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## Traditional Use of Malaysian Plants for Insect Bite: A Review

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**Abstract** – The reaction of insect bites to humans is often neglected as it is considered not to have life threatening effects. In recent years, the disease transmission caused by the insects has become an eye opener for researchers to study in detail the reactions caused by the arthropods. Insect bites could cause various mild or severe effects on humans which necessitate effective insecticides or treatment. However, the commercially available insecticides contain various chemicals, making it not environmentally friendly. Therefore, this review focusses on the traditional use of medicinal plants available in Malaysia used for insect bites. Plants have various properties against insects, including anti-inflammatory, antioxidant, anti-feeding, analgesic, and antinociceptive properties. The plants listed here are easily accessible, cost effective, and environmentally friendly. With that in mind, this review focusses on the description of Malaysian plants that have been used traditionally for insect bites.

**Keywords** – *Insect bite, medicinal plant, insecticide, traditional, Malaysia*

### 1. INTRODUCTION

Insect bite reactions are commonly reported throughout the world which causes wound or reaction. Insects have three-part body, compound eyes, three pairs of jointed legs and two antennae are arthropods and exoskeleton. Some insects cause wound through bites while, certain insects inflict wound and inject venom through sting (1). Mosquitoes are members of the order Diptera, suborder Nematocera and family Culicidae (1).

The foreign materials introduced by the insects through its bites or stings may result in dermatological reactions including swelling, pain, skin irritation and some adverse reaction in certain situations (2). Hence, an effective repellent or treatment against bites and stings are necessary. However, the chemicals present in the commercially available pesticides are extremely harmful to humans as their toxicity affects the nervous system and the skin, causing swelling, rashes, and eye irritation. Therefore, the use of bio-based natural repellents or treatment are highly recommended over chemical repellents (3). Numerous natural sources of insect repellent are available in the market. All these natural products

have their own ingredients to act as pesticides or to treat insect bites. Each plant discussed has its own active ingredients that play an important role in treating insect bites. In this review, description of Malaysian plants is given that have been traditionally used traditionally in the treatment of insect bites.

### 2. *MENTHA X PIPERITA* L (PEPPERMINT)

Peppermint, scientifically known as *Mentha x piperita* L belongs to the genus *Mentha* and Lamiaceae family. This plant is also known as the mint or sage family. It is also known as *daun pudina* in Malay. The species originated in Europe and is distributed in northern and eastern Europe, Africa, United States of America, and Asia. *Mentha x piperita* is a natural hybrid from *Mentha spicata* and *Mentha aquatica* (4). Peppermint is known as an aromatic herb and grows to 30-90 cm and its stems are quadrangular and erect. The stems are highly branched with purplish or tonged violets. The leaves are dim or light green and in the shape of oblong-ovate, opposite, serrate and short-petioled with toothed margins and range between 4 and 5 cm long. The flowers are 8 mm long, purple, or reddish coloured, whereas the fruits

consist of four ellipsoidal nutlets. The plant is commonly known for its biological effects and healthy properties, hence it's an important therapeutic aromatic herb.

The biological effects include antimicrobial, anti-inflammatory, antioxidant, anti-allergic, anti-viral and anti-hypertensive properties (4). Mint possesses many active compounds beneficial to human society. Previous study has shown that mint essential oil is composed of various secondary metabolites (5, 6). The main chemical compounds present in mint include limonene, cineole, menthofuran, menthone, menthy, isomenthone, acetate, isopulegol, menthol, pulegone and carvone (7). Other chemical compounds present in mint include flavonoid glycoside, polyphenols, luteolin-diglucuronide and eriodictiol glucopyranosyl-rhamnopyranoside (8). However, the amount of chemical compounds varies between species due to genetic factors, physiological and geographical variations and environmental conditions (9). Previous study has shown that the essential oil of mint has been used as a mosquito repellent (10). The mint oil can create a cooling sensation on the skin for burning, stinging, and itching sensation caused by bites or stings of insects. In addition, the study shows that mint oil can act as an antimicrobial and an anti-inflammatory, which can reduce the risk of infection associated with some insect bites (6). Peppermint oil has a strong mosquito repellent action against different species of mosquitoes. The oil is used in selective areas where water is stagnant as it affects the fertility of mosquitoes that emerge from larvae exposed to peppermint oil, whereby, the oil has strong larvicidal activity against various species of mosquitoes (11).

### 3. *PHYLLANTHUS ACIDUS* (OTAHEITE GOOSEBERRY)

The Otaheite gooseberry, scientifically known as *Phyllanthus acidus* (*P. acidus*), is an edible small yellow berry fruit member of the family Euphorbiaceae. The trees are also known as Malay Gooseberry, Star Gooseberry, Indian Gooseberry, and Country Gooseberry. In Malaysia, it is called *Cermai*, *Ceremai*, *Cermela*, or *Kemangur*. The *P. acidus* originated from the coastal region of north-eastern Brazil and is widely distributed in Thailand, South Vietnam, Laos, Indonesia, India, Myanmar, Polynesia, the islands of the West Indies and Peninsular Malaysia. The gooseberry tree is small, 4-9 m tall, with sparingly branched trees and the bark is rough, lenticel, glabrous branchlets grouped at the apex of the

branches, giving the crown an open, spreading appearance. The leaves are pinnate shaped, 20-40 cm long and the leaflets are broadly ovoid, short, and simple. The tree has pinkish, small, clusters of 5-12 cm long flowers. The fruits are greenish yellow to pale yellow, glossy, waxy, 1.5-2.5 cm in diameter and have 6-8 shallow lobes. The fruits are juicy, firm, thin and enclose a hard, grooved stone with 6-8 seeds in 5-8 mm diameter. All the fruits grow in clusters along the old branches (12).

The *P. acidus* is often used as an anti-inflammatory, antibacterial and antidiabetic agent and known to be rich in antioxidants. The trees are rich in phytochemicals which are beneficial for human health. The phytochemicals found are alkaloids, flavonoids, phenols, steroids, terpenoids, mucilage and tannins. These active phytochemicals are detected in various parts of the trees. A study reported that the results in biological effects are associated with the high level of flavonoids and phenolics. The main source of phenolics and flavonoids are from the seeds. Thus, the seeds have promising carbohydrate hydrolysing enzyme inhibitory and antioxidant effects (13). The fruits are also rich in antioxidants, ascorbic acid and phenolic compounds (14). The *Phyllanthus* species is commonly used to treat insect poison and acts as a mosquito repellent. A study reported that *P. acidus* has insecticidal and medicinal values as it is proven that certain chemicals found in the plant are able to disturb the senses of mosquitoes (15). The chemicals are alkaloids and flavonoids. Alkaloids release insecticidal smoke when the plants are burnt. The smoke repels mosquitoes through direct toxicity where it affects the acetylcholine receptors in the nervous system, or the membrane sodium channels of nerves. Flavonoids act as mosquito repellents by binding to proteins and exhibiting toxicity. The usage of natural products as mosquito repellents can minimize some environmental effects caused by pesticidal compounds (15).

### 4. *PARKIA SPECIOSA* (STINK BEAN)

*Parkia speciosa* (*P. speciosa*) or stink bean is also known as Petai in Malaysia, Indonesia, and Singapore, as Sator or Sataw in Thailand and U'pang in the Philippines. *P. speciosa* is a member of the Fabaceae family and a popular plant in Southeast Asia (16). This bean is commonly found in Malaysia, Indonesia, Thailand, Borneo, Singapore, Madagascar, India and the Philippines (17). The trees have a stem 1 m in diameter and

40 m in height. The sticky bean trees have fruit that is 35-55 cm long and 3-5 cm wide. It is oblong shaped, while the seeds are 2 cm in width and 3.5 cm in length. The shape is round at reaching maturity. The flower has a long stalk of 30-45 cm with a width of 2-6 cm, creamy white in colour with a leathery texture. The propagation of plants occurs by a few methods, including stem cutting, sowing and budding (17).

The *P. speciosa* is a plant rich in nutrients and phytochemicals which is capable to fulfil the needs of the food industry. The seed is the most nutritious part of this plant. The seeds are rich in carbohydrates, proteins, fats, fibres, fatty acids, and minerals. The minerals present are calcium, magnesium, potassium, iron, and phosphorus. In addition, the seeds contain phenolics, flavonoids, vitamin C and vitamin E. However, carbohydrates and potassium are detected in high concentration in the seeds. A few portions of trees are edible, including flowers, seeds, and pods. Furthermore, phenolics, alkaloids, terpenoids and flavonoids are found in all parts of the trees (18).

The plant is rich in antioxidants, especially total phenolics, which have the potential to be developed as a phytomedicine due to the presence of  $\beta$ -sitosterol, stigmasterone, stigmasterol, thiazolidine-4-carboxylic acid, trithiolane and hexathionine (16). This gives the plant high antioxidant benefits. The fruits are commonly used as an ingredient in cooking. However, it is also used as medicine traditionally to treat diabetes, clean and detoxify the urinary tract and kidneys, in cases of inflammation, liver failure, itchiness and to eliminate intestinal worms and oedema. The seeds are consumed as remedies (18). Furthermore, the peels of *P. speciosa* have an anti-inflammatory property. Thus, they are used to treat mosquito bites. The peels are rubbed on the affected area of the skin, resulting in the reduction of swelling (19). Flavonoids and lupeol, which are present in the fatty acid, are a pharmacologically active triterpenoid having anti-inflammatory properties (17). Flavonoids can inhibit the development of inflammation by reducing reactive oxygen species. Thus, it helps in treating inflammation caused by mosquito bites (20).

##### 5. CURCUMA ZANTHORRHIZA (JAVENESE TURMERIC)

*Curcuma Zanthorrhiza* (*C. zanthorrhiza*) belongs to the family Zingiberaceae and its synonym is *Curcuma xanthorrhiza*. The plant is commonly known as Javanese turmeric, Javan turmeric,

Giant curcuma, Java turmeric, Indian saffron and False turmeric. Its common names in Malaysia and Indonesia are *Temus lawas* and *Temu lawak* respectively. *C. zanthorrhiza* originated from Java, Indonesia. It is currently also found in Vietnam, Philippines, Yunnan in China, Malaysia, India, Surinam and Thailand (21). The plant has a pseudo stem with a height of 2-2.5 m and grows in clumps. The leaves are wide (18 cm) and long (50-55 cm), and each plant has 2-9 leaves. The flower stalks are slim and hairy with a length of 4-37 cm. The flower grows out of the rhizome and is surrounded by many leaves whose length is proportional or exceeds the level of the flower crown. The parent rhizome has an oval round shape, whereas the branch rhizome in the side part is elongated. Each plant has 3-4 branches of rhizome. This plant has a fibrous root system and the length is about 2.5 cm with an irregular location (22).

The *C. zanthorrhiza* has the potential to treat various diseases due to its antibacterial, antioxidant, antitumor, anti-inflammatory, neuroprotective and hepatoprotective properties. Terpenoids and curcuminoids are the most abundant phytochemicals in plants. The rhizome contains the main ingredients for the medicinal part, which are curcuminoids and sesquiterpenoids. The rhizome also contains xanthorrhizol (22). Curcuma species are known to treat insect bites (23). A study reported that *C. zanthorrhiza* has insecticidal properties where xanthorrhizol from the rhizome showed toxicity against the neonate larvae of *Spodoptera littoralis*. Topical contact of xanthorrhizol results in significant mortality of the larvae one hour after treatment (21). Furthermore, the ethanolic extract of the plant has mosquito repellent potential, especially against *Aedes* species (24).

##### 6. CITRUS HYSTRIX (KAFFIR LIME)

*Citrus* species are widely used in traditional medicine, culinary and as flavouring agent in foods. The species belongs to the Rutaceae family, and the commonly identified species are *Citrus hystrix*, *Citrus aurantifolia* Swingle, *Citrus microcarpa* Bunge, *Citrus limn* Burm and *Citrus mim* Merr. The native of the plant is Southeast Asia, including China, India, and Indochinese peninsula. The plant is widely distributed in Australia, the Netherlands, Germany, France, Italy, and Spain. The common names of *Citrus hystrix* (*C. hystrix*) are Kaffir lime, Maurities papeda, while it's known as Combava in France, Spain, and Italy. In Malaysia, it is known as *limau*

*purut. C. hystrix* are small trees of 2.5-3 m width and 3-6 m height. The trees have glabrous, spiny, crooked branches which are not straight. The leaves have unique characteristics, 7.5-10 cm long and 5 cm wide, unifoliolate, broadly ovate to ovate oblong, dark green on top and lighter at the bottom. However, the leaves have strong fragrances. The flowers are small, white, fragrant, while there are 4-5 petals, ovate oblong, yellowish white tinged with pink. The fruit colour is green turning to yellowish when ripe, large, globose, verrucose, warty and ovoid to elliptic, and has a 5-7 cm diameter. The fruit has an acidic and bitter taste with wrinkles on the skin of the fruit. The seeds are ridged, oblong and numerous (25).

The plant has a high content of flavonoid and phenolic compounds such as anthocyanin pigments, flavanols, flavones and isoflavones, thus being a potential antioxidant (25). In addition, it has several pharmacological properties including antiviral, anti-inflammatory, anti-allergenic, anti-ageing, and anti-carcinogenic properties. Furthermore, the fruits and leaves are often used to treat flu, hypertension, fever, diarrhoea, abdominal pains, and high blood pressure. The fruits are used as fragrances and flavours in cooking and medical treatments (25).

The essential oil from the leaf of Kaffir lime has insecticidal properties, especially against *Aedes aegypti* larvae (26), where the oil is rich in limonene, citronellal, pinene and citronellol. The oil applied on the skin is proven to keep against mosquito bites during day and night (27). The limonene present in the essential oil has acetylcholinesterase inhibition. This results in the accumulation of acetylcholine in the synapse, thereby the post-synaptic membrane in permanent stimulation. This condition leads to lack of coordination in the neuromuscular system and causes death. The oil applied can enter the body through mosquito larvae and be absorbed into the digestive tract through the intestinal wall. The oil circulation together with haemolymph results in a lack of energy in mosquitoes due to disruption in metabolism causing death (28).

#### 7. TAMARINDUS INDICA LINN (TAMARIND)

*Tamarindus indica* Linn (*T. indica* L) belongs to the Caesalpinaceae family, a subfamily of the Fabaceae family. It is commonly known as tamarind and is called Chinja in Ayurveda or Amlika in Hindi. In Malaysia and Indonesia, it is called Asam jawa. Tamarind is a tropical fruit found in Africa and Asia, which is highly valued for its pulp (29). The trees average 20-25 m in height, 1

m in diameter, and grow slowly but have a long life expectancy, lasting about 80 to 200 years on average (30). *T. indica* L extracts were found to have antidiabetic, hypolipidemic, hepatoprotective and antimicrobial properties (31). A phytochemical screening of the tamarind extract revealed the presence of flavonoids and tannins in pulp and saponins in seed that supported the traditional uses of the plant for treating various diseases (32). This plant is one of the most widely used in traditional medicine in Africa for treating many diseases, including fever, dysentery, jaundice, gonococci, and digestive disorders. In Malaysia, its fruits are traditionally used to treat fever, swellings, insect bites and stings (33). A previous animal study has shown that the aqueous extract of *T. indica* L leaves had anti-inflammatory and antinociceptive activities if given intraperitoneally in rats (34) that might support its use in treating insect bites.

#### 8. PIPER BETLE L (BETEL)

*Piper betle* L, also known as Sirih in Malaysia and Indonesia, Betel in English, Phlu in Thailand, and Paan in India and Bangladesh, is a member of the Piperaceae family (35). It is a creeper, dioecious, rootless, grows about one meter in height, and has many small adventitious leaves that mostly grow in hot and damped countries (36). *Piper betle* (*P. betle*) is believed to be native to Malaysia, however the plant is also cultivated in India, Sri Lanka, Bangladesh, Burma, and many other countries (36). Because of its known medicinal properties, *P. betle* is widely used throughout the world, even in modern times. It is also used in all aspects of human life, such as social, cultural, and religious aspects. *P. betle* leaves are traditionally used to treat wounds, boils, insect bites, and to aid digestion (37). The leaves are used for various conditions such as foul breath, for strengthening the tooth, as a feminine wash and for headaches and arthritis (38). A previous animal study showed that ingestion of the methanolic extract of *P. betle* leaves in rats had analgesic and anti-inflammatory properties (39) which support its use in treating insect bites by applying the paste of the leaves topically.

#### 9. CYMBOPOGON CITRATUS (LEMON GRASS)

*Cymbopogon citratus* (*C. citratus*) is an aromatic plant known as lemon grass and belongs to the Poaceae family. This perennial plant has long and slender leaves. *C. citratus* is an enduring herb native to Asia, Africa, South and North America

(40). The plant is called *Serai* in Malay. The major constituents identified in *C. citratus* essential oil were geraniol (27.04 %), neral (19.93 %) and myrcene (27.04 %) (41). However, other compounds such as jasmonates, polyketide, dihydrophenanthrenes, furanocoumarins, phenolics, and flavonoids have also been identified (42). The lemon-like scent is derived from a cyclic monoterpene (citral). *C. citratus* has various biological properties such as antimicrobial, anti-carcinogenic, anti-inflammatory, antioxidant, cardio-protective, antitussive, antiseptic, and anti-rheumatic properties (43). A previous animal study showed that *C. citratus* essential oil demonstrated anti-inflammatory and analgesic effects (41) and hence used in treating insect bites by applying the essential oil topically. Apart from that, its essential oil has also been used against insects, particularly mosquitoes, by interrupting certain phases of their growth. A previous study reported that *C. citratus* essential oil has larvicidal activity against *Aedes aegypti* by destroying intestinal cells microvilli, muscle as well as the fat body mass (44).

#### 10. *COLEUS BLUMEI* (COLEUS)

*Coleus blumei* (*C. blumei*), also known as *Solenostemon scutellarioides*, a member of the Lamiaceae family and the *Coleus* genus, is known by a variety of names in various parts of the world. This plant is commonly known as 'Ati-ati' by Malay population. In Philippines, it is known as 'Mayana' (45) and 'Miana' in Indonesia (46). It is native to Java (47), but now can be found in many tropical regions including Southeast Asia, Africa, and Australia (48). *C. blumei* varieties from Java are well-known house and garden plants that can grow up to one metre tall. *C. blumei* has square stems and two-lipped flowers that are small, blue, and in spikes. The phytochemical screenings showed that the *C. blumei* leaves extract contains flavonoid, terpenoid, tannin and saponin (49). The herb has been extensively studied as well as reported in several fields of science. The multiple potential of the herb includes anthelmintic activity (46), wound healing (45), anti-inflammatory effect (50), antiproliferative (50), antifungal (51), and antibacterial properties which includes oral bacteria (49) and methicillin-resistant *Staphylococcus aureus* (MRSA) (48). The compounds that are responsible for its anti-inflammatory, antiproliferative and anti-MRSA activities are terpenoids. (48, 50). *Coleus* genus is used in some communities for treating insect bites (51) which may be due to its anti-inflammatory effect. A previous animal study

showed that this plant caused necrosis of intestinal cells, liver, and kidney at 4000 mg/kg (52).

#### 11. *FIBRAUREA TINCTORIA* LOUR (AKAR BADI)

*Fibraurea tinctori* Lour is a Menispermaceae species and *Fibraurea* is the genus name. According to the literature, various Malaysian tribal groups have distinct names for this plant; Akar badi, Akar Kinching Kerbau, Akar Kuning, Akar kunyit, Akar penawar and Sekunyit. This species is widely distributed in Northern India, the Nicobar Islands, Burma, Thailand, Vietnam, eastern and southern China, Malaysia (Malaysian Peninsula, Sarawak, and Sabah), Brunei, Indonesia, and Philippines. In southeast Asia, this plant species is mostly found in native forests and rarely planted in gardens or residences (53, 54). *Fibraurea tinctoria* Lour is a huge, woody, climbing vine that can grow up to 40 metres tall with a stem diameter of up to 5 cm and yellow-coloured wood. The ethnomedicinal benefits attributed to this plant vary depending on the ethnic group that lives in the region where it grows. Ethnic Penan use the fresh juice from the stem to treat poisonous bites from insects, snakes, centipedes, and scorpions (55). However, the mechanism of action of this plant in treating insect bites is still unknown.

Based on the identification of several chemical compounds from this plant, proto-berberine alkaloids and furanodi terpenoids, was found. Further analysis found berberrubine, fibleucin, fibraurin, 6-hydroxyfibraurin, palmatrubine, pseudojatrorrhizine, carboxyfibleucin, chasmatine, colombamine, jatrorrhizine, magnoflorine, and palmatine. As the alkaloid in this plant was reported to effectively reduce the inflammation, this plant may reduce the inflammation-induced by insect bites (56).

#### 12. *GONIOTHALAMUS TAPISOIDES* MAT SALLEH (SELADA)

*Goniothalamus tapisoides* Mat Salleh, also known as Selada or Semukau, is endemic to Borneo, particularly in Sarawak's southern region. Borneo, northeast India, Myanmar, Thailand, Vietnam, Sumatra, Malaysian Peninsular, Singapore, Java, northeast Celebes, and the Philippines. This species is a little tree that grows to approximately 5 metres in height and is used as an abortifacient and to treat poisonous animal bites such as snakes, scorpions, and insect bites by the indigenous people (57). From the stem bark of this plant, eleven chemicals were isolated, namely, goniomicin A, goniomicin B, goniomicin C,

goniomicin D, tapisoidin, goniotalamin, 9-deoxygoniopyrpyrone, pterodondiol, liriodenine, benzamide and cinnamic acid. Spectroscopic analysis was carried out for known compounds and comparison was made with published data to identify all substances. The cytotoxic activity of goniotalamin against a colon cancer cell line (HT-29) was low, with an IC<sub>50</sub> of 5.60 M. With an IC<sub>50</sub> of 0.207 M, goniomicin B had the highest antioxidant activity of all the substances examined in the 2,2-diphenyl-1-picryl-hydrazyl-hydrate (DPPH) assay (58). According to Mat-Salleh et. al. (59) various ethnic groups pounded the leaves and bark and applied to wounds caused by snake and insect bites.

### 13. *CYATHULA PROSTRATA* (L) BLUME (HOOKWEED)

*Cyathula prostrata* (L) Blume (Amaratheceae) is a branching annual herb/shrub with stem trails on the ground that bears rhomboid-oblong leaves and sticky fruits. The species is also known by common name depending on the place and community as Ara Songsang (Kedah), Daun Ngarang (Malay), Hookweed (English), Ncharang (Bidayuh), Punt (Selako), Sansam Bawi (Timugon) (60). In Nigeria and other African countries, various preparations of this plant's leaves, stems, and roots have traditionally been used to treat a variety of illnesses, including articular rheumatism, cough, skin diseases, scabies, craw-craw, snake bites, bruises, liver problem, dysentery, diarrhoea, nausea, cholera vomiting blood, and many others (61). A teaspoon of the dried powdered root is boiled in water and given thrice day as a fever remedy among the Kurichayas tribe of Kannur District in Kerala, India (62). According to Gideon et al. (63), only alkaloids were detected in the ethanol extracts of leaf and stem bark, while terpenoids, tannins, flavonoids, saponins, glycosides, and steroids were found in the leaf, stem bark, and root extracts of *Cyathula prostrata* phytochemical analysis. The methanolic extract of this plant has been shown to have anti-inflammatory and analgesic properties, justifying its use in the traditional treatment of aches and insect bites by pounding the leaves into a paste and rubbing it on the affected area (60, 64).

### 14. *ZINGIBER OFFICINALE* ROSCOE (GINGER)

Ginger is obtained from the subterranean stems or rhizomes of the plant *Zingiber officinale* Roscoe, which is the most widely used spice. Ginger is widely described in the literature to be used as a

spice and flavouring agent all over the world and have a variety of medical benefits. It is also called as Halia (Malay), Halia Putih (Malay), Haliak (Orang Seletar), and Layo (Dusun). It is grown in Asia, Central, South America and Africa and comes from the underground stems or rhizomes of the plant. The plant is usually 3 to 4 feet tall with long, elongated, alternately arranged leaves (65). The therapeutic and biological qualities of the *Zingiber* genus are well known throughout the world. *Zingiber officinale* (*Z. officinale*) is the most well-known and researched species in this genus (66). Biological properties such as antibacterial, antioxidant, cytotoxic, insecticidal, and anti-inflammatory activities as well as food preservation characteristics have been found in several research. The chemical components of *Z. officinale* essential oil, which mostly consists of monoterpene and sesquiterpene hydrocarbons, have been attributed to these properties.

Zingiberene gives the plant its characteristic flavour and scent and geranial, ar-curcumene, -bisabolene, -sesquiphellandrene, and neral are the most abundant compounds found. Gingerol and shogaol are two more pungent constituents found in lower amounts (67). As it includes oleoresin chemicals that give ginger its spicy flavour, as well as essential oil compounds including various components such as zingiberene, zingiberol, and kaemferol, red ginger (*Z. officinale* Roscoe var. *rubrum*), it has the potential to be used as a vegetable pesticide. Zingiberene functions as a receptor, enabling anti-feeding impulses to be activated on insect central neurons, leading insects to lose their ability to detect and recognise nearby food. The activity of feeding larvae is reduced when olfactory organs are inhibited and the gastrointestinal tract is damaged, leading the larvae to become weak and die slowly. Furthermore, red ginger includes antioxidant components that can aid in the neutralisation of free radical damage in the body. The flavonoid kaempferol works as a potent respiratory inhibitor for insects, blocking the olfactory organs in their bodies, causing the insect's breathing system to be disrupted (68).

### 15. *ALOE BARBADENSIS* (ALOE VERA)

Aloe vera (*Aloe barbadensis* Miller, Xanthorrhoeaceae) is a perennial green herb with vivid yellow tubular blossoms found in North Africa, the Middle East of Asia, the Southern Mediterranean, and the Canary Islands. Locally, the plant is known as *lidah buaya*. Aloe vera has been traditionally used to treat skin injuries (burns,

cuts, insect bites, and eczemas). Furthermore, Aloe vera has been found to have anticancer, antioxidant, antidiabetic, and antihyperlipidemic effects. It contains more than 75 different compounds, including vitamins (A, C, E, and B12), enzymes (amylase, catalase, and peroxidase), minerals (zinc, copper, selenium, and calcium), sugars (monosaccharides like mannose-6-phosphate and polysaccharides like glucomannans), anthraquinones (aloin and emodin), and fatty acids (salicylic acid, lignin, and saponins) (69). The capacity of Aloe vera and active chemicals in wound healing is the focus of many *in vitro* investigations on skin protection. The most often utilised cell lines are the immortalised human keratinocyte HaCaT cell line, the main normal human epidermal keratinocyte HEKa cell line, and fibroblast cell lines. According to this research, Aloe vera and its principal components (aloesin, aloin, and emodin) protect the body primarily through antioxidant and anti-inflammatory processes. As a result of lysosomal membrane integrity, Aloe vera enhanced keratinocyte proliferation and differentiation by upregulating bFGF, and VEGF-A expression in fibroblasts (70). Since Aloe vera has anti-inflammatory properties, it could help to treat itching caused by insect bites.

#### 16. MYRISTICA FRAGRANS HOUTT

Nutmeg belongs to the family Myristicaceae, scientifically known as *Myristica Fragrans* Houtt and is native to the Spice Islands or Moluccas of Indonesia (71). The nutmeg tree is indigenous to the Molucca Isles and is raised in Sumatra, Mauritius, French Guiana, and various places in the West Indian islands and cultivated in Penang, Malaysia (72). The common names of this plant are magic, mace, myristica oil, muscdier, nux moschata, and muskatbaum. In Malaysia, it is commonly known as *buah pala*. The nutmeg tree is 20-25 feet high with smooth, greyish-brown bark. The leaves are alternate on petioles, plane above, approaching elliptical, aromatic, glossy above and paler beneath. The flowers are small and dioecious in axillary. The peduncles and pedicels are glabrous, often pressed close to the flower. The fruit has a spherical shape or has the shape of a small pear. The nuts are broadly ovate with a rugged, dark brown, hard, glossy shell and pale. Nutmeg seeds are pale brown, oval, smooth when fresh and later become shrivelled and have irregular vertical lines on the surface (73).

This plant contains fat (30-40%) and 10% of essential oils. The oils are composed of myristic acid, trymiristin, glycerides of stearic, palmitic, tridecanoic acids, lauric, elemicin, safrole, and eugenol (74). Nutmeg has pharmacological activities including antioxidant, anti-microbial, anti-inflammatory, anti-carcinogenic and hepatoprotective activity and immunomodulatory properties (74). The nutmeg oil has mosquito repellent properties because it mainly consists of  $\alpha$ -pinene, which has been reported to possess repellent activity (75).  $\alpha$ -pinene is a monoterpene hydrocarbon involved in the membrane disruption of insects (74). In addition, a study conducted in Malaysia has reported that nutmeg oil is an alternative mosquito repellent to be used with the main constituent  $\alpha$ -pinene (75). Additionally, camphor, plasticizers, bases, solvents, perfumes, and synthetic pine oil are all produced from nutmeg essential oil. Nutmeg includes numerous chemical substances classified as antioxidants that promote health and prevent disease (74).

#### 17. OCIMUM BASILICUM L.

Basil is a common name in English for *Ocimum basilicum* L., and it is called Basilikum, Basilic, and Albahaca in German, French, and Spanish. There are more than 30 species of herbs and shrubs in *Ocimum*. *Ocimum basilicum* L., (*O. basilicum*) is commonly known as sweet basil (76) and commonly known as *selasih* in Malaysia. *O. basilicum* belongs to the Lamiaceae family, genus of *Ocimum*, order of Lamiales, class of Magnoliopsida, and phylum of Magnoliopsida (77). Basil is an aromatic plant that has various pharmacological benefits and is commonly used in cooking. The plant is native to Asia, southern and central American and Africa (76). *O. basilicum* is a medium-sized herb with a potent aroma and a silky velvety touch. The herb's leaves are ovate, opposite, simple, and whole. They range in length from 3 to 5 cm. Its flowers are 8-12 mm long and are arranged in rings with 6-10 blossoms in each. The petals might be white, pink, or purplish in colour. The herb's leaves have both glandular and non-glandular hair on both sides (78). The oil of *Ocimum* spp. mainly consists of myrcene, thymol, camphor, and D-limonene and some other components which have repellent properties. The oils have been shown to repel insects and have larvicidal activities against blue bottle flies, house flies, and mosquitoes. Furthermore, the oil has antioxidant, anti-inflammatory, anti-microbial, anti-carcinogenic, and muscle relaxant properties (78).

The role of various Malaysian plants and their roles in treating insect bites has been summarised in Table 1.

**Table 1.** Malaysian plants and their roles in treating insect bite

Scientific name	Common name	Role in treating insect bite or as a repellent
<i>Mentha x piperita</i> L	Peppermint	Oil creates a cooling sensation on the skin
<i>Phyllanthus acidus</i>	Otaheite gooseberry	Affects the acetylcholine receptors in the nervous system, or the membrane sodium channels of nerves
<i>Parkia speciosa</i>	Stink bean	Inhibits the development of inflammation by reducing reactive oxygen species
<i>Curcuma zanthorrhiza</i>	Javene turmeric	Xanthorrhizol from the rhizome of the plant is toxic against the neonate larvae
<i>Citrus hystrix</i>	Kaffir lime	Essential oil has acetylcholinesterase inhibition
<i>Tamarindus indica</i> Linn	Tamarind	Leaves have anti-inflammatory and antinociceptive activities
<i>Piper betle</i> L	Betle	Analgesic and anti-inflammatory properties
<i>Cymbopogon citratus</i>	Lemon grass	Anti-inflammatory and analgesic effects on the insects
<i>Coleus blumei</i>	Coleus	Anti-inflammatory property
<i>Fibraurea tinctori</i> Lour	Akar badi	Known to effectively reduce the inflammation caused by insect bite
<i>Goniothalamus tapisoides</i>	Selada or	High antioxidant activity
<i>Mat Salleh</i>	Semukau	
<i>Cyathula prostrata</i> (L) Blume	Hookweed	Have anti-inflammatory and analgesic properties
<i>Zingiber officinale</i> Roscoe	Ginger	Zingiberene functions as a receptor, enabling anti-feeding impulses
<i>Aloe barbadensis</i> Miller	Aloe vera	Anti-inflammatory properties
<i>Myristica Fragrans</i> Houltt	Nutmeg	Anti-inflammatory property
<i>Ocimum Basilicum</i>	Basil	Anti-inflammatory property

## 18. CONCLUSION

Insect bite reactions are commonly reported in clinical practice. In certain conditions, insect bites may lead to serious medical conditions which might threaten a person's life. This warrants prevention and efficient treatment. Furthermore, diseases transmitted through mosquitoes have been alarming in recent years requiring an effective preventive method. Numerous studies have been conducted to use natural products as repellents as it has more benefits.

The ingredients are widely used in various fields including medicine, culinary, perfumes and flavouring agents. Pesticides based on natural products are safe and environmentally friendly compared to pesticides from synthetic chemicals. Furthermore, essential oils extracted from the plants are extensively used as an effective mosquito repellent. As the plants are easily obtained, it results in a cost effective, simple,

accessible green alternative which can be exploited for the benefit of mankind.

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## CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

## REFERENCES

- [1] Singh S, Mann B. Insect Bite Reactions. Indian Journal of Dermatology, Venereology and Leprology. 2013;79(2):151.
- [2] Rockwell EM, Johnson P. The Insect Bite Reaction: II Evaluation of the Allergic Reaction. Journal of Investigative Dermatology. 1952;19(2):137-55.

- [3] Shukla D, Wijayapala S, Vankar PS. Effective Mosquito Repellent From Plant Based Formulation. *International Journal of Mosquito Research*. 2018;5(1):19-24.
- [4] Mahendran G, Rahman LU. Ethnomedicinal, Phytochemical and Pharmacological Updates on Peppermint (*Mentha x piperita* L.)-A Review. *Phytotherapy Research*. 2020;34(9):2088-139.
- [5] Riachi LG, De Maria CA. Peppermint Antioxidants Revisited. *Food Chemistry*. 2015;176:72-81.
- [6] Loolae M, Moasefi N, Rasouli H, Adibi H. Peppermint and its Functionality: A Review. *Archives of Clinical Microbiology* 2017;8(4):54.
- [7] Alankar S. A Review on Peppermint Oil. *Asian Journal of Pharmaceutical and Clinical Research*. 2009;2(2):27-33.
- [8] Areias F, Valentao P, Andrade P, Ferreres F, Seabra R. Phenolic Fingerprint of Peppermint Leaves. *Food Chemistry*. 2001;73(3):307-11.
- [9] Park YJ, Baskar TB, Yeo SK, Arasu MV, Al-Dhabi NA, Lim SS, et al. Composition of Volatile Compounds and In Vitro Antimicrobial Activity of Nine *Mentha* spp. *SpringerPlus*. 2016;5(1):1-10.
- [10] Abagli A, Alavo T. Essential Oil from Bush Mint, *Hyptis suaveolens*, is as Effective as DEET for Personal Protection Against Mosquito Bites. *The Open Entomology Journal*. 2011;5(1).
- [11] Ansari M, Vasudevan P, Tandon M, Razdan R. Larvicidal and Mosquito Repellent Action of Peppermint (*Mentha piperita*) Oil. *Bioresource Technology*. 2000;71(3):267-71.
- [12] Lim T. *Phyllanthus acidus*. *Edible Medicinal and Non-Medicinal Plants*: Springer; 2012. p. 252-7.
- [13] Chigurupati S. Antioxidant and Antidiabetic Properties of *Phyllanthus acidus* (L.) Skeels Ethanolic Seed Extract. *International Food Research Journal*. 2020;27(4):775-82.
- [14] Loan DTT, Tra TTT, Nguyet TNM, Man LVV, editors. Enzymatic Extraction of Star Gooseberry (*Phyllanthus acidus*) Juice With High Antioxidant Level. *American Institute of Physics Conference Proceedings*; 2017: American Institute of Physics.
- [15] Samuel T, Kalarani, A., Vinodha, V., Arivoli, S., Selvakumar, S., Meeran, M. Syedalifathima, A. . Repellent Property of Plants Against Mosquitoes in Field Conditions by Traditional Method. *International Journal of Zoology and Applied Biosciences*. 2019;6(4).
- [16] Kamisah Y, Othman F, Qodriyah HMS, Jaarin K. *Parkia speciosa* hassk.: A Potential Phytomedicine. *Evidence-Based Complementary and Alternative Medicine*. 2013;2013.
- [17] Chhikara N, Devi HR, Jaglan S, Sharma P, Gupta P, Panghal A. Bioactive Compounds, Food Applications and Health Benefits of *Parkia speciosa* (stinky beans): A Review. *Agriculture & Food Security*. 2018;7(1):1-9.
- [18] Ahmad NI, Rahman SA, Leong Y-H, Azizul NH. A Review on the Phytochemicals of *Parkia speciosa*, Stinky Beans as Potential Phytomedicine. *Journal of Food Science and Nutrition Research*. 2019;2(3):151-73.
- [19] Hasim, Faridah DN, Kurniawati DA. Antibacterial Activity of *Parkia speciosa* Hassk. Peel to *Escherichia coli* and *Staphylococcus aureus* Bacteria. *Journal of Chemical and Pharmaceutical Research*. 2015;7(4):239-43.
- [20] Ginwala R, Bhavsar R, Chigbu DGI, Jain P, Khan ZK. Potential Role of Flavonoids in Treating Chronic Inflammatory Diseases With a Special Focus on the Anti-Inflammatory Activity of Apigenin. *Antioxidants*. 2019;8(2):35.
- [21] Lim T. *Curcuma zanthorrhiza*. *Edible Medicinal and Non-Medicinal Plants*: Springer; 2016. p. 371-88.
- [22] Rahmat E, Lee J, Kang Y. Javanese Turmeric (*Curcuma xanthorrhiza* Roxb.): Ethnobotany, Phytochemistry, Biotechnology, and Pharmacological Activities. *Evidence-Based Complementary and Alternative Medicine*. 2021;2021.
- [23] Dosoky NS, Setzer WN. Chemical Composition and Biological Activities of Essential Oils of *Curcuma* species. *Nutrients*. 2018;10(9):1196.
- [24] Govindarajan M, Sivakumar R. Mosquito Adulticidal and Repellent Activities of Botanical Extracts Against Malarial Vector, *Anopheles stephensi* Liston (Diptera: Culicidae). *Asian Pacific Journal of Tropical Medicine*. 2011;4(12):941-7.
- [25] Agouillal F, Taher ZM, Moghrani H, Nasrallah N, El Enshasy H. A Review of Genetic Taxonomy, Biomolecules Chemistry and Bioactivities of *Citrus hystrix* DC. *Biosciences Biotechnology Research Asia*. 2017;14(1):285.
- [26] Abirami A, Nagarani G, Siddhuraju P. The Medicinal and Nutritional Role of Underutilized Citrus Fruit-Citrus *hystrix* (Kaffir Lime): A Review. *Drug Invention Today*. 2014;6(1):1-5.
- [27] Tawatsin A, Wratten SD, Scott RR, Thavara U, Techadamrongsin Y. Repellency of Volatile Oils from Plants Against Three Mosquito Vectors. *Journal of Vector Ecology*. 2001;26:76-82.
- [28] Wikandari RJ, Surati S. The Effect of Kaffir Lime (*Citrus hystrix*) Essential Oil on Behavior and Mortality of *Aedes aegypti* Larvae. *Jurnal Riset Kesehatan*. 2020;9(1):6-11.
- [29] De Caluwe E, Halamoua K, Van Damme P. *Tamarindus indica* L.—A Review of Traditional Uses, Phytochemistry and Pharmacology. *Afrika Focus*. 2010;23(1):53-83.
- [30] Panara K, Harisha C, Shukla V. Pharmacognostic and Phytochemical Evaluation of Fruit Pulp of *Tamarindus indica* linn. *International Journal of Ayurvedic Medicine* 2014;5:37-42.
- [31] Meher B, Dash DK, Roy A. A review on: Phytochemistry, Pharmacology and Traditional Uses of *Tamarindus indica* L. *World Journal Pharmacy and Pharmaceutical Science*. 2014;3(10):229-40.
- [32] Rana M, Sharma P, Mahima R, Sharma P. Proximate and Phytochemical Screening of The Seed and Pulp of *Tamarind indica*. *Journal of Medicinal Plants Studies*. 2018;6(2):111-5.
- [33] Ong HC, Zuki RM, Milow P. Traditional Knowledge of Medicinal Plants Among the Malay Villagers in Kampung Mak Kemas, Terengganu, Malaysia. *Studies on Ethnomedicine*. 2011;5(3):175-85.
- [34] Akor S, Wampana B, Sodipo O. Antinociceptive and Anti-inflammatory Activities of The Aqueous Leaf Extract of *Tamarindus indica* L. in Albino Rats. *Journal of Plant Studies*. 2015;4(2):44.
- [35] Hoque MM, Rattila S, Shishir MA, Bari M, Inatsu Y, Kawamoto S. Antibacterial Activity of Ethanol Extract of Betel Leaf (*Piper betle* L.) Against Some Food Borne Pathogens. *Bangladesh Journal of Microbiology*. 2011;28(2):58-63.
- [36] Dwivedi V, Tripathi S. Review Study on Potential Activity of *Piper betle*. *Journal of Pharmacognosy and Phytochemistry*. 2014;3(4):93-8.
- [37] Sundang M, Nasir SNS, Sipaut CS, Othman H. Antioxidant Activity, Phenolic, Flavonoid and Tannin Content of *Piper betle* and *Leucosyke capitella*. *Malaysian Journal of Fundamental and Applied Sciences*. 2012;8(1).
- [38] Nayaka NMDMW, Sasadara MMV, Sanjaya DA, Yuda PESK, Dewi NLKAA, Cahyaningsih E, et al. *Piper betle* (L): Recent Review of Antibacterial and Antifungal Properties, Safety Profiles, and Commercial Applications. *Molecules*. 2021;26(8):2321.
- [39] Alam B, Akter F, Parvin N, Pia RS, Akter S, Chowdhury J, et al. Antioxidant, Analgesic and Anti-inflammatory

- Activities of The Methanolic Extract of Piper betle Leaves. *Avicenna Journal of Phytomedicine*. 2013;3(2):112.
- [40] Oladeji OS, Adelowo FE, Ayodele DT, Odelade KA. Phytochemistry and Pharmacological Activities of *Cymbopogon citratus*: A Review. *Scientific African*. 2019;6:e00137.
- [41] Gbenou JD, Ahounou JF, Akakpo HB, Laleye A, Yayi E, Gbaguidi F, et al. Phytochemical Composition of *Cymbopogon citratus* and *Eucalyptus citriodora* Essential Oils and Their Anti-inflammatory and Analgesic Properties on Wistar Rats. *Molecular Biology Reports*. 2013;40(2):1127-34.
- [42] Boeira CP, Piovesan N, Flores DCB, Soquetta MB, Lucas BN, Heck RT, et al. Phytochemical Characterization and Antimicrobial Activity of *Cymbopogon citratus* Extract for Application as Natural Antioxidant in Fresh Sausage. *Food Chemistry*. 2020;319:126553.
- [43] Ekpenyong CE, Akpan E, Nyoh A. Ethnopharmacology, Phytochemistry, and Biological Activities of *Cymbopogon citratus* (DC.) Stapf Extracts. *Chinese Journal of Natural Medicines*. 2015;13(5):321-37.
- [44] Seye F, Fall A, Toure M, Ndione R, Ndiaye M. Histopathological Effects of *Cymbopogon citratus* (Lemongrass) Essential Oil on Late Third Instar Larvae of *Aedes aegypti* L.(Diptera: Culicidae). *Biology and Medicine (Aligarh)*. 2021;13:100287.
- [45] Moron MJ, Acero LH. Mayana (*Coleus blumei*) Leaves Ointment in Wound Healing of Albino Rats (*Rattus albus*). *International Journal of Food Engineering* 2017;3(1):18-22.
- [46] Ridwan Y, Satrija F, Handharyani E. Aktivitas Anticestoda In Vitro Metabolit Sekunder Daun Miana (*Coleus blumei* Benth) terhadap Cacing *Hymenolepis microstoma*. *Jurnal Medik Veteriner*. 2020;3(1):31-7.
- [47] Bercu R. Comparative Anatomy of Two Cultivated Species of *Coleus blumei* Benth.(Lamiaceae) Leaves With Ornamental Value. *Annals of the University of Craiova-Agriculture, Montanology, Cadastre Series*. 2015;43(1):372-81.
- [48] Jurkaninova S, Kubinova R, Nejezchlebova M, Gazdova M, Hanakova Z, Dall Acqua S. Anti-MRSA Activity of Abietane Diterpenes From *Coleus blumei* Benth. *Natural Product Research*. 2021;35(18):3033-9.
- [49] Bismelah N, Ahmad R, Kassim ZM, Ismail N, editors. *Coleus blumei* Extract as a Potential Antibacterial Oral Rinse. IOP Conference Series: Earth and Environmental Science; 2019: IOP Publishing.
- [50] Cretton S, Sarau N, Monteillier A, Righi D, Marcourt L, Genta-Jouve G, et al. Anti-inflammatory and Antiproliferative Diterpenoids from *Plectranthus scutellarioides*. *Phytochemistry*. 2018;154:39-46.
- [51] Khattak MMAK, Taher M, Abdulrahman S, Bakar IA, Damanik R, Yahaya A. Anti-bacterial and Anti-fungal Activity of *Coleus* Leaves Consumed as Breast-milk Stimulant. *Nutrition & Food Science*. 2013.
- [52] Ridwan Y, Satrija F, Handharyani E. Toksisitas Akut Ekstrak Daun Miana (*Coleus Blumei* Benth) pada Mencit (*Mus Musculus*). *Acta Veterinaria Indonesiana*. 2020;8(1):55-61.
- [53] Siwon J, Verpoorte R, Svendsen AB. Studies on Indonesian Medicinal Plants VI\* Further Alkaloids from *Fibraurea chloroleuca*. *Planta Medica*. 1981;41(01):65-8.
- [54] Zalizar L, Rahayu I, Nor Y, editors. Potency of *Fibraurea tinctora* Lour. Extract as Anti-bacterial Agents Towards Pathogenic Bacteria. IOP Conference Series: Earth and Environmental Science; 2019: IOP Publishing.
- [55] Galappathie S. Investigation of Antimicrobial Activity and Phytochemical Characterisation of Plant Extracts: Swinburne University of Technology; 2018.
- [56] Filali I, Bouajila J, Znati M, Bousejra-EI Garah F, Ben Jannet H. Synthesis of New Isoxazoline Derivatives From Harmine and Evaluation of Their Anti-alzheimer, Anti-cancer and Anti-inflammatory Activities. *Journal of Enzyme Inhibition and Medicinal Chemistry*. 2015;30(3):371-6.
- [57] Ahmad Fb, Moharm B, Jantan I. A Comparative Study of the Constituents of the Essential Oils of *Goniothalamus tapis* Miq. and *G. tapisoides* Mat Salleh from Borneo. *Journal of Essential Oil Research*. 2010;22(6):499-502.
- [58] Kim RPT, Bihud V, Bin Mohamad K, Leong KH, Bin Mohamad J, Bin Ahmad F, et al. Cytotoxic and Antioxidant Compounds from The Stem Bark of *Goniothalamus Tapisoides* Mat Salleh. *Molecules*. 2013;18(1):128-39.
- [59] Mat-Salleh K, Latiff A. *Tumbuhan Ubatan Malaysia*. Pusat Pengurusan Penyelidikan Universiti Kebangsaan Malaysia; 2002.
- [60] Kulip J. An Ethnobotanical Survey of Medicinal and Other Useful Plants of Muruts in Sabah, Malaysia. *Teloepa*. 2003;10(1):81-98.
- [61] Odugbemi T. *Outline and Pictures of Medicinal Plants*. Nigeria University of Lagos Press. 2006:283.
- [62] Rajith N, Ramachandran V. Ethnomedicines of Kurichyas, Kannur District, Western Ghats, Kerala. *NIScPR Online Periodicals Respiratory*. 2010.
- [63] Ogu GI, Tanimowo WO, Nwachukwu PU, Igere BE. Antimicrobial and Phytochemical Evaluation of the Leaf, stem bark And Root Extracts of *Cyathula prostrata* (L) Blume Against Some Human Pathogens. *Journal of Complementary Medicine Research*. 2012;1(1):35-43.
- [64] Ibrahim B, Sowemimo A, van Rooyen A, Van de Venter M. Antiinflammatory, Analgesic and Antioxidant Activities of *Cyathula prostrata* (Linn.) Blume (Amaranthaceae). *Journal of Ethnopharmacology*. 2012;141(1):282-9.
- [65] Sharifi-Rad M, Varoni EM, Salehi B, Sharifi-Rad J, Matthews KR, Ayatollahi SA, et al. Plants of the Genus *Zingiber* as a Source of Bioactive Phytochemicals: From Tradition to Pharmacy. *Molecules*. 2017;22(12):2145.
- [66] An K, Zhao D, Wang Z, Wu J, Xu Y, Xiao G. Comparison of Different Drying Methods on Chinese Ginger (*Zingiber officinale* Roscoe): Changes in Volatiles, Chemical Profile, Antioxidant Properties, and Microstructure. *Food Chemistry*. 2016;197:1292-300.
- [67] Lin R-J, Chen C-Y, Lu C-M, Ma Y-H, Chung L-Y, Wang J-J, et al. Anthelmintic Constituents from Ginger (*Zingiber officinale*) Against *Hymenolepis nana*. *Acta Tropica*. 2014;140:50-60.
- [68] Anwar C, Syukur KY, Dalilah D, Salni S, Novrikasari N. The Efficacy of Red Ginger Fraction (*Zingiber officinale* Roscoe var. *rubrum*) as Insecticidal *Aedes aegypti*. *Bioscientia Medicina: Journal of Biomedicine and Translational Research*. 2018;2(2):31-41.
- [69] Maan AA, Nazir A, Khan MKI, Ahmad T, Zia R, Murid M, et al. The Therapeutic Properties and Applications of Aloe Vera: A Review. *Journal of Herbal Medicine*. 2018;12:1-10.
- [70] de Oliveira ACL, Tabrez S, Shakil S, Khan MI, Asghar MN, Matias BD, et al. Mutagenic, Antioxidant and Wound Healing Properties of Aloe Vera. *Journal of Ethnopharmacology*. 2018;227:191-7.
- [71] Beckerman B, Persaud H. Nutmeg Overdose: Spice Not So Nice. *Complementary Therapies in Medicine*. 2019;46:44-6.
- [72] Tan K, Khoo H, Azrina A. Comparison of Antioxidant Components and Antioxidant Capacity in Different Parts of Nutmeg (*Myristica fragrans*). *International Food Research Journal*. 2013;20(3).
- [73] Periasamy G, Karim A, Gibrelibanos M, Gebremedhin G. Nutmeg (*Myristica fragrans* Houtt.) Oils. *Essential Oils in*

- Food Preservation, Flavor and Safety: Elsevier; 2016. p. 607-16.
- [74] Naeem N, Rehman R, Mushtaq A, Ghania JB. Nutmeg: A Review On Uses and Biological Properties. *International journal of Chemical and Biochemical Sciences* 2016;9:107-10.
- [75] Lim V, Mohd Narawi M, Chiu HI, Tung WH, Tan JJ, Lee CK. Selected Essential Oils as Repellents Against *Aedes aegypti*: Validation of the Bioconstituents Using Gas Chromatography. *Journal of Essential Oil Bearing Plants*. 2019;22(4):1058-73.
- [76] Shahrajabian MH, Sun W, Cheng Q. Chemical Components and Pharmacological Benefits of Basil (*Ocimum basilicum*): A Review. *International Journal of Food Properties*. 2020;23(1):1961-70.
- [77] Ali N, Setzerb WN. Pharmacological Activities of Basil Oil A Review. *Recent Progress in Medicinal Plants*. 2013;37:286-307.
- [78] Bariyah S, Ahmed D, Ikram M. *Ocimum basilicum*: A Review on Phytochemical and Pharmacological Studies. *Pakistan Journal of Chemistry* 2012;2(2):78-85.