 1953, the patent was cancelled in 1997 for lack of authenticity (Finetti, 2011). Another example is neem, a plant used in traditional Indian medicine, which was patented as having anti-fungal properties. The Indian government provided substantial proof on the documentation of the traditional use of neem to the European Patent Office to invalidate the patent, causing the patent to be cancelled in 2008 (Abbott, 2014). Thus, it is crucial to document traditional knowledge to prevent biopiracy issues.

2.3.2.3 Drug developments and commercialisation

Indigenous and local communities possess substantial knowledge about medicinal usage and the preparation of herbs. This information is very valuable not only for indigenous and local communities only but also contributes to the development of pharmaceutical treatments. According to Kinghorn *et al*. (2011), the drug discovery from medicinal plants can be aided by ethnopharmacology, which is a mode of the scientific study of the indigenous medicinal uses of particular plant species. Ethnopharmacological information on traditional use can provide clues for compounds that are therapeutically useful in humans. In line with this notion, a study using 122 plant-derived compounds globally used as drugs showed that 80% of them come from plants that have ethnomedical usage, similar or related to the indications for which the respective pure compounds are prescribed (Fabricant & Farnsworth, 2001).

Drug discovery from plants started in the 19th century when a German pharmacist, Friedrich Serturner, succeeded in isolating the analgesic and sleep-inducing agent *mophium* (morphine) from opium. This triggered the examinations of other medicinal herbs and many bioactive compounds mainly alkaloids have been isolated since from their natural resources (Atanasov *et al*., 2016). Alkaloid has been reported to exhibit a range of bioactivity such as anticancer agents, anti-inflammatory, antiviral, antibacterial and antifungal (Cragg & Newman, 2013). Some examples of bioactive alkaloids are vinca alkaloids, vinblastine and vincristine isolated from *Catharanthus roseus*, Paclitaxel and baccatins derived from leaves of various *Taxus* species, topotecan, irinotecan, and belotecan isolated from *Camptotheca acuminate*, which are reported as anticancer agents (Cragg & Newman, 2013). Other examples of alkaloids include berberine isolated from *Berberies* and *Coptis* genera, warifteine from *Cissampelos*

sympodialis, as well as quinolizidine alkaloids matrine and oxymatrine from *Sophora subprostrata* that showed anti-inflammatory activity (Souto *et al*., 2011).

In Ayurvedic medicine, several active constituents from plants are used for different ailments. For example, curcumin from *Curcuma longa* and glycyrrhizin from *Glycyrrhiza glabra* Linn are used for their anti-inflammatory activity. Meanwhile, kutkin from *Picrorhiza kurroa* Royale ex Benth, bacoside from *Bacopa monnieri* Linn, and vasicine from *Adhatoda vasica* Nees are used for the antiasthmatic effect. Other examples are cathecin from *Albizia lebbeck* Benth and curcligoside A from *Curculigo orchioides* Gaertn, which are used for antiallergic effects (Mukherjee *et al*., 2010).

Fabricant & Farnsworth (2001) listed several drugs derived from plants that are discovered from ethnopharmacological data. For example, aesin from *Aesculus hippocastanum* L. and bromelain from *Ananas comosus* (L.) Merrill for anti-inflammatory. Besides, Colchicine from *Colchicum autumnale* L., etoposide from *Podophyllum peltatum* L., and monocrotaline from *Crotolaria sessiliflora* L. are utilised for anti-tumour. Other examples are Deserpidine from *Rauvolfia canescens* L., protoveratrines A & B from *Veratrum album* L., and reserpine from *Rauvolfia serpentina* (L.) for anti-hypertensive.

2.4 Medicinal plants usage among indigenous communities in Malaysia

A total of 213 species of plants have been identified as medicinal to the indigenous Jah Hut, Semang, Semai, and Temuan communities in Peninsular Malaysia (Milow *et al*., 2017). Lin (2005) reported 16 plant species that were commonly used to cure some common diseases including headache and diarrhoea by Jah Hut in Kampung Keboi, Jerantut, Pahang. Ong *et al.* (2012a) conducted a study on Jah Hut at Kampung Pos Penderang, Pahang and documented 53 medicinal plants used for treating various

ailments. Some of these plants have been reported to have similar uses by other tribes, suggesting that these plant species may be worthy of further studies in the laboratory and may have the potential in treating various diseases. Ong *et al.* (2012b) documented Semai medicinal plants at Kampung Batu 16, Tapah Perak. They documented 37 species of plants, most of which are used in ritual, healing protection, and herbal medicine for post-partum mothers. Meanwhile, a study has been conducted by Samuel *et al.* (2010) among Semang tribes of *orang asli* in Kampung Bawang, Perak and documented the use of traditional medicine among them. A total of 62 medicinal plant species have been documented where most of these plants were used to relieve pain and cure wounds. The Kensiu tribe is the minority tribe among the indigenous people of Peninsular Malaysia. Mohammad *et al.* (2012) recorded 39 plants species used by them to treat a variety of ailments such as asthma, hypertension and diabetes.

Ong *et al.* (2011a) reported on the traditional medicinal plants used by the Temuan people in Kampung Tering, Negeri Sembilan. The plants were used to treat various types of diseases, from simple ailments such as joint paint to serious conditions such as hypertension. Azliza *et al.* (2012) conducted a study on ethnomedicinal resources of the Temuan tribe in Ulu Kuang, Gombak Selangor and found 47 species of plants from 36 families. Nevertheless, documentation of traditional knowledge on medicinal plants usage by native people is still far from complete (Ong *et al*., 2012a). To expand these studies, medicinal plants of more villages of indigenous tribes should be recorded or documented.

2.5 Bioactivity of medicinal plants

The issue that was not sufficiently addressed in previous research of indigenous tribes on medicinal plants is the veracity of information obtained (Milow *et al*., 2017). Documentation of medicinal plants is important as it would be the basis for the

development of modern drugs. In this study, some plant species were extracted for the evaluation of bioactive potential. This is important to scientifically validate indigenous ethnomedical claims. One of the research objectives is to identify the anti-inflammatory effect of the selected plants since inflammation may contribute to many ailments and diseases, both acute and chronic diseases involving inflammation. The anti-inflammatory activity potentially identified from the selected plants could be the basis to develop new anti-inflammatory medications and may contribute to the pharmacology field.

2.5.1 Inflammation

Inflammation is a phenomenon that involves complex biological responses to injury, infection, or irritants characterised by heat, redness, pain, swelling, and disturbed function of the organs (Napagoda *et al*., 2018). Inflammation can be divided into two groups; acute inflammation and chronic inflammation. Acute inflammation reflects an initial body response to harmful stimuli. On the other side, when the inflammatory response is out of a fraction resulting in body damage, chronic inflammation occurs. According to Patel *et al*. (2017), "cyclooxygenases (COX) are the key enzymes in the synthesis of prostaglandin, prostacyclins and thromboxanes that are involved in inflammation, pain, and platelet aggregation".

Chronic inflammation is the cause of advanced-age diseases such as heart attacks, Alzheimer disease, and cancer (Murugesan & Devipunnoswamy, 2014). Non-steroidal anti-inflammatory drugs (NSAIDs) are among the most commonly used medicines in the world and their anti-inflammatory and analgesic effects provide the main benefits. They block the activity of COX1 and COX2 enzymes that assist the production of prostaglandin. However, their uses mainly increase the risk of gastrointestinal and cardiovascular disorders (Sostres *et al*., 2010; Al-Saeed, 2011) as well as renal damage

(Dixit *et al*., 2010; Nelson *et al*., 2019). Nowadays, there is a lot of research done to explore the anti-inflammatory activity of medicinal plants that have fewer side effects besides being more affordable and easily available (Patel *et al.*, 2017).

2.5.2 Protein denaturation and inflammatory disorder

Protein denaturation results in the loss of biological properties of protein molecules. Protein loses its secondary structure and tertiary structure by application of external stress or compound such as heat, concentrated inorganic salt, and strong base or acid. When denatured, proteins lose their biological function. Protein denaturation is a well-known cause of inflammation (Leelaprakash & Dass, 2011; Sangeetha & Vidhya, 2016). Protein denaturation has been linked with the formation of inflammatory disorders like rheumatoid arthritis, diabetes, and cancer (Sarveswaran *et al*., 2017). Therefore, the ability of substance or plants extracts to prevent protein denaturation may also help to prevent inflammation disorders.

The protein denaturation method has been used to test the anti-inflammatory activity of many plants such as water extract of *Albuca setosa* leaves (Umapathy *et al*., 2010), ethanol extract of *Withania somnifera* root (Chandra *et al*., 2012), methanol extract of *Murraya Koenigi* (Gambhire *et al*., 2009), *Amaranthus caudatus* L. (Sen *et al*., 2015), *Rhizophora mucronata* leaves (Kumari *et al*., 2015), and hydroalcoholic extracts of *Pedalium murex* (L.) stem (Sangeetha & Vidhya, 2016). The aforementioned studies revealed inhibitory effects of these plants against protein denaturation *in vitro,* suggestive of anti-inflammatory activity.

2.5.3 Medicinal plants and anti-inflammatory activity

A large number of medicinal plants have been extensively used to alleviate pathological conditions associated with inflammation (Jayawera, 1982). Medicinal

plants have been used to treat inflammation since ancient times as in Ayurveda and traditional Chinese medicine (TCM). Ayurveda, the ancient Indian medicinal system, is based on ancient writings that describe natural and holistic approaches to physical and mental health (NCCIH, 2020). All over India, there are some indigenous medicinal plants available with anti-inflammatory capabilities. Plants from the Solanaceae, Euphorbiaceae, Asteraceae, Zingiberaceae and Leguminoceae families have been reported to exhibit potent anti-inflammatory activity. Some of the medicinal plants from these families contain chemical constituents, which are derivatives of steroids supported by modern clinical studies on their role as anti-inflammatory agents (Patel *et al*., 2017).

Traditional Chinese Medicine (TCM) has evolved over thousands of years. TCM practitioners use herbal products and various mind and body practices to address health problems (NCCIH, 2020). A large number of studies have reported on the anti-inflammatory properties of traditional Chinese herbs. For example, Muluye *et al*. (2014) reported that *Scutellaria baicalensis, Flos Lonicerae,* and *Viola yedoensis* have anti-inflammatory effects that act through different mechanisms of action and multiple targets. Besides, Chen & Zhang (2014) analysed the correlation between TCM characteristics and their anti-inflammatory activity, suggesting that herbs with pungent flavour are candidates of effective anti-inflammatory agents. Pan *et al*. (2011) reported that various natural products derived from TCM have been shown to successfully suppress pro-inflammatory pathways and control inflammation-associated diseases. Anti-inflammatory effects of TCM occur by inhibiting the expression of the master transcription factors (such as nuclear factor-κB (NF- κB)) pro-inflammatory cytokines (such as tumour necrosis factor-α (TNF-α)), chemokines, intercellular adhesion molecule expression and pro-inflammatory mediators (iNOS), as well as cyclooxygenase 2 (COX2) (Pan *et al*., 2011).

In Malaysia, many plants have been identified to possess anti-inflammatory activity. *Melicope ptelefolia* (Tenggek burung) and *Portulaca oleracea* (Gelang pasir) were reported to have strong anti-inflammatory activity (Abas *et al*., 2006). *Jatropha curcas* (Jarak pagar), *Curcuma longa* (Kunyit), *Labisia pumila* (Kacip fatimah), *Eurycoma longifolia* (Tongkat ali), *Carica papaya* (Betik), and *Oenanthe javanica* (Selom) were also revealed to have high anti-inflammatory activity (Bakar *et al*., 2018). The activity is associated with the occurrence of diverse naturally occurring phytochemicals from diverse groups such as flavonoids, coumarins, alkaloids, steroids, benzophenone, triterpenoids, curcuminoids, and cinnamic acid (Bakar *et al*., 2018). However, further investigation on the possible underlying mechanism and isolation of active compounds present in specific plant species is yet to be carried out.

CHAPTER 3: METHODOLOGY

3.1 Study area

This study was conducted at a Temuan tribe village, Kampung Orang Asli Hulu Kemensah, located in sub-district Hulu Klang of Ampang district in the state of Selangor, Malaysia (3°13'34.0"N, 101°46'39.1"E). The location of the village is approximately 20 km from Kuala Lumpur city centre. Figure 3.1 shows the location of the study site in Peninsular Malaysia and Figure 3.2 displays the location of the study site in Ampang, Selangor. The study area was chosen based on:

1) Recommendation from JAKOA based on knowledge and usage of medicinal plants demonstrated by the villagers.

2) Proximity to a nearby forest where villagers collect medicinal plants.

3) Accessibility to the village by private transportation.

There are 17 houses in this village with a population of 102 individuals. This village is led by the village head Jamil a/l Atong. Most of the villagers are involved in farming and collecting forest products. They are also involved in handcrafting and work at the chalets for tourists located nearby the village.

The welfare of the Temuan people at the study site is managed by the Department of Orang Asli Development (JAKOA). The village infrastructure and facilities include water and electricity supply, community hall and tarred roads. The houses in the village are mostly built using brick walls and only a few houses are built by wooden planks. The view of the village is very greenish, surrounded by vegetation and streams nearby.

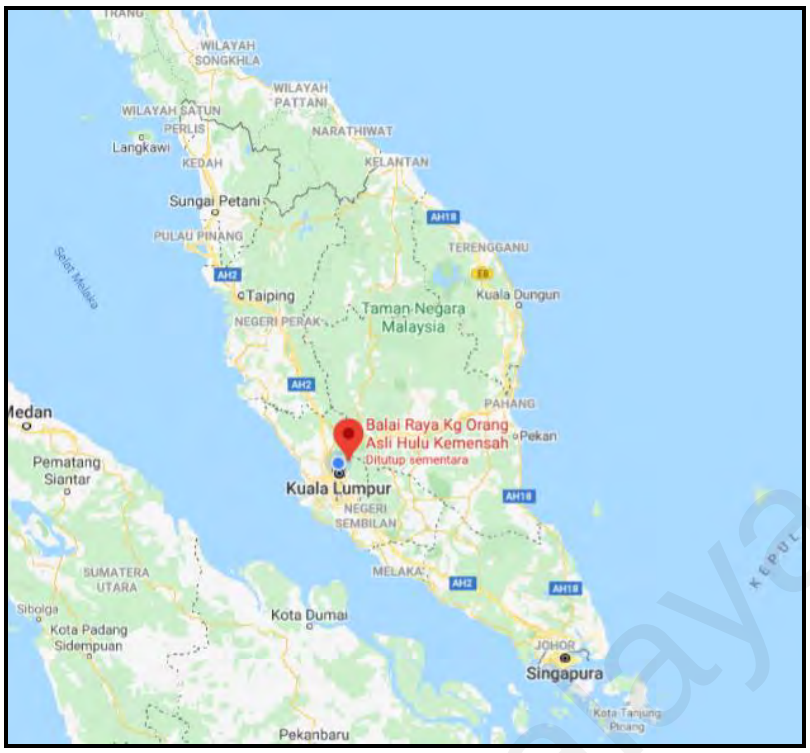


Figure 3.1: Location of Kampung Orang Asli Hulu Kemensah in Penisular Malaysia (photo sourced from Google Maps).

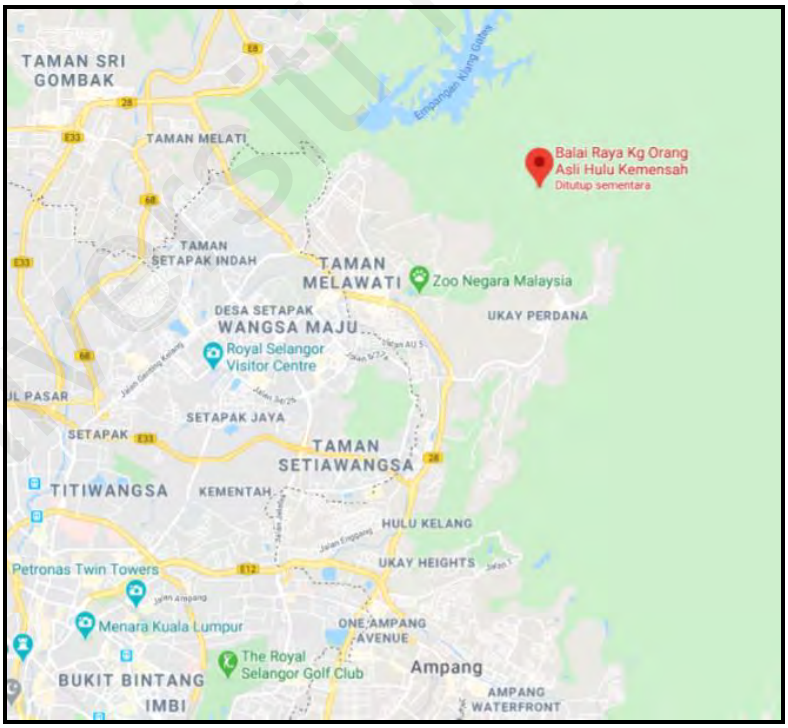


Figure 3.2: Location of Kampung Orang Asli Hulu Kemensah in district Ampang, Selangor (photo sourced from Google Maps).

3.2 Medicinal plants data collection

3.2.1 Ethical approval and informed consent

Ethical approval from JAKOA was obtained on 31st July 2019 (Reference Number: JAKOA/PP.30.032Jld 45 (40); Appendix 1), while ethical approval was gained from the University of Malaya Research Ethics committee on 10th October 2019 (Reference Number: UM.TNC2/UMREC – 662; Appendix 2). Written informed consent was collected from all respondents before the interviews (Appendix 3).

3.2.2 Selection of respondents

All respondents were in the age range of 20-80, both males and females. The respondents were selected through peer recommendation based on their knowledge about the medicinal plants. The exclusion criteria for this selection were respondents who declined to participate and those who are not from the Temuan tribe. Before the interviews, respondents were briefly explained about the purpose and methodology of this research.

3.2.3 Study visits and questionnaire

Eight field trips to Kampung Orang Asli Hulu Kemensah were conducted from October 2019 until December 2019. All information obtained through interaction with villagers were collected through a questionnaire. The demographic information gathered for each respondent included gender, age, educational background and occupation (Appendix 4). For medicinal plants, the name of the plant, treatment conditions, plant part used, method of preparation and method of application were recorded (Martin, 1995) (Appendix 5).

3.2.4 Plants identification

To aid in plant identification, photographs, leaves, seeds, flowers, and common names were collected (Martin, 1995). Species identification was also done using books, journals, and plant websites (Azliza *et al*., 2012; Hussin, 2014; Milow *et al*., 2012; Mohammad *et al.*, 2012; Ong *et al.*, 2011a; Ong *et al.*, 2011d). The plant websites used were Malaysia Biodiversity Information System MyBIS (http://www.mybis.gov.my) and Flora and Fauna Web (http://www.nparks.gov.sg). The identification of the species was also done with the assistance of a Science Officer, Mr Khairul Azmi bin Abdul Rahman affiliated with Rimba Ilmu, Universiti Malaya.

3.3 Plant extraction and anti-inflammatory assay

3.3.1 Plant selection for anti-inflammatory analysis

Plants for anti-inflammatory assay were chosen based on these criteria:

i) Plants used to treat inflammatory conditions such as swelling, flu, fever, cough, and asthma.

ii) Availability of the plants for sampling.

iii) Research on the anti-inflammatory activity of the plants through *in vitro* assays proposed in this study was unavailable.

3.3.2 Plant specimen collection

Three medicinal plants were chosen for anti-inflammatory analysis; *Cinnamomum javanicum (medang)*, *Clidemia hirta (senduduk bulu)* and *Zingiber montanum (bonglai)*. *C. javanicum* and *Z. montanum* were collected from Kampung Orang Asli Hulu Kemensah while *C. hirta* was collected from Rimba Ilmu, University Malaya. *C. hirta*

was collected at Rimba Ilmu as it was difficult to obtain the plant in the village in large quantities for extraction.

3.3.3 Plants verification and herbarium specimen deposition

The plant identifications were verified by Senior Lecturer, Dr Yong Kien Thai from the Institute of Biological Sciences, Faculty of Science, Universiti Malaya. Then, the plant specimens were deposited at the Universiti Malaya Herbarium (KLU) for future reference for other researchers. The accession numbers are; *Clidemia hirta* (KLU50131), *Cinnamomum javanicum* (KLU50133) and *Zingiber montanum* (KLU50132).

For *C. javanicum* and *Z. montanum*, the species of the plant could not be identified since there were not enough samples of parts such as flowers and fruits. According to the villagers, the flowers and fruits of the plant are difficult to obtain as the plants produce their fruits and flowers only in certain periods. These plants were identified by the villagers and their scientific names were confirmed based on their common names in the literature (Hamirah *et al*., 2007; Ong *et al.*, 2011a; Othman *et al*., 2019).

3.3.4 Plant extraction

Selected plants were pre-cleaned and cut into small pieces using scissors and secateurs. The plant specimens were dried under the shade for one week. Two different types of extracts, which are ethanol extract and aqueous extract, were prepared.

The ethanol extract was prepared using 80% ethanol. Approximately 40 g plant specimens were soaked in 1.5 L 80% ethanol for three days at room temperature.

The aqueous extracts were prepared using the decoction method. Due to limited plant samples and to obtain a sufficient amount of crude extract for each plant, different

weights of the plant samples were used. Plants samples weight for *C. javanicum, C. hirta* and *Z. Montanum* were 136.78 g, 238.28 g, and 36.19 g, respectively. Then, the aqueous extract was prepared by boiling the plant material in 6 L distilled water for two hours.

After that, ethanol and aqueous extracts were filtered separately using cotton wool to obtain a clear filtrate. Then, the extracts were concentrated using a rotary evaporator (Buchi Rotavapor, Switzerland) while submerged in a water bath set at not more than 40 °C. The dried crude extracts obtained were put in tight vials and dried in a desiccator overnight. Then, the crude extracts were stored at -20 °C before use in the anti-inflammatory assay.

3.3.5 Anti-inflammatory assay

Inhibition of protein denaturation assay was done according to Bouhlali *et al*. (2016) with minor modifications. In this assay, bovine serum albumin (BSA) was used as the protein source. Denaturation of protein was induced by keeping the reaction mixture at 70 °C in a water bath for 5 minutes. A stock solution of plant extracts (1 mg/ml) was prepared in dimethyl sulfoxide (DMSO) (Fisher Scientific, UK) and then diluted with distilled water to several concentrations (100, 200, 300, 400 and 500 µg/ml). Indomethacin (Sigma, USA) was used as a positive control. The same range of concentrations was used for indomethacin. DMSO instead of plant extract was used as a negative control. Then, 2 ml of 1% BSA (Vivantis, USA) prepared in phosphate-buffered saline (PBS, pH 6.4) was added to 2 ml of plant extracts with varying concentrations. After that, the mixtures were incubated at ambient temperature for 20 min and then heated at 70 °C for 5 min. After cooling under running tap water, their absorbance was measured at 660 nm with a UV-VIS spectrophotometer (Shimadzu,

Japan). The experiment was carried out in triplicates and the percentage inhibition for protein denaturation was calculated using the following equation:

$$\% \text{ inhibition of denaturation} = (1\text{-}D/C) \text{ X } 100. \quad (2.1)$$

Where D is the absorbance of the test sample and C is the absorbance of negative control (without test sample or reference drug).

3.4 Statistical analysis

The collected medicinal plant data was compiled using Microsoft Office Word 2007 and Microsoft Office Excel 2007. Figures were generated using Microsoft Office Excel 2007.

Statistical analysis of anti-inflammatory assay was done using SPSS version 22.0. Data were expressed as means ± S.E.M. For comparison between ethanol and aqueous extract, a t-test was performed. $p<0.05$ was considered statistically significant.

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Traditional knowledge and utilisation of medicinal plants by Temuan tribes in Kampung Orang Asli Hulu Kemensah

A total of 14 villagers were interviewed during this study, which comprised seven males and seven females. Most of the respondents aged 30 and above have gone through primary or secondary education. Our findings indicate that the Temuan people in Kampung Orang Asli Hulu Kemensah still preserve their knowledge and utilisation of medicinal plants. According to the villagers, they tend to use medicinal plants as their primary health care. Their first try is to cure the ailments with medicinal plants, and if the ailments are not cured, they have to go to the clinic or nearby hospital to seek medication. This may be due to the availability of medicinal plants and the affordability of modern medicines.

This study recorded a total of 45 species of medicinal plants used in Kampung Orang Asli Hulu Kemensah. Generally, the medicinal plants recorded are from herbs and woody plants. Table 4.1 lists these medicinal plants including species name, family name, local names, ailments or conditions treated, parts used, preparation and administration of the plants.

The 45 species of medicinal plants recorded belong to 32 families. The most common family was Fabaceae, which is represented by five species, followed by Zingiberaceae (four species). The Fabaceae (Leguminosae) was the third largest family of flowering plants. The fruit is technically called legume or pod. Examples of medicinal plants listed in this study are *Parkia speciosa* (petai) and *Archidendron jiringa* (jering). Zingiberaceae is the ginger family of flowering plants. Members of the family frequently have flesh rhizomes. Examples of medicinal plants listed in this study are *Curcuma longa* (kunyit) and *Zingiber montanum* (bonglai).

The families Asteraceae, Arecaceae, Melastomataceae, Menispermaceae, Poaceae, and Rubiaceae were each represented by two species of medicinal plants. Families represented by one species of the medicinal plants were Annonaceae, Araceae, Blechnaceae, Caricaceae, Cucurbitaceae, Gentianaceae, Hypericaceae, Hypoxidaceae, Lauraceae, Lythraceae, Malvaceae, Marantaceae, Muntingiaceae, Musaceae, Myrsinaceae, Oxalidaceae, Phyllanthaceae, Piperaceae, Polypodiaceae, Simaroubaceae, Smilacaceae, Thymelaeaceae, Urticaceae and Vitaceae. Medicinal plants used by the villagers belong to a variety of families, demonstrating that these villagers use numerous plant taxa for medicinal plant purposes.

4.2 Highlighted medicinal plant species

Among the medicinal plants documented, *Cinnamomum javanicum* was observed as the medicinal plant that treats the most ailments and conditions with seven ailments and conditions. This was followed by *Curcuma longa* with five ailments and conditions. *Homalomena sagittifolia* was the most commonly used medicinal plant species by Temuan in this village where 11 of 14 respondents use the species. Meanwhile, *Cratoxylum formosum* was the species with the highest number of parts used among all the medicinal plants recorded.

Curcuma longa, or commonly known as turmeric, is used to treat swelling, wounds, burns, bone fractures and ear pain. It is used by pounding the rhizome and applying it topically to the affected area. In comparison, the Temuan people in Kampung Tering, Negeri Sembilan used the pounded rhizome of *C. longa* to treat acne and pimples (Ong *et al*., 2011). In addition, the Javanese Malay community in Parit Jelutong, Batu Pahat Johor use *C. longa* for various ailments and conditions. Decoctions or infusions from the rhizome are used for anti-ageing, dyspepsia, postnatal care, flu, detoxification, facial and skincare, and internal wound healing (Ismail *et al*., 2018). Leaf and rhizome of *C.*

longa are also used by villagers Kampung Batu Ring, Lenggong, Hulu Perak for spice, skin and maternity (Aziz & Zakaria *et al*., 2013). In addition, Malay villagers in Kampung Mak Kemas, Terengganu use the rhizome for postpartum, pimples, sores and abrasion. The young rhizome is used for facial dermatitis by eating it raw. Meanwhile, the old rhizome is used for anti-ageing by taking the juice orally. The old rhizome is also used to treat difficulty in breathing by applying the juice topically on the chest (Ong *et al*., 2011d). This shows that there are similarities and differences in the usage of *C. longa* among indigenous and local communities, besides indicating that there is diverse knowledge on the usage of *C. longa* among indigenous and local communities in Malaysia. A lot of research has been done on *C. longa*. It possesses a bioactive compound called curcumin that has therapeutic potential as an anti-cancer, anti-diabetic, anti-inflammatory and anti-ageing agent (Kotha & Luthria, 2019). This verified the traditional knowledge and usage of *C. longa* among indigenous and local communities in Malaysia.

Homalomena sagittifolia (Kemoyang) is widely used by the Temuan people in Kampung Orang Asli Hulu Kemensah to treat postpartum. Its leaf is heated and bound on hot *batu tungku* and is applied topically on the stomach. It is also used to treat the bone fracture and jaundice. For bone fracture and jaundice, its leaf is heated first and bound at the bone fracture site and baby's body, respectively. The Temuan tribe of Ayer Hitam Forest, Selangor also use *H. sagittifolia* for different applications. They drink its leaf and root decoction to treat fever. They also apply its pounded root on distended stomachs (Hanum & Hamzah, 1999). There are only a few studies done on the biochemical compound and pharmacological activity of *H. sagittifolia.* A study by Eldeen *et al*. (2016) showed that the leaves of *H. sagittifolia* possess trans-phytol and glycolipids compounds that are responsible for the anti-inflammatory and antibacterial properties of this plant. Further studies on *H. sagittifolia* should be done as this plant is

most commonly used by Temuan people in Kampung Orang Asli Hulu Kemensah. This plant also needs to be preserved as it is exposed to over-exploitation due to being regularly collected and used by Temuan people.

Figure 4.1: *Homalomena sagittifolia* (Araceae) (Photo taken at Kampung Orang Asli Hulu Kemensah).

Cratoxylum formosum (Mampat) recorded the highest number of parts used among all the medicinal plants documented in this study. Its stem exudate, root and leaf are used to treat various ailments and conditions. The stem exudate is used to treat wounds by cooking it with coconut oil and applying it to the wound area. According to the villagers, this mixture acts as a 'glue' to close the wound. Meanwhile, its root is used to treat diabetes by drinking its root decoction. The leaves are also used to treat jaundice by taking a bath with the decoction of the leaf. It is also a very popular herbal plant in Thailand; the leaf is used for food poisoning and to stop internal bleeding, while the root is used to treat diarrhoea (Anderson, 1986). Many studies have been carried out to

explore its chemical and medicinal properties. *C. formosum* leaves possess antioxidants and potential roles in the protection of vascular dysfunction (Kukongviriyapan *et al*., 2007). Leaf extracts also showed potent cytotoxicity against cholangiocarcinoma cells (CCA), the most common form of liver cancer in the Southeast Asean region (Senggunprai *et al*., 2016). Moreover, the ethanolic extract of *C. formosum* leaves also showed gastroprotective activity against gastric mucosal damage in rats (Sripanidkulchai *et al*., 2010). Altogether, these studies show that *C. formosum* has a lot of medicinal properties with some of the ethnomedical claims that have been verified by scientific evidence.

Figure 4.2: *Cratoxylum formosum* (Jack) Dyer (Hypericaceae) (Photo taken at Kampung Orang Asli Hulu Kemensah).

Table 4.1: List of medicinal plant species and their application

BIL	Botanical name	Local name	Ailments (s) or conditions (s) treated	Part (s) used	Preparation (s)	Administration
1.	*Alpinia purpurata* (Zingiberaceae)	Tepus cacing	Ringworm disease	Root	Decoction	Taken orally
2.	*Archidendron jiringa* (Jack) Nielsen (Fabaceae)	Jering	Diabetes	Root	Decoction	Taken orally
3.	*Areca catechu* (Arecaceae)	Pinang	Diabetes	Root	Decoction	Taken orally
4.	*Aquilaria malaccensism* (Thymelaeaceae)	Pokok gaharu	Asthma	Bark core	Raw	Inhalation
5.	*Averrhoa bilimbi* (Oxalidaceae)	Belimbing buluh	Jaundice	Leaf	Decoction with root and leaf of *Pericampylus glaucus*	Bath
6.	*Bambusa* sp. (Poaceae)	Buluh muda	Asthma	Juice from stem-taken in the morning	Raw	Taken orally
7.	*Bauhinia* sp. (Fabaceae)	Akar lepang	Asthma	Juice from stem	Raw	Taken orally
8.	*Blechnum orientalis* (Blechnaceae)	Paku daging	Wound	Leaf	Pounded	Applied topically

9.	*Calamus manan* (Arecaceae)	Rotan manau	Asthma	Juice from stem	Raw	Taken orally
10.	*Carica papaya* (Caricaceae)	Betik	Hypertension Diabetes	Leaf	Cooked	Taken orally
11.	*Cinnamomum javanicum* (Lauraceae)	Medang	Breast engorgement	Stem bark	Pounded	Applied topically
			Hypertension Pustule Internal swelling Internal injury Cough Colic	Root	Decoction	Taken orally
12.	*Clidemia hirta* (Melastomataceae)	Senduduk bulu	Waist pain Diarrhoea Flu	Root	Decoction	Taken orally
13.	*Coscinium blumeanum* (Menispermaceae)	Akar mengkunyit	Jaundice Urinary tract infection	Root	Decoction	Taken orally
14.	*Cratoxylum formosum* (Hypericaceae)	Mampat	Wound	Stem exudates	Cooked with coconut oil	Applied topically
			Diabetes	Root	Decoction	Taken orally
			Jaundice	Leaf	Decoction	Bath

15.	*Curcuma longa* (Zingiberaceae)	Kunyit	Swollen Wound Burns Bone fracture Ear pain	Rhizome	Pounded	Applied topically
16.	*Donax canniformis* (Marantaceae)	Bemban	Pustule	Fruit	Raw	Taken orally
			Breast cancer	Root	Decoction	Taken orally
17.	*Durio zibethinus* (Malvaceae)	Pokok durian	Postpartum Stomach ache	Stem bark	Decoction	Taken orally
18.	*Eurycoma longifolia* (Simaroubaceae)	Tongkat ali	Men and women general health Hypertension	Root	Decoction	Taken orally
19.	*Fagraea obovata* (Gentianaceae)	Akar tengkuk jawak	Asthma	Root	Infuse in water	Taken orally
20.	*Flemingia strobilifera* (Fabaceae)	Daun serengan	To help baby walk To help adults who have difficulty in walking	Leaf	Decoction	Bath
21.	*Hodgsonia macrocarpa* (Cucurbitaceae)	Akar teruak	Flu Cough	Juice from stem	Raw	Taken orally
22.	*Homalomena sagittifolia* (Araceae)	Kemoyang	Postpartum	Leaf	Heated	Bound on hot *batu tungku* and applied topically at the stomach.
			Bone fracture Jaundice			Bound topically

23.	*Labisia pumila* (Myrsinaceae)	Kacip Fatimah	Postpartum Women general health	Root	Decoction	Taken orally
24.	*Lawsonia inermis* (Lythraceae)	Daun inai	Wound Pustule	Leaf	Pounded	Bound and applied topically
25.	*Leptaspis urceolata* (Poaceae)	Pokok pelekat anak/perenas	Fertility	Rhizome	Decoction	Taken orally
26.	*Melastoma malabathricum* (Melastomataceae)	Akar kelodok putih/Senduduk putih	Dysentry Constipation Menstrual pain	Root	Decoction	Taken orally
27.	*Mikania micrantha* (Asteraceae)	Daun gentam/ulan	Wound	Leaf	Pounded	Applied topically
28.	*Molinera latifolia* (Hypoxidaceae)	Lembak	Centipede bite	Leaf	Raw	Bound topically
29.	*Muntingia calabura* (Muntingiaceae)	Pokok ceri	Hypertension	Fruit	Raw	Taken orally
30.	*Musa spp.* (Musaceae)	Jantung pisang	Increase breast milk secretion	Fruit	Cooked	Taken orally
31.	*Parkia speciosa* (Fabaceae)	Petai	Diabetes Hypertension	Root	Decoction	Taken orally
32.	*Pericampylus glaucus* (Menispermaceae)	Akar gasing	Jaundice	Root Leaf	Decoction	Bath
33.	*Phyllanthus amarus* (Phyllanthaceae)	Dukung anak	Jaundice	Leaf	Decoction	Bath
34.	*Piper betel* (Piperaceae)	Daun sireh	Wound	Leaf	Pounded	Applied topically

35.	*Poikilospermum suaveolens* (Urticaceae)	Akar setawan	Asthma Flu	Juice from stem	Raw	Taken orally
36.	*Polyalthia bullata* (Annonaceae)	Tongkat ali hitam	Lethargy	Root	Decoction	Taken orally
37.	*Pyrrosia piloselloides* (Polypodiaceae)	Pokok duit-duit	Pustule	Leaf	Pounded	Applied topically
38.	*Saprosma corymbosa* (Rubiaceae)	Akar sementut	Ringworm disease	Root	Decoction	Taken orally
39.	*Senna alata* (Fabaceae)	Gelenggang	Tinea corporis Tinea versicolor	Leaf	Pounded	Applied topically/bath
40.	*Smilax myosotiflora* (Smilacaceae)	Ubi jaga	Men and women general health	Rhizome	Decoction/raw with *Piper betel L*	Taken orally
41.	*Uncaria callophylla* (Rubiaceae)	Akar kelait	Asthma Cough Flu	Juice from stem	Raw	Taken orally
42.	*Vernonia arborea* (Asteraceae)	Akar barah dalam	Cancer	Root	Decoction	Taken orally
43.	*Vitis vinifera* (Vitaceae)	Buah anggur	Jaundice	Juice from fruit	Raw	Taken orally
44.	*Zingiber montanum* (Zingiberaceae)	Bonglai	Swollen Itch	Rhizome	Pounded	Applied topically
45.	*Zingiber spectabile* (Zingiberaceae)	Chadak	Mouth ulcer Toothache	Stem exudates	Raw	Applied topically

4.3 Ailments or conditions treated

Temuan people in Kampung Orang Asli Hulu Kemensah still depend on medicinal plants in treating ailments and conditions from simple ailments to chronic diseases such as diabetes, hypertension, and asthma. According to the results obtained during the survey, 36 ailments and health conditions are treated using plants by the Temuan community in Kampung Orang Asli Hulu Kemensah. The ailments and conditions treated include inflammatory-related disease, gastrointestinal problems, dermatological problems and other health problems.

Asthma and jaundice are the most common ailment and health conditions treated with seven species of medicinal plants. The next most common ailment and health condition treated is wounds with six species of medicinal plants, followed by hypertension and diabetes with five species of medicinal plants each. Asthma is mainly treated by drinking raw juice from the stem of the medicinal plants *Poikilospermum suaveolens* (Blume) Merr., *Uncaria callophylla* Blume, *Bauhinia* sp*., Bambusa* sp. and *Calamus manan.* Juice from the stem of *P. suaveolens* (Blume) Merr. and *U. callophylla* Blume is also used to treat flu. The juice from the stem of *Bambusa* sp. needs to be collected in the morning and taken from young plants. According to the villagers, the juice from the stem of the medicinal plants above can be consumed as an alternative to fresh water in case of water shortage in the forest.

Another plant that is used to treat asthma is *Aquilaria malaccensism* Lamk. Its application involves inhalation of the plant bark core. Asthma is one of the inflammation-related disorders. Ma *et al*. (2021) reported the anti-inflammatory effect of one sesquiterpene from *A. malaccensism* agarwood, which significantly inhibits NO production in LPS-induced macrophages. This gives the evidence for traditional knowledge of *A. malaccensism* in treating asthma. In comparison, the Jah Hut tribe at

Kampung Pos Penderas, Pahang also burn dried wood and leaves of *A. malaccensism* as part of a healing ceremony to treat various ailments (Ong *et al*., 2012a).

Besides, *Fagraea obovata* is also used by the Temuan community interviewed to treat asthma by drinking water infused with its roots. Similarly, the Temuans in Ulu Kuang village, Gombak were also reported to use *F. obovata* to treat asthma by drinking its root processed by decoction (Azliza *et al*., 2012), suggesting that it is a shared practice due to tradition and/or availability of the plant according to the locality.

Jaundice is mainly treated by rinsing the body with the leaf decoction of medicinal plants. The four species of medicinal plants utilised for this purpose are *Averrhoa bilimbi*, *Pericampylus glaucus*, *Cratoxylum formosum* (Jack) Dyer and *Phyllanthus amarus.* Leaves of *A. bilimbi* are decocted together with *the* root and leaf of *P. glaucus* to treat jaundice. Leaves extract of *A. bilimbi* contains various biochemical compounds such as flavonoids, phenols, tannins, alkaloids, cardiac glycosides (Alhassan & Ahmed, 2016). A study by Nagmoti *et al*. (2010) showed that methanolic of *A. bilimbi* leaves have hepatoprotective effects by preventing the elevation of serum bilirubin. High bilirubin in new born babies will cause jaundice; therefore, it is rational to use *A. bilimbi* for jaundice as ethnomedical claims.

Figure 4.3: *Averrhoa bilimbi* (Oxalidaceae) (Photo taken at Kampung Orang Asli Hulu Kemensah, Selangor).

The juice from the fruit of *Vitis vinifera* L. is given orally to babies with jaundice. According to the villagers, only some of the juice is to be given orally to the baby to treat jaundice. Another medicinal plant used to treat jaundice is *Coscinium blumeanum,* where its root decoction is drunk by the mother. The effects on the baby can be seen when the mother breastfeeds the baby.

Figure 4.4: *Coscinium blumeanum* (Menispermaceae) (Photo taken at Kampung Orang Asli Hulu Kemensah, Selangor).

Wounds are treated mainly by topically applying pounded leaves on the wound. The medicinal plants used to treat wounds are *Mikania micrantha*, *Lawsonia inermis, Piper betel*, and *Blechnum orientalis*. Similarly, the Kensiu tribe of Lubuk Ulu Legong, Kedah also use pounded leaves of *L. inermis* to treat cuts and wounds (Mohammad *et al.*, 2012). A lot of research studies have been done on *L. inermis* as it contains various types of chemical compounds like terpenoids, alkaloids, phenolic compounds, tannins which are responsible for various pharmacological activities of this plant (Chaudhary *et al*., 2010). A study by Rekik *et al*. (2019) showed that the high content of bioactive components in *L. inermis* oil induces an effective wound healing effect in *in vivo* study. This verified the ethnomedical claims of *L. inermis* to treat wounds.

Piper betel is also used to treat wounds by applying the pounded leaf to the wound. This corresponds with pharmacological studies done by Keat *et al*. (2010), which showed a protective effect of *P. betel* in the early phase in wound healing by increasing

wound contraction rate and total protein content. Traditional medicine practitioners of the rural Malay village in Masjid Ijok Village, Perak also use the poultice of *P. betel* leaf to stop bleeding in the nose (Ramli *et al*., 2015).

In wound healing, water extract of *B. orientalis* has been examined on Sprague Dawley rats and showed a significant reduction in wound size and higher collagen synthesis (Lai *et al*., 2011). All the scientific studies verified the traditional knowledge of the plants in treating wounds.

4.4 Parts of the plant used

Temuan at Kampung Orang Asli Hulu Kemensah utilised almost all of the plant parts to treat ailments and conditions. There are seven different plants part used in treating ailments and conditions. Figure 4.5 shows the percentage of plant parts used in the preparation of medicine used by Temuan at Kampung Orang Asli Hulu Kemensah. Among the plant parts utilised to treat the ailments or conditions, the root was observed to be the most frequently used part of the plant with 34% (17 species) of the plants documented from this village. This was followed by leaf and juice from the stem with 28% (14 species) and 12% (6 species), respectively. Use of fruit, stem barks/stem exudates and rhizome made up to 8% (4 species), respectively. Only 2% (1 species) use inner stem wood or '*teras*' to treat the ailments or conditions.

The practice of using roots is in agreement with previous studies on the Temuan community (Ong *et al*., 2011c; Azliza *et al*., 2012). A previous study on the Kensiu Tribe of Lubuk Ulu Legong, Kedah Malaysia also showed that the root is the main part used in medicinal plants (Mohammad *et al*., 2012). According to Milow *et al.* (2017) root and leaves are the two most common medicinal plant parts used by the indigenous tribes in Peninsular Malaysia. In traditional Chinese pharmacopoeia, more than one-quarter of the preparations are derived from root/rhizomes (Rasmann *et al*., 2012). The

practice of mainly using roots can be supported by the research done by Lezoul *et al*. (2020) on several medicinal plants showing that roots and leaves contain a higher number of bioactive compounds compared to other plant parts.

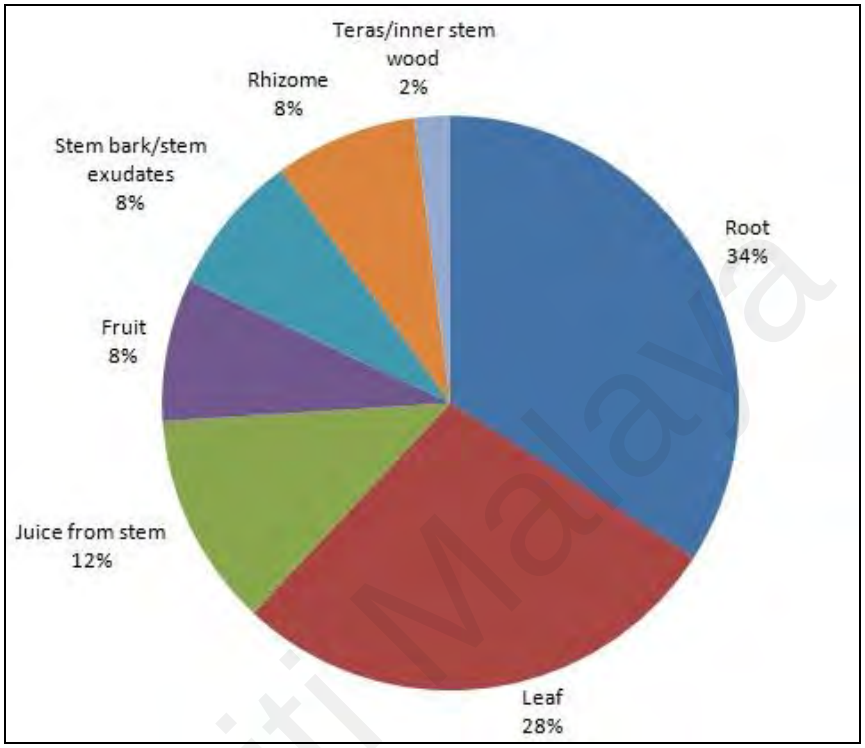


Figure 4.5: Percentage of plant parts used in the preparation of medicinal plant.

Parkia speciosa Hassk, *Areca catechu L*., and *Polyalthia bullata* King are examples of medicinal plants whose roots have been used to treat ailments and health conditions. *Parkia speciosa* Hassk or *petai* is used to treat hypertension and diabetes in Kampung Orang Asli Hulu Kemensah. The root is decocted and consumed orally. Similarly, it is used by the Temuan tribe in Ulu Kuang Village, Gombak and Kampung Tering, Negeri Sembilan to treat hypertension and diabetes by taking its root decoction orally (Ong *et al*., 2011a; Azliza *et al*., 2012). The similarities of its usage suggest the effectiveness of *petai* root in treating hypertension and diabetes. This can be taken as clues for drug development and is worthy of further investigation. Meanwhile, rural Malay villagers of

Masjid Ijok Village, Perak use its fruit infusion to treat diabetes by taking it orally (Ramli *et al*., 2015). This practice agrees with pharmacological studies in which empty pods and seeds of *P. speciosa* contain flavonoids, polyphenol and phytosterol that demonstrated good anti-oxidant activity, hypoglycaemic effects and anti-cancer properties (Kamisah *et al*., 2013).

Areca catechu L. or locally known as *pinang* is used in Kampung Orang Asli Hulu Kemensah to treat diabetes. The root decoction is taken orally. Meanwhile, Malay practitioners of traditional medicine in Masjid Ijok Village, Perak use its root decoction to treat kidney stones (Ramli *et al*., 2015). Its fruits are used by the Kensiu Tribe of Lubuk Ulu Legong Kedah to treat fever. The fruits are soaked in water that has been "blessed" with an incantation and the resulting infusion is taken orally (Mohammad *et al*., 2012). This shows that the root of *A. catechu* and its fruit are used among indigenous and local communities for different applications. A lot of compounds are isolated mainly from the seeds *A. catechu* such as flavons, alkaloids and tannins, which contribute to many pharmacological activities of this plant. These include antiparasitic effects, regulatory effects on blood glucose and lipids, antibacterial and antifungal effects, as well as anti-inflammatory and promotion of digestive functions (Peng *et al*., 2015). Thus, some of the traditional usages have been validated by the current investigations. However, Wu *et al*. (2010) reported that this plant also contains arecoline that contributes to the toxic effects.

Polyalthia bullata King or better known as *Tongkat ali hitam* is among the plants used by indigenous people to cure lethargy in Kampung Orang Asli Hulu Kemensah. It is used by drinking water of the decocted root orally. Similarly, the Jakun community of Kampung Peta, Johor drink its root decoction for fatigue (Sabran *et al*., 2016). The Temuan people in Ulu Kuang village drink its root decoction to treat asthma, diabetes

and waist pain (Azliza *et al*., 2012). The Jah Hut community at Kampung Penderas, Pahang also drink its root decoction as a male tonic (Ong *et al*., 2012a). These demonstrate the various usages of *P. bullata* King roots to treat different ailments and conditions among indigenous people. Fatty acid (*cis* - vaccenic) and its methyl ester profiled from the root extract of *P. bullata* have been shown to display antioxidant activity (Zaman *et al*., 2020). Alkaloid compounds have been also detected in the root extract of this plant, which possess anti-microbial, anti-inflammatory, anticancer, antimalarial, antifungal and anti-parasitic activities (Addla *et al*., 2012; Gensicka-Kowalewska *et al*., 2017; Kukowska, 2017), which gives evidence to some of the ethnomedical claims of *P. bullata*.

Figure 4.6: *Polyalthia bullata* King. (Annonaceae) (Photo taken at Kampung Orang Asli Hulu Kemensah, Selangor).

4.5 Preparations of medicinal plants

There are six different methods used by Orang Asli at Kampung Hulu Kemensah in preparing the medicinal plants for treating ailments and conditions. Medicinal plants are used in two ways: through the process of preparation or direct use. Figure 4.7 shows the

percentage of methods used in preparing the medicinal plants by Orang Asli at Kampung Hulu Kemensah. The most common method used in the preparation of medicinal plants was decoction with 46% (23 species), followed by eaten/applied/inhaled raw with 26% (13 species), pounded with 18% (9 species), cooked with 6% (3 species), heated and infused in water with 2% (1 species).

The decoction, which is mainly used for the preparation of medicinal plants, is consistent with other available reports (Ong *et al*., 2011a; Ong *et al*., 2011c; Azliza *et al.*, 2012; Mohammad *et al*., 2012; Ismail *et al*., 2018). The decoction is also a commonly used preparation method in Traditional Chinese medicine (TCM). Total phenolic compounds were highest in the decoction method compared to other extraction methods (Wang *et al*., 2019; Lezoul *et al*., 2020; Martins *et al.,* 2014). This suggests that the preparation of a decoction is more effective than other methods in extracting phenolic compounds.

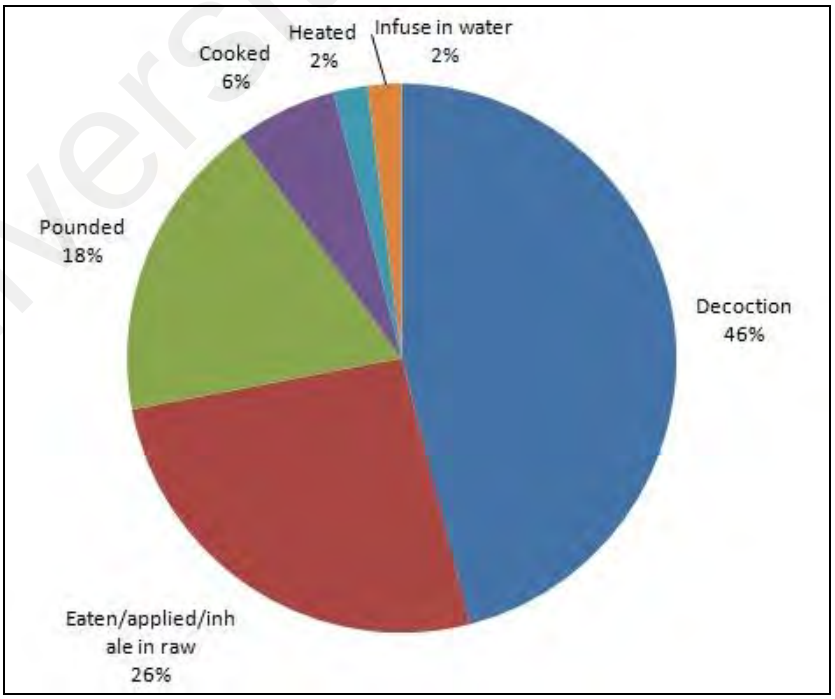


Figure 4.7: Percentage of methods used in preparing the medicinal plant

Labisia pumila, Eurycoma longifolia and *Phyllanthus amarus* are examples of the medicinal plants for which decoction is used to prepare the medicinal plants in treating ailments and conditions. *Labisia pumila* or known as *Kacip fatimah* is a popular herb in Malaysia. It is usually used for women's health. Similarly, Temuan people in Kampung Orang Asli Hulu Kemensah also use *Labisia pumila* for women's general health and to treat postpartum, which is used by drinking the water of the decocted root. Indigenous and local communities in Malaysia use both root and leaf decoction of *Kacip fatimah* to treat ailments and conditions. As for Temuan in Ulu Kuang village, they utilise both leaf and root decoction for overall health and swelling (postpartum) (Azliza *et al.*, 2012). Meanwhile, Kensiu tribe of Lubuk Ulu Legong, Kedah only drink root decoction for postpartum and to increase energy (Mohammad *et al*., 2012). The Javanese-Malay community in Parit Jelutong, Johor drink decoction of leaves of *Kacip fatimah* as a health tonic for pre-and post-menopausal women (Ismail *et al*., 2018). Extensive research has been done on this plant to explore its biochemical compound and activity. Biochemical compounds in these plants exhibit pharmacological activities such as anti-estrogenic disease, antioxidant, and anti-microbial, which agree with the traditional usage of this plant to maintain the female reproductive system, as postpartum medication, and to enhance sexual function (Chua *et al*., 2012).

Eurycoma longifolia or *Tongkat ali* is also a popular herb in Malaysia used by many local communities for men's health. Similarly, for the Temuan in Kampung Orang Asli Hulu Kemensah, it is used for men's and women's general health by drinking its root decoction. Moreover, it is also used for hypertension by taking its root decoction orally. Similarly, other indigenous and local communities use its root decoction as an energy booster or sexual energy for men (Azliza *et al.*, 2012; Ong *et al*., 2011a; Ismail *et al*., 2018; Mohammad *et al*., 2012; Samuel *et al*., 2010). The root decoction is also used to

treat hypertension (Azliza *et al*., 2012; Mohammad *et al*., 2012). Numerous *in vivo* animal studies and human clinical trials have been conducted to examine the role of *Tongkat ali* in various sexual disorders in men. This plant has been shown to have good potential to improve male sexual health (Thu *et al*., 2017). This gives evidence to the traditional use of *Tongkat ali* for male health.

Phyllanthus amarus or *Dukung anak* is used to treat jaundice in Kampung Orang Asli Hulu Kemensah, Selangor by taking a bath with a decoction of its leaves. Similarly, Malay villagers in Kg Mek Kemas, Terengganu and Orang Asli Kg Bawong Perak use a decoction of the whole plant to treat jaundice by taking a bath (Ong *et al*., 2011d; Samuel *et al*., 2010). Neonatal jaundice is very common in new-borns owing to high bilirubin production. According to Maity *et al*. (2013), the ethanol extract of *P. amarus* root has a potential for bilirubin clearance in neonatal jaundice in mice where gallic acid is the major compound responsible for this activity. Therefore, it is rational to use this plant for jaundice as ethnomedical claims. Meanwhile, other villagers use *P. amarus* to treat other conditions and ailments. Malay villagers in Kg Mek Kemas, Terengganu also orally drink whole plant decoction to treat diabetes, hypertension, and pain during menses (Ong *et al*., 2011d). Meanwhile, the Javanese-Malay community, Parit Jelutong, Batu Pahat Johor use a decoction of its leaves to treat diarrhoea and fever. Decoction of its fruit is also used to treat haemorrhoids and as a blood purifier (Ismail *et al*., 2018).

4.6 Administration of medicinal plants

A total of four different administrations of medicinal plants are used by Temuan in Kampung Orang Asli Hulu Kemensah to treat ailments and conditions. The administration of medicinal plants is done either by oral consumption, applied/bound topically, inhalation or bath. Figure 4.8 shows the percentage of the administration of

medicinal plants used by Temuan in Kampung Orang Asli Hulu Kemensah. The most common administration of medicinal plants was taken orally with 60% (30 species), followed by applied/bound topically with 26% (13 species), bath with 12% (six species), and inhalation with 2% (one species).

The administration of medicinal plants is most often via oral administration and is in agreement with other studies (Ong *et al*., 2011a; Ong *et al*., 2011c; Azliza *et al*., 2012; Mohammad *et al*., 2012; Ismail *et al*., 2018), This might be owing to the feasibility and ease of administration of the method (Homayun et al., 2019).

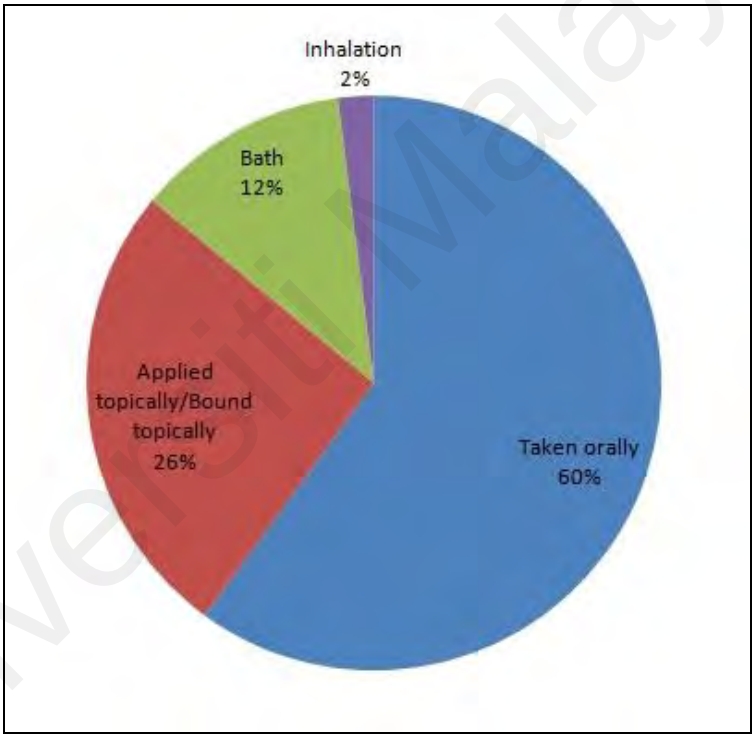


Figure 4.8: Percentage of administration used in medicinal plant

Smilax myosotiflora, Carica papaya and *Durio zibethinus* are examples of medicinal plants taken orally as the mode of administration of the medicinal plants in treating ailments and conditions. *Smilax myosotiflora* or *ubi jaga* is used in Kampung Orang Asli Hulu Kemensah for the general health of men and women. Its rhizome is taken orally by decoction or raw with *Piper betel L.* Similarly, Temuan in Ulu Kuang village

consume it by decocting the rhizome for overall health. Its decocted rhizome is also consumed to treat fracture and muscle pain (Azliza *et al.*, 2012). Meanwhile, the Jah Hut tribe consume its decocted rhizome for virility and back pain (Lin, 2005). The traditional practice of *S. myosotiflora* for men general health and sexual performance agrees with the study by Wan *et al*. (2016), which demonstrated that methanolic extract of *S. myosotiflora* promotes sexual booster as it increases the testosterone level in the treated rats.

Carica papaya is used to treat hypertension and diabetes in Kampung Orang Asli Hulu Kemensah where its leaves are cooked and taken orally. Similarly, Javanese-Malay in Parit Jelutong, Batu Pahat, Johor use shoot decoction or ate it raw to treat hypertension and diabetes (Ismail *et al*., 2018). Malay villagers in Mek Kemas, Terengganu also use its shoots and flowers to treat hypertension by scalding and eating them. According to Santana *et al*. (2019), the leaves of *C. papaya* contain a high level of saponins, tocopherol, flavonoids, polyphenolic compounds, benzyl isothiocyanate and pro-anthocyanins. Pulp, leaves and seeds of *C. papaya* have been shown to display hypolipidemic, hypoglycaemic, anti-hypertensive, and increased antioxidant activity in *in vitro* and *in vivo* experimental models (Santana *et al*., 2019). This supports the ethnomedical claims of *C. papaya* leaves, which are used for hypertension and diabetes. Meanwhile, other villagers use *C. papaya* to treat other conditions and ailments. Leaves of *C. papaya* are used to treat amenorrhea (absence of menstruation); the leaves are blended with water and juice taken orally (Ong *et al*., 2011d). Practitioners of the medicinal plant at Masjid Ijok, Perak used its ripe fruit to treat constipation by taking it orally (Ramli *et al*., 2015).

The Temuan in Kampung Orang Asli Hulu Kemensah use *Durio zibethinus* for postpartum and to treat stomach ache by taking the water decoction of the stem bark

orally. A study by Jiang *et al*. (2020) showed that the polysaccharide of D *zibethinus* bark can regulate intestinal flora and treat functional constipation in rats. Meanwhile, Temuan in Ulu Kuang village drink its root decoction to treat hypertension and diabetes (Azliza *et al.*, 2012). Similarly, Ong & Azliza (2015) reported that Orang Asli in Selangor including Mah Meri and Temuan tribe drink its root decoction to treat diabetes.

4.7 Medicinal plants for anti-inflammatory analysis

Three medicinal plants, which are *Cinnamomum javanicum, Clidemia hirta and Zingiber montanum*, were chosen for anti-inflammatory assay. These medicinal plants are used by Temuan Kg Orang Asli Hulu Kemensah to treat inflammatory conditions like swelling, pain or flu.

4.7.1 *Cinnamomum javanicum*

Figure 4.9: *Cinnamomum javanicum* (Lauraceae) (Photo taken at Kampung Orang Asli Hulu Kemensah, Selangor).

Cinnamomum javanicum (synonym; *Cinnamomum sulphuratum, Cinnamomum neglectum* and *Laurus malabatrum*) belongs to the family Lauraceae. The bark of *Cinnamomum* spp. is widely used as a spice in Malaysia and other countries. The famous species is *Cinnamomum zeylanicum*, which is usually known as *kayu manis* in Malaysia. *C. javanicum* has been widely used as traditional medicine for chest pain, abscess, fatigue, lethargy, abdominal disorder, gynaecological disorder, postpartum, colic, abortion, spasmodic, and sexual debility (Kumar *et al*., 2019). *C. javanicum* (Medang) is used by Temuan in Kampung Hulu Kemensah to treat internal swelling. It is prepared by decocting its root and is taken orally. Apart from treating internal swelling, its root decoction is also used to treat hypertension, pustule, internal injury, cough and colic. Its stem bark is also used to treat breast engorgement in breastfeeding mothers, which is prepared by applying the pounded of the stem bark topically. Meanwhile, the Temuan community in Kampung Tering, Negeri Sembilan use *C. javanicum* to treat abscess. It is done by pounding its leaves and applying them to affected parts topically (Ong *et al*., 2011a).

Pharmacological properties of *C. javanicum* include anti-inflammatory (Maridass, 2008), anti-microbial (Yuan *et al*., 2017), anti-viral (Rizwana *et al*., 2010), anti-fungal (Jantan & Ali, 1992), and antioxidant (Salleh *et al*., 2016). Maridass (2008) reported that methanolic extract of bark of *C. sulphuratum* inhibited carrageenan-induced paw oedema formation. Since the root is commonly used in Temuan Kg Orang Asli Hulu Kemensah, the root was selected to be evaluated for anti-inflammatory assay by the protein denaturation inhibition method.

4.7.2 *Clidemia hirta*

Figure 4.10: *Clidemia hirta* (Melastomaceae) (Photo taken at Kampung Orang Asli Hulu Kemensah, Selangor).

Clidemia hirta (Koster's curse), also known as soap bush, belongs to the family Melastomaceae. It is known as *senduduk bulu* and *keduduk bulu* among the Malay and indigenous communities, respectively. Fruits of *C. hirta* are edible and its leaves can be used as soap. The stem is used to treat menstruation in women by boiling it. The leaf is used to treat bleeding or wound by pounding and applying topically. The decoction of the leaf is used as an antidysenteric and antispasmodic agent, besides being soaked in water and used as an antiseptic for the woman genital region (McClatchey, 1996; Rizki *et al*., 2019). In many areas, it is considered a weed or invasive species. *Clidemia hirta* disturbs food crop cultivation and a lot of studies have been done to control its growth (Dewalt *et al*., 2004; Hafiz *et al*., 2014; Ramadzan *et al*., 2012). However, for indigenous people, *C. hirta* is used as medicine to treat waist pain, flu and diarrhoea in Kampung Orang Asli Hulu Kemensah. It is prepared by decocting its root and taken orally. Malay villagers in Masjid Ijok, Perak drink its root decoction as a poison antidote (Ramli *et al*., 2015).

There are only a few studies on *C. hirta*'s antibacterial (Melendez & Capriles, 2006; Norhayati *et al*., 2013; Tatiana Lopez *et al*., 2016), antioxidant (Lopez *et al*., 2016; Narasimham *et al*., 2017) and anticancer (Narasimham *et al*., 2017) properties. To date, there is no report on the anti-inflammatory effects of *C. hirta*. Thus, this study focuses on exploring *in vitro* anti-inflammatory activity of the *Clidemia hirta* root extract using the protein denaturation inhibition method.

4.7.3 *Zingiber montanum*

Figure 4.11: *Zingiber montanum* (Zingiberaceae) (Photo taken at Kampung Orang Asli Hulu Kemensah, Selangor).

Zingiber montanum belongs to the family Zingiberaceae. Its synonyms include *Zingiber cassumunar, Zingiber anthorrhiza, Amomum montanum, Amomum cassumunar, Amomum xanthorhiza, Cassumunar roxburghii, Costus cassumunar,* and *Jaegera Montana*. It is known as *bonglai* among indigenous people. *Zingiber montanum*

is used throughout the world as traditional medicine. Singh *et al.* (2015) have reviewed its medicinal uses. In Malaysia, it is used for postpartum, stomach ache and vermifuge. Meanwhile, in Thailand, the oil of *Z. montanum* is used to treat muscle pain by rubbing it. Besides, in Indonesia and India, it is commonly used to treat stomachaches. Meanwhile, in Canada, it is used to treat asthma by combining it with other medicinal plants (either with tarragon or Rosemary and cypress). In the United States, *Z. montanum* is used as a post-operative blend on knee surgery. Apart from that, *Zingiber montanum* has been reported to be used for swelling, rheumatism, numb feet, painful parts, asthma, bruises, fever, diarrhoea and others in Manipur, India (Sharma *et al*., 2007). *Zingiber montanum*, locally known as *Plai* in Thailand, is extensively used to treat musculoskeletal pain, sprain and bruise (Chongmelaxme *et al*., 2017).

Zingiber montanum is used in Kampung Orang Asli Hulu Kemensah to treat swelling. It is prepared by pounding its rhizome and applying it topically. Besides treating swelling, its rhizome can be used to treat itches. The Temuan in Ulu Kuang village also use the grated rhizome to treat gout, shingles and ascites (Azliza *et al.*, 2012). Many studies have shown pharmacological activities of *Z. montanum* providing some evidence for the ethnomedicinal claims. These include anti-inflammatory (Panthong *et al*., 1997; Tanticharoenwiwat *et al*., 2017), anticancer (Anasamy *et al*., 2013), antioxidant (Nagano *et al*., 1997), and anti-microbial activities (Pithayanukul *et al*., 2007). Compound D {(E) -4- (3, 4 – dimethoxyphenyl) but-3-en-2-ol} has been isolated from *Z. montanum* and showed anti-inflammatory activity (Panthong *et al*., 1997). It showed significant anti-inflammatory effects on carrageenan rat paw induced oedema. In this study, a protein denaturation inhibition test was conducted to gain insight into the anti-inflammatory activity of *Z. montanum*.

4.8 Anti-inflammatory activity

The anti-inflammatory activity of three medicinal plants, which are *Cinnamomum javanicum, Clidemia hirta and Zingiber montanum*, was analysed using the inhibition of protein denaturation method. Protein denaturation is a well-documented cause of inflammation (Anoop & Bindu, 2015; Sangeetha & Vidhya, 2016). Protein denaturation refers to the loss of biological properties of protein molecules. The ability of substance or plant extracts to prevent protein denaturation may also help prevent inflammation disorders.

Anti-inflammatory activity of three medicinal plants namely *Cinnamomum javanicum, Clidemia hirta and Zingiber montanum* was analysed with indomethacin used as a positive control. This present study showed that ethanol and aqueous extract of three medicinal plants inhibited protein denaturation. Table 4.2 and figure 4.12 show the percentage inhibition of protein denaturation of Indomethacin in different concentrations. The highest percentage inhibition of protein denaturation for indomethacin (69.32 ± 0.00%) was observed at the concentration of 200 µg/ml. Indomethacin is one of the most potent NSAIDs used in treating arthritis and other joint inflammatory conditions. Indomethacin is also effective in the treatment of migraine and headache, which have become known as 'indomethacin-responsive' headache disorder (VanderPluym, 2015). Indomethacin, like other NSAIDs, produces an anti-inflammatory effect by inhibiting the synthesis of prostaglandin as well as COX1 and COX2 enzymes (Seibert *et al*., 1997; Blobaum *et al*., 2013). Additionally, according to Lucas (2016), indomethacin may have potent vasoconstrictive activity and nitric oxide-dependent inhibitory pathway activity.

Table 4.2: Effects of indomethacin on inhibition of protein denaturation.

Concentration (µg/ml)	Percentage inhibition (%)
100	57.14 ± 0.00
200	69.32 ± 0.00
300	16.21 ± 1.82
400	5.26 ± 3.04
500	4.02 ± 1.3

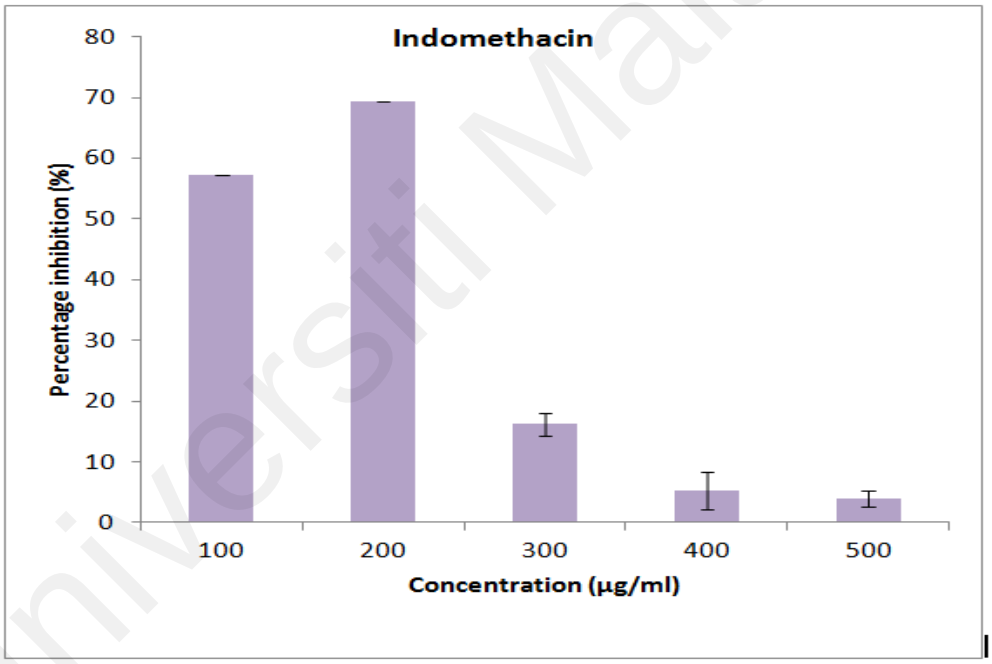


Figure 4.12: Percentage inhibition of protein denaturation of indomethacin in different concentration

4.8.1 *Cinamomum javanicum*

Table 4.3 and figure 4.13 display the percentage inhibition of protein denaturation of *Cinnamomum javanicum* in different concentrations. The highest percentage inhibition of protein denaturation of *C. javanicum* for ethanol extract (48.00 ± 4.00%) and aqueous

extract (45.33 ± 3.53%) was observed at the concentration of 300 µg/ml. There was no significant difference in percentage inhibition between ethanol and aqueous extract at the concentration of 100 µg/ml, 200 µg/ml, 300 µg/ml, and 400 µg/ml except for the concentration of 500 µg/ml. Aqueous extract showed higher percentage inhibition (12.28 ± 4.39%) than ethanol extract (-3.51 ± 0.88%) at concentration of 500 µg/ml. Ethanol extract at the concentration of 500 µg/ml showed small negative inhibition.

The result of this study showed that aqueous extract of *C. javanicum* inhibited protein denaturation similar to the ethanol extract, and even showed higher inhibition at 500 µg/ml. This result supports the decoction practice of the *C. javanicum* root to treat inflammatory conditions among villagers of Kampung Orang Asli Hulu Kemensah. The highest percentage inhibition of protein denaturation of *C. javanicum* for ethanol extract (48.00 ± 4.00%) and aqueous extract (45.33 ± 3.53%) was lower compared to the highest percentage inhibition of Indomethacin (69.32 ± 0.00%), which was at the concentration of 200 µg/ml.

A previous study reported the anti-inflammatory activity of *C. javanicum* plant bark on carrageenan-induced oedema formation in albino rats. Findings from the study showed that methanolic extract of this plant bark (200 mg/kg) significantly inhibited oedema formation by 71.43% (Maridass, 2008). Maridass (2008) also reported that methanolic crude extracts of *C. javanicum* bark consist of terpenoids and phenolic groups and that this compound may be responsible for anti-inflammatory activity. According to Baruah *et al*. (1999), the stem bark oil and leaf oil of *C. javanicum* was found to be rich in cinnamaldehydes (66.4%) and citral isomers (45.4%), respectively. Citral isomers found were neral (17.6%) and geranial (27.8%).

Cinnamaldehydes is the cinnamon tree's most important constituent (Rao & Gan, 2014). The anti-inflammatory activity of cinnamaldehyde was demonstrated in both *in*

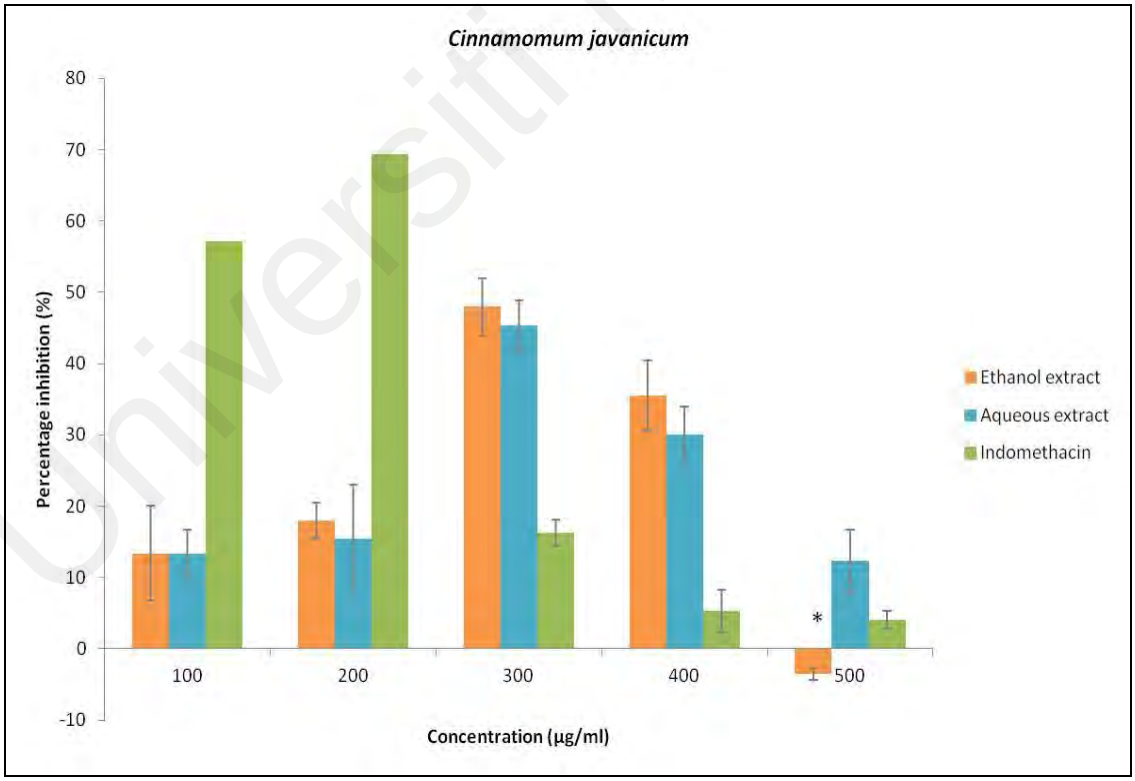
vivo and *in vitro* experimental models. In *in vitro* experiment, Chao *et al*. (2008) found that a low concentration of cinnamaldehydes (μM) inhibited the secretion of pro-inflammatory cytokines, which are interleukin-1beta (IL-1β) and TNF-α in lipopolysaccharide (LPS) or lipoteichoic acid (LTA) stimulated murine macrophages. Liao *et al*. (2012) investigated the anti-inflammatory activity of cinnamaldehyde in both *in vitro* and *in vivo* models. In the *in vitro* model, cinnamaldehyde significantly inhibited the level of nitric oxide (NO), TNF-α and prostaglandin E2 in LPS-stimulated macrophages. In the *in vivo* model, cinnamaldehyde reduced carrageenan-induced rat paw oedema and increased the activities of superoxide dismutase (SOD), catalase (CAT) and glutathione peroxidase (GPX) in paw tissue.

Citral has a rich lemony scent; plants such as ginger and lemongrass are rich in citral content (Kiran *et al*., 2013; Wilson *et al*., 2002). Liao *et al*. (2015) revealed the anti-inflammatory activity of citral isomers. They separated citral into neral and geranial pure forms. Both neral and geranial demonstrated their efficacy in inhibiting cytokine expression in LPS-stimulated murine macrophages. More potent anti-inflammatory activity was shown by neral, including significant inhibition of cytokine secretion (IL-6 and IL-1β and TNF-α) and inflammatory molecule expression (COX-2, iNOS, pro IL-1β and NLRP-3) (Liao *et al*., 2015). The anti-inflammatory effect of aqueous and ethanol extract of *C. javanicum* root in this study might be due to the presence of the bioactive compound discussed above. However, further study is warranted to analyse biochemical compounds in the root of *C. javanicum* itself since the villagers of Kampung Orang Asli Hulu Kemensah use the root of *C. javanicum* to treat inflammatory conditions. Further *in vitro* and *in vivo* studies can also be conducted to analyse the anti-inflammatory activity of the *C. javanicum* root and investigate its underlying mechanism.

Table 4.3: Effects of ethanolic and aqueous extract of *C. javanicum* on inhibition of protein denaturation.

Concentration (µg/ml)	Percentage inhibition (%)		
	Ethanol extract	Aqueous extract	Indomethacin
100	13.33 ± 6.67	13.33 ± 3.33	57.14 ± 0.00
200	17.95 ± 2.56	15.38 ± 7.69	69.32 ± 0.00
300	48.00 ± 4.00	45.33 ± 3.53	16.21 ± 1.82
400	35.48 ± 4.93	30.11 ± 3.88	5.26 ± 3.04
500	(-3.51) ± 0.88*	12.28 ± 4.39	4.02 ± 1.3

* $p<0.05$ as compared to aqueous extract.



* $p<0.05$ as compared to aqueous extract.

Figure 4.13: Percentage inhibition of protein denaturation of *C. javanicum* in different concentrations.

4.8.2 *Clidemia hirta*

Table 4.4 and figure 4.14 showed the percentage inhibition of protein denaturation of *Clidemia hirta* in different concentrations. The highest percentage inhibition of protein denaturation of *C. hirta* for ethanol extract (37.06 ± 4.04%) and aqueous extract (30.07 ± 8.07%) was observed at the concentration of 100 µg/ml. There was no significant difference in percentage inhibition between ethanol and aqueous extract at the concentration of 100 µg/ml, 200 µg/ml, and 300 µg/ml except for the concentration of 400 µg/ml and 500 µg/ml. Aqueous extract showed a higher negative percentage inhibition than ethanol extract for both concentrations of 400 µg/ml and 500 µg/ml. In higher concentration, it yielded a negative value of inhibition, which shows that it resulted in increased denaturation of proteins, thus suggesting some form of toxicity (William *et al*., 2008).

The result of this study showed that aqueous extract of *C. hirta* inhibited protein denaturation similar to ethanol extract at the concentration of 100 µg/ml, 200 µg/ml, and 300 µg/ml. This result supports the decoction practice of the *C. hirta* root to treat inflammatory conditions among villagers of Kampung Orang Asli Hulu Kemensah. The highest percentage inhibition of protein denaturation of *C. hirta* for ethanol extract (37.06 ± 4.04%) and aqueous extract (30.07 ± 8.07%) was lower compared to the highest percentage inhibition of Indomethacin (69.32 ± 0.00%), which was at the concentration of 200 µg/ml.

To date, there is no report on the anti-inflammatory effects of *C. hirta*, but the compounds in *C. hirta* root have been studied by El Abdellaoui *et al*. (2014). They successfully isolated a compound from the root of *C. hirta* identified as arjunolic acid, a triterpenoid saponin. The arjunolic acid showed antibacterial properties (El Abdellaoui *et al*., 2014). The anti-inflammatory activity of this triterpenoid saponin from the root of

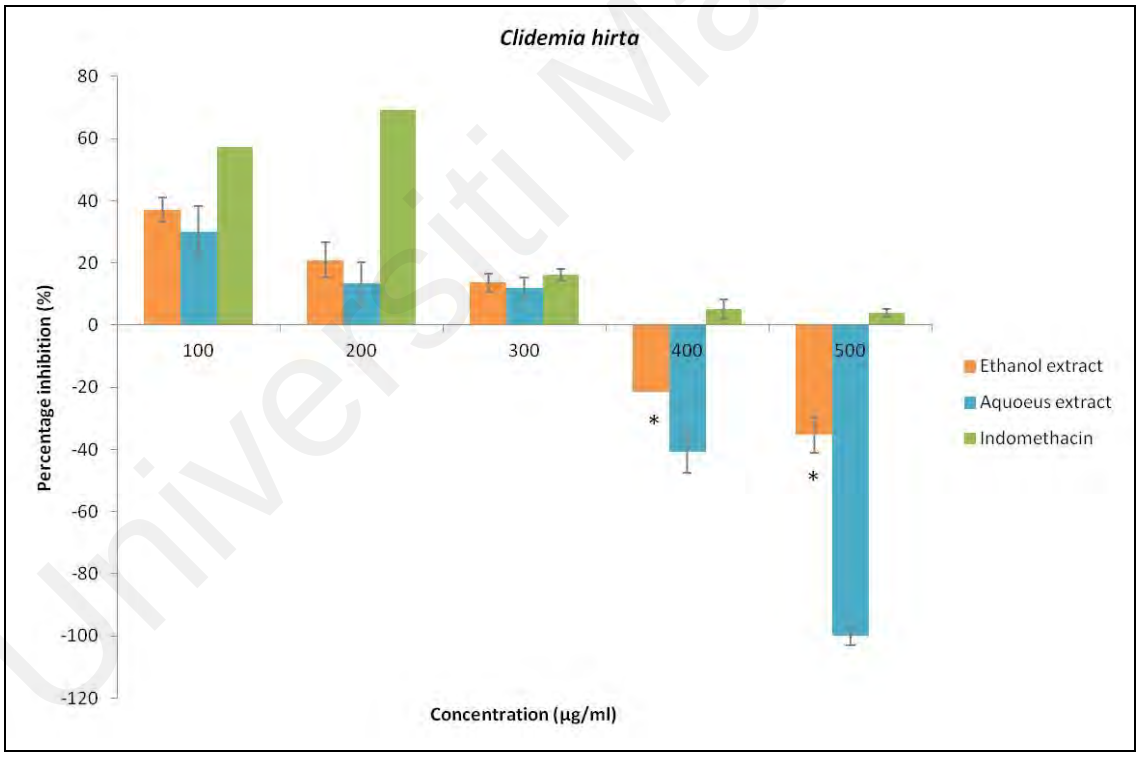
C. hirta was not tested in any research. However, there are several studies done to evaluate the anti-inflammatory potential of this triterpenoid saponin extracted from different medicinal plants. For example, arjunolic acid from *Terminalia terbula* was tested for anti-inflammatory activity, while arjunolic acid inhibited nitric oxide (NO) production induced by LPS in macrophages. Their activities are mediated by inhibiting the protein expression of iNOS and COX2 (Yang *et al*., 2014). Nono *et al*. (2014) isolated arjunolic acid from the root of *Dissotis thollonii* Cogn. This plant was in the same family as *C. hirta*, which is Melastomaceae. They found that the MeOH, n-BuOH, and EtOAc extract of *D. thollonii* showed a reduction of NO level in lipopolysaccharide (LPS) stimulated NO production in RAW 264.7 murine macrophage cells.

Facundo *et al*. (2005) quantified arjunolic acid from dried roots ethanolic extract of *Combretum leprosum* and revealed the presence of 65% arjunolic acid in the dried root of the plant. The root extract was able to significantly inhibit carrageenan-induced paw oedema with 37.6%. Besides anti-inflammatory potential, arjunolic acid also has a lot of bioactivities such as antioxidant, antimicrobial, antitumour, antifungal, antidiabetic, and wound healing (Ghosh & Sil, 2013). The anti-inflammatory effect of water and ethanol extract of *C. hirta* root in this study might be due to the presence of the arjunolic acid, a triterpenoid saponin. However, further in vitro and in vivo studies are strongly recommended to analyse the anti-inflammatory effect of C. hirta root and investigate the underlying mechanism. *C. hirta* is considered a weed or invasive species in many areas. By investigating the biochemical activities of this plant, it is hoped that this plant can be used for medicinal purposes in the future.

Table 4.4: Effects of ethanolic and aqueous extract of *C. hirta* on inhibition of protein denaturation.

Concentration (µg/ml)	Percentage inhibition (%)		
	Ethanol extract	Aqueous extract	Indomethacin
100	37.06 ± 4.04	30.07 ± 8.07	57.14 ± 0.00
200	20.9 ± 5.65	13.37 ± 6.79	69.32 ± 0.00
300	13.71 ± 2.93	12.01 ± 3.38	16.21 ± 1.82
400	(-21.39) ± 0.00 *	(-40.66) ± 6.95	5.26 ± 3.04
500	(-35.35) ± 5.62 *	(-100.00) ± 3.03	4.02 ± 1.3

* $p<0.05$ as compared to aqueous extract.



* $p<0.05$ as compared to aqueous extract.

Figure 4.14: Percentage inhibition of protein denaturation of *C. hirta* in different concentrations.

4.8.3 *Zingiber montanum*

Table 4.5 and figure 4.15 showed the percentage inhibition of protein denaturation of *Zingiber montanum* in different concentrations. The highest percentage inhibition of protein denaturation of *Z. montanum* for ethanol extract (34.27 ± 0.00%) and aqueous extract (37.4 ± 3.13%) was observed at the concentration of 100 µg/ml. There was no significant difference in percentage inhibition between ethanol and aqueous extract at the concentration of 100 µg/ml, 200 µg/ml, and 500 µg/ml except for the concentrations of 300 µg/ml and 400 µg/ml. Ethanol extract showed positive percentage inhibition while aqueous extract displayed negative percentage inhibition for both concentrations of 300 µg/ml and 400 µg/ml.

In contrast with *C. javanicum* and *C. hirta* in which the decoction method is used to treat anti-inflammatory conditions, *Z. montanum* is used by villagers of Kampung Orang Asli Hulu Kemensah by pounding its rhizome to treat swelling and itch. The result of this study showed that ethanol extract of *Z. montanum* inhibited protein denaturation similar to an aqueous extract at the concentrations of 100 µg/ml, 200 µg/ml, and 500 µg/ml. At the concentrations of 300 µg/ml and 400 µg/ml, the ethanol extract showed better inhibition compared to aqueous extract. The highest percentage inhibition of protein denaturation of *Z. montanum* for ethanol extract (34.27 ± 0.00%) and aqueous extract (37.4 ± 3.13%) was lower compared to the highest percentage inhibition of indomethacin (69.32 ± 0.00%), which was at the concentration of 200 µg/ml.

Anti-inflammatory activity of *Z. montanum* has been reported in several studies. A previous study reported a significant anti-inflammatory effect of compound D {(E) -4-(3, 4 – dimethoxyphenyl) but-3-en-2-ol} from *Z. montanum* on carrageenan-induced rat paw oedema (Panthong *et al*., 1997). Compound D exerted a better effect than aspirin at

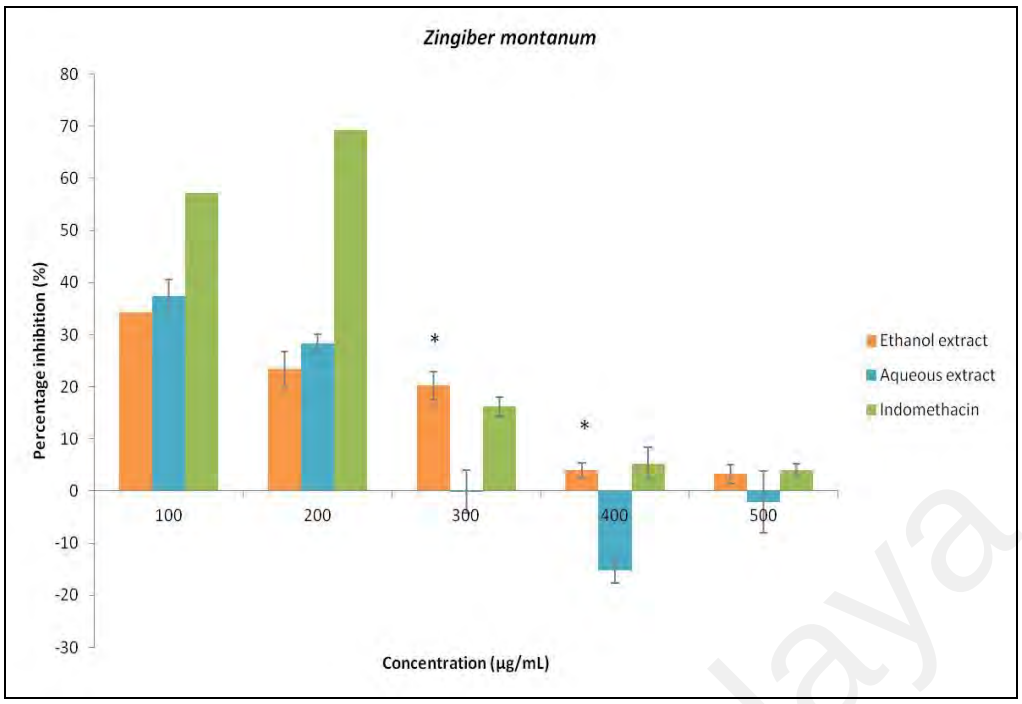
the same dosage level (300 mg/kg). Compound D {(E) -4- (3, 4 – dimethoxyphenyl) but-3-en-2-ol} (DMPBD) was also tested on rat ear oedema. Results showed that DMPBD inhibited ear oedema more potent than standard drugs. In 12-O-tetradecanoylphorbol 13-acetate (TPA) induced ear oedema, DMPBD was 11 times more potent than Diclofenac with IC_{50} of 660 and 7200 nmol, respectively (Jennapongsa *et al*., 2003).

Z. montanum or known as *Phlai* is produced in capsule form in Thailand. Research done by Tanticharoenwiwat *et al*. (2017) showed good antihistamine activity in both 100 mg *Phlai* capsule (4 mg of compound D) and 200 mg *Phlai* capsule (8 mg of compound D). The inhibitory effect of the *Phlai* capsule was found to be less potent than loratadine (antihistamine drug) in the histamine skin prick test. The anti-inflammatory effect of water and ethanol extract of *Z. montanum* rhizome in this study might be due to the presence of the compound D. However, further studies are recommended to investigate the underlying mechanism of this anti-inflammatory activity.

Table 4.5: Effects of ethanolic and aqueous extract of *Z. montanum* on inhibition of protein denaturation.

Concentration (µg/ml)	Percentage inhibition (%)		
	Ethanol extract	Aqueous extract	Indomethacin
100	34.27 ± 0.00	37.4 ± 3.13	57.14 ± 0.00
200	23.33 ± 3.33	28.33 ± 1.67	69.32 ± 0.00
300	20.19 ± 2.71*	(-0.16) ± 4.14	16.21 ± 1.82
400	3.98 ± 1.37*	(-15.23) ± 2.38	5.26 ± 3.04
500	3.23 ± 1.86	(-2.15) ± 5.99	4.02 ± 1.3

* $p<0.05$ as compared to aqueous extract



* $p<0.05$ as compared to aqueous extract.

Figure 4.15: Percentage inhibition of protein denaturation of *Z. montanum* in different concentrations.

In conclusion, all medicinal plants extracts were most effective in inhibiting the protein denaturation at the concentrations of 100 µl/ml (*C. hirta, Z. montanum*) and 300 µl/ml (*C. javanicum*). Nevertheless, the percentage of inhibition was lower compared to the indomethacin. *C. javanicum* showed the highest percentage inhibition of protein denaturation among other medicinal plant extracts. The medicinal plant extracts and indomethacin can be arranged according to their potency in inhibiting the protein denaturation in the following order: Indomethacin (69.32 ± 0.00%) > ethanol extract *C. javanicum* (48.00 ± 4.00%) > water extract of *C. javanicum* (45.33 ± 3.53%) > water extract of *Z. montanum* (37.4 ± 3.13%) > ethanol extract *C.hirta* (37.06 ± 4.04%) > ethanol extract *Z. montanum* (34.27 ± 0.00%) > water extract of *C.hirta* (30.07 ± 8.07%).

The result of anti-inflammatory activities of the medicinal plants in this study provided some support for the ethnomedicinal claims by indigenous people in Kampung Orang Asli Hulu Kemensah who use these medicinal plants for inflammatory conditions. Lastly, further studies are strongly recommended to analyse the biochemical compounds and reveal the underlying mechanisms responsible for the anti-inflammatory activities of medicinal plants in this study. In addition, the possible toxicity of medicinal plants to the human need to be explored.

CHAPTER 5: CONCLUSION

The Temuan is one of the largest indigenous tribes in Malaysia. Their lifestyle is closely related to the use of medicinal plants. After eight days of interviews, this study has successfully documented the information of medicinal plants from 14 respondents comprising 50% males and 50% females. A total of 45 medicinal plants species from 32 families was recorded in Kampung Orang Asli Hulu Kemensah. The most common families were Fabaceae and Zingiberaceae. All the medicinal plants recorded are used to treat 36 different ailments or health conditions, with the most common being asthma, jaundice, wound, hypertension, and diabetes. The root and leaves are the most frequently used parts of the medicinal plant to treat ailments and health conditions with 17 and 14 species, respectively. The common method used in the preparation of medicinal plants is decoction with 46% (23 species). The most common administration of medicinal plants is via oral administration with 60% (30 species).

Cinnamomum javanicum, Clidemia hirta, and *Zingiber montanum* have been selected for anti-inflammatory analysis. These three medicinal plants species possess a good anti-inflammatory activity through inhibition of protein denaturation. The medicinal plant extracts can be arranged according to their potency in inhibiting the protein denaturation in the following order: ethanol extract of *C. javanicum* (48.00 ± 4.00%) > water extract of *C .javanicum* (45.33 ± 3.53%) > water extract of *Z. montanum* (37.4 ± 3.13%) > ethanol extract *C. hirta* (37.06 ± 4.04%) > ethanol extract of *Z. montanum* (34.27 ± 0.00%) > water extract of *C. hirta* (30.07 ± 8.07%). By discovering anti-inflammatory potential from medicinal plant extracts, it is hoped that it can serve as the basis for the development of new anti-inflammatory medications in the future.

The knowledge of the medicinal plants should be appreciated; documentation of their usage is crucial to conserve the knowledge and ensure their utilisation in the future.

Furthermore, the knowledge on medicinal plants used can be the basis for further studies to determine their chemical constituents and their efficacy in treating ailments. These studies may potentially contribute to the development of new pharmaceuticals and thereby promote public health. Studies like this are also important for promoting the conservation of medicinal plants and their habitats. Furthermore, recognition should be given to respective indigenous tribes for all significant findings and patents obtained from the knowledge they have generously shared.

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