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Phytochemical Properties and Traditional Uses of Selected Medicinal Plants in Malaysia: A Review

Abstract - Medicinal plants have healing properties and are able to synthesize various chemical compounds. These chemicals (also known as phytochemical compounds) play vital roles in determining the pharmacological properties existing in certain plants. The phytochemical compounds present in plants are associated with primary and secondary constituents. Most of the time, the secondary constituents exhibit the bioactivities in plants such as antimicrobial, antioxidant, antidiabetic, antibacterial and anti-inflammatory properties. Some common medicinal plants that have been used in curing various diseases by traditional practitioners in Malaysia are *Ficus deltoidea* Jack, *Andrographis paniculata*, *Curcuma longa, Clinacanthus nutans* and *Eurycoma longifolia* Jack. This review discusses the morphology, phytochemical compounds and phytochemical properties of selected medicinal plants in Malaysia. The plants of focus have been found to possess anti-cancer and anti-diabetic effects. This review, it is hoped will enable Malaysian researchers to explore further on the potential of these plants in investigating new and novel drugs in the future.

Keywords **- Malaysia, plants, phytochemical compounds, properties**

1 INTRODUCTION

Malaysia is one of the tropical rainforest countries that is rich with its traditional medicines and herbal plants. Herbal plants have been used for many years to cure various diseases including diabetes mellitus, skin rashes, fever, insect and snake bites. As stated by World Health Organization (WHO), each part of the plant is useful and contains active compounds that are important for therapeutic purposes or which are precursors for the synthesis of useful drugs [1]. These active compounds such as tannins, saponins, alkaloids, terpenoids, steroids and flavonoids produce definite physiological actions in human [2]. Some of these active compounds are non-essential towards the plants that produce them [2], even though they act as a powerful medicine for human beings.

Phytochemical compounds can be divided into two categories which are primary and secondary constituents [3]. Primary constituents consist of chlorophylls, proteins, amino acids and common sugars while the secondary constituents consist of terpenoids, alkaloids and phenolic compounds [3].

Terpenoids are chemical compounds that are derived from isoprene molecule (C_5H_8) [4]. Scientifically, the roles of terpenoids in pharmacological activities are anti-inflammatory, anti-bacterial, anti-protozoan, anti-fungal, anti-viral, anti-allergen in addition to acting as an immune booster and antineoplastic [3].

Alkaloids were first introduced by Meisner in the beginning of nineteenth century to designate natural compounds that react like a base, alkali, since alkaloids are derived from organic nitrogenous bases. The alkaloids are plant-derived compounds containing nitrogen and can be found in over 20% of plant species [5, 6]. Alkaloids have high impact on human beings in many areas including medical, economics and social affairs [5]. Phenolic compounds or polyphenolic compounds are one of the secondary constituents that can be found in plants and are involved in defence against ultra-violet radiation and aggression by pathogens [7]. Chemically, phenolic compounds contain at least 1 aromatic hydrocarbon ring with 1 or more hydroxyl groups attached [6]. Flavonoids,

coumarins, benzoic acids and tannins can be classified as polyphenolic compounds with the flavonoids as the largest and most diverse group [6]. These secondary constituents are most essential in pharmaceutical developments besides being vital in the adaptations of plants to their environments [8]. Almost all humans in the world prefer traditional plants as a treatment option and around 80 % of the world population rely on traditional medicines for primary health care [9]. In Malaysia, a variety of medicinal plants exist which include *Ficus deltoidea*, *Andrographis paniculata*, *Curcuma longa*, *Clinacanthus nutans* and *Cinnamomum verum*. This paper will discuss the phytochemical compounds present in five selected common traditional plants in Malaysia, namely, *Ficus deltoidea*, *Andrographis paniculata*, *Cinnamomum verum*, *Clinacanthus nutans* and *Curcuma longa*.

This review was prepared by searching some databases like PubMed, Medline, Scopus, PLoS and Google Scholar using the keywords phytochemical properties, *Ficus deltoidea* Jack, *Andrographis paniculata*, *Curcuma longa*, *Cinnamomum verum* and *Clinacanthus nutans*. For each medicinal plant, the general information about phytochemical compounds, their families, the pharmacological properties and their traditional uses are reported. However, the phytochemical properties of these plants are limited only to that reported by Malaysian researchers.

2 COMMON MEDICINAL PLANTS IN MALAYSIA AND THEIR MORPHOLOGY

The plants included in this review are *Ficus deltoidea* (*F. deltoidea*), *Andrographis paniculata* (*A. paniculata*), *Cinnamomum verum* (*C. verum*), *Clinacanthus nutans* (*C. nutans*) and *Curcuma longa* (*C. longa*). Tables I and II give the details of the synonyms, common names and the morphology of these medicinal plants.

Table I: Synonyms for the selected plants and their family

Plants	*F. deltoidea* Jack	*A. paniculata*	*C. nutans*	*C. verum*	*C. longa*
Family	Moraceae	Acanthaceae	Acanthaceae	Lauraceae	Zingiberaceae
Synonyms	*F. deltoidea* var. *angustifolia* (Miq.) Corner, *F. deltoidea* forma *angustissina* Corner, *F. deltoidea* var. *arenaria* Corner, *F. deltoidea* var. *bilobata* Corner, *F. deltoidea* var. *borneensis* Corner, *F. deltoidea* forma *subhirsuta* Corner, *F. deltoidea* var. *kunstleri* (King) Corner, *F. deltoidea* var. *lutescens* (Desf.) Corner, *F. deltoidea* forma *longipedunculata* Corner, *F. deltoidea* forma *subsessilis* (Miq.) Corner, *F. deltoidea* var. *peltata* Corner, *F. deltoidea* var. *recurvate* Kochummen and *F. deltoidea* var. *trengganuensis* Corner.	*Justicia paniculata*	*Clinacanthus nutans* var. *robinsonii Benoist*, *Clinacanthus burmanni Nees*, *Justicia nutans Burm. F*	*Cinnamomum zeylanicum*	*Curcuma domestica* Valeton
Common name	Mas cotek	Hempedu bumi	Belalai gajah	Kulit kayu manis	Kunyit

Table II: Morphology of the selected medicinal plants

Plants	Morphology
F. deltoidea	• Leaf shapes: deltoid, elliptic obovate, spatulate or rhomboid • Leaf lamina: oblong, elliptic, obtriangular, oblanceolate, spatulate, linear and suborbicular (12)
A. paniculata	• branched annual herbaceous plant • grows erect to a height of 30.0-110.0 cm • Leaf: glabrous, up to 8.0 cm long and 2.5 cm broad, pinnate, acute apex and entire margin by having a smooth edge • Stem: dark green with 0.3-1.0 m in height, 2.0-6.0 mm in diameter, quadrangular with longitudinal furrows and wings on the angles of the younger parts (80)
C. nutans	• perennial herb/shrub • grows around 1.0-3.0 m in height with pubescent or short hair branches • Leaf: pale green, simple, opposite, narrowly elliptic oblong or lanceolate with a diameter 0.5-1.5 cm and 2.5-13.0 cm long • Stem: straight green with white internodes and vertical strips (81)
C. verum	• small evergreen tropical tree • grows up to 10.0-15.0 m tall • Leaf: leathery appearance and usually opposite, glabrous on both surfaces while the leaf blade is greenish white abaxially, green and shiny adaxially, ovate or ovate-lanceolate, 11.0 to 16.0 cm long, with pointed tips (82)
C. longa	• perennial herb • grows up to 1.0 m high with a short stem and distributed throughout tropical and subtropical regions • Leaf: glabrous, elliptical-lanceolate in shape and around 30.0 cm long and 10.0 cm broad • The inflorescences of *C. longa* are made up of light green to whitish, cone or oblong in shape with 10.0-15.0 cm long and 5.0-7.0 cm wide • The rhizomes of *C. longa* are orange-brown and dark-yellow to bright orange pulp in colour arising from the tuber and branch out at right angle as secondary rhizomes (83)

Figure 1: *Ficus deltoidea* Jack plant.

Traditionally, *F. deltoidea* (Figure 1) has been used commonly as decorative houseplant and as traditional medicines [10] to heal ailments including sores, wounds, rheumatism, diabetes and as an after-birth tonic [11]. For many years, the dried leaves of *F. deltoidea* have been consumed and distributed among Malaysians as herbal tea and capsules. The decoction of the leaves is claimed to have antioxidant, antidiabetic, and aphrodisiac properties as well as in improving the blood circulation and in treating gout [11, 12, 13].

Figure 2: *Andrographis paniculata* plant.

A. paniculata (Figure 2) leaves have always been taken orally to reduce diabetes and high blood pressure. *A. paniculata* has a broad range of therapeutic properties and hence has been used for many years to treat upper gastrointestinal tract and upper respiratory infections, fever and Herpes [14]. Based on Roy et al., andrographolide is one of the bioactive components present in *A. paniculata* and has been reported for its anti-cancer [15], anti-HIV [16] and cardio protective properties among others [17].

Figure 3: *Clinacanthus nutans* plant.

In Malaysia, *C. nutans* (Figure 3) has been utilized traditionally to treat skin rashes, scorpion and insect bites; lesions caused by *Herpes simplex*, Diabetes mellitus, fever and are also used as diuretics [18, 19]. Some traditional practitioners in Malaysia boil the fresh leaves of *C. nutans* with water and consume as herbal tea [20]. *C. nutans* has been used as an antivenom, anti-inflammatory, analgesic, antidiabetic, anti-rheumatism, antiviral and as an antioxidant [21].

Figure 4: *Cinnamomum verum* plant.

Traditionally in Malaysia, stem bark of *C. verum* (Figure 4) is used to improve blood circulation, to make the body feel warm, to encourage contraction of the uterus, to expel wind, to prevent fits and as a laxative [22]. Besides that, the essential oils of *C. verum* are used in aromatherapy to ease emotional and mental fatigue [22]. The aromatic, astringent, expectorant and carminative properties of the bark of *C. verum* is used to treat stomach cramps, gastric irritation, dysentery, diarrhoea [23], neuralgia, rheumatism, toothache and paralysis of the tongue. *C. verum* stimulates the uterine muscles by reducing the

difficulties in deliveries due to inadequate contractions, promotes regular and easy menstruation and is taken as a warming herb for cold conditions. *C. verum* is also used as traditional remedy for aching muscles and other symptoms of viral conditions such as colds and flu [24].

Figure 5: *Curcuma longa* plant.

Traditionally, *C. longa* (Figure 5) has been applied in Malay traditional medicine for parturition, to treat amenorrhea, swelling, urogenital problems, wounds and as diuretic, lactagogue and tonic. Usually, hot water mixture of ground rhizome parts of *C. longa* is given orally to improve blood circulation, to regain body strength, to expel wind, to ease muscular and joint pain as well as to ease abdominal discomfort [22].

3 PHYTOCHEMICAL COMPOUNDS AND PHYTOCHEMICAL PROPERTIES OF MEDICINAL PLANTS

3.1 Phytochemical compounds

Several studies on *F. deltoidea* leaves have been carried out to identify and isolate the phytochemical constituents of *F. deltoidea*. Study by Lip et al. using nuclear magnetic resonance (NMR) and mass spectrometers has identified moretenol ($C_{30}H_{50}O$) in *F. deltoidea* leaves [25].

Meanwhile, another study by Suryati et al. discovered an antibacterial compound known as lupeol ($C_{30}H_{50}O$) (Figure 6A) which exhibited toxicity against *Staphylococcus aureus*, *Bacillus subtilis*, and *Escherichia coli* [25, 26]. Also, the flavonoid compounds (rutin, quercetin and naringenin - Figure 6B, C, D) present in *F. deltoidea* leaves were confirmed by liquid chromatography-mass spectrometry (LC-MS) [27].

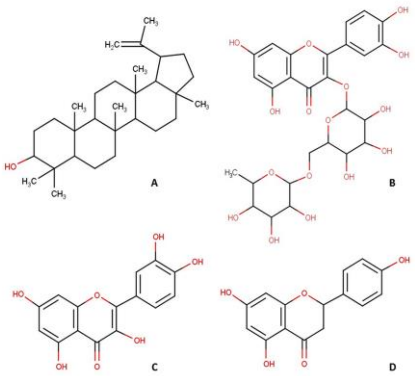


Figure 6: Phytochemical compounds present in *F. deltoidea* A: Lupeol; B: Rutin; C: Quercetin and D: Narigenin.

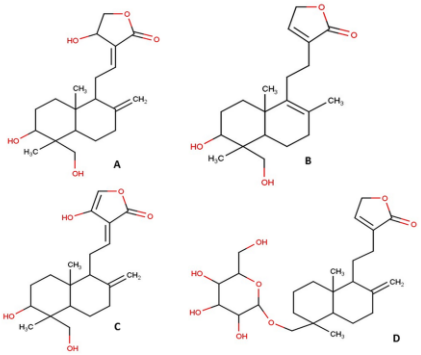


Figure 7: Phytochemical compounds present in *A. paniculata* A: Andrographolide; B: Deoxyandrographolide; C: Neoandrographolide and D: Dehydroandrographolide.

Based on previous studies, the aerial parts of *A. paniculata* (leaves and stems) were used in the extraction and isolation of the active phytochemical compounds [17, 28]. The major active phytochemical compound that was found in *A. paniculata* was andrographolide ($C_{20}H_{30}O_5$) (Figure 7A) [28].

Andrographolide is colourless, crystalline in appearance that has a bitter taste [15, 28] and exhibits therapeutic effects such as anti-inflammatory, anti-microbial, anti-viral, immuno-stimulatory, anti-platelet aggregation [29, 30], anti-cancer, anti-HIV [14], cardio-protective and hepatoprotective effects [14, 17, 31]. Apart from that, other active phytochemical compounds present in *A. paniculata* are deoxyandrographolide ($C_{20}H_{30}O_4$), neoandrographolide ($C_{26}H_{40}O_8$) and dehydroandrographolide ($C_{20}H_{28}O_4$) (Figure 7B, C, D-respectively) [32]. Dehydroandrographolide has properties such as hypotensive effect, vasorelaxant activity, anti-stimulant effect on production of nitric oxide and shows inhibition against human immuno-deficiency virus [30]. Also,

andrographolide, neoandrographolide, and dehydroandrographolide are reported to have virucidal properties against *Herpes simplex* virus type 1 (HSV-1) [33].

Teshima and colleagues isolated six C-glycosyl flavones from methanolic extract of *C. nutans* leaves including vitexin, isomollupentin 7-O-β-glucopyranoside, orientin, isoorientin, schaftoside ($C_{26}H_{28}O_{14}$) and isovitexin (Figure 8A, B, C, D, E, F-respectively) [34].

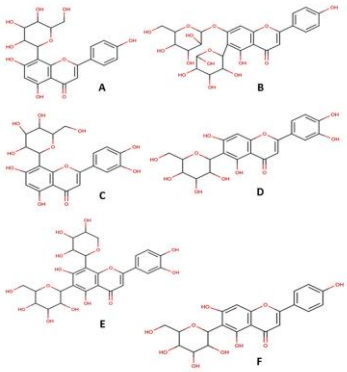


Figure 8: Six C-glycosyl flavones present in methanolic extract of *C. nutans* A: Vitexin; B: Isomollupentin 7-O-β-glucopyranoside; C: Orientin; D: Isoorientin; E: Schaftoside and F: Isovitexin.

These compounds possessed significant pharmacological properties such as antimicrobial (isoorientin and vitexin), hepatoprotective (isoorientin) and antioxidant activities (isovitexin) [34]. Gas chromatography mass spectrometry (GCMS) analysis of chloroform extract of *C. nutans* identified the major compound which was 1,2-benzenedicarboxylic acid, mono (2-ethylhexyl) ester. This phytochemical compound contributes to the medicinal activity and possesses anti-microbial, antioxidant and antiproliferative properties [35]. Previous studies on the active phytochemical compounds of *C. nutans* extracts also discovered stigmasterol, β-sitosterol, lupeol [36] and betulin [37] (Figure 9A, B, C, D, E-respectively).

Previous study has shown that the major active phytochemical compounds in *C. verum* were eugenol ($C_{10}H_{12}O_2$) [38], linalool ($C_{10}H_{18}O$), cinnamaldehyde (C_9H_8O) [39], coumarin ($C_9H_6O_2$) [23] and benzyl benzoate ($C_{14}H_{12}O_2$) [40]. Coumarins are active compounds that can be found naturally in plants including *C. verum* and possess anticoagulant properties. High percentage of coumarin in plants can lead to health risks and become toxic to the liver if this compound is consumed in higher quantity on a regular basis.

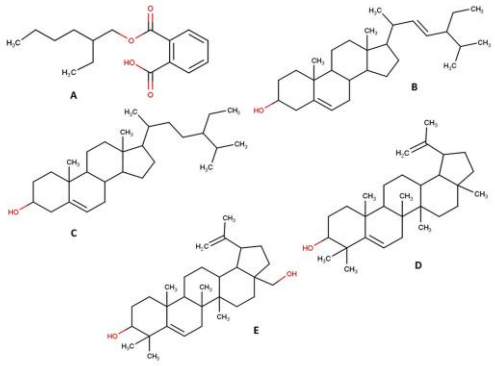


Figure 9: Other phytochemical compounds present in *C. nutans* A: 1, 2-benzenedicarboxylic acid, mono (2- ethylhexyl) ester; B: stigmasterol; C: β-sitosterol and D: Lupeol and E: Betulin.

However, *C. verum* only contains low percentage of coumarin and still considered as safe and free from causing health risks [41]. The inhibitory activity of *C. verum* extract was attributed to the presence of cinnamaldehyde [42]. Previous studies have also shown that sensitive and resistant bacteria strain of *Helicobacter pylori* was completely inhibited by cinnamaldehyde compound [42, 43]. These active compounds of *C. verum* are very important as they possess important pharmacological properties as shown in Table III.

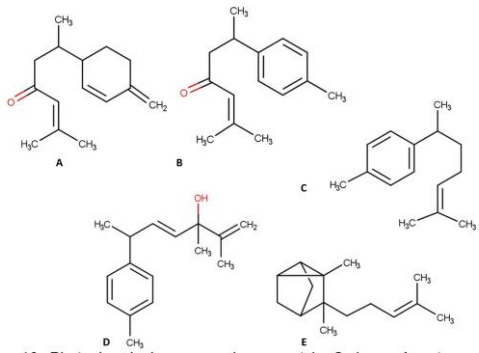
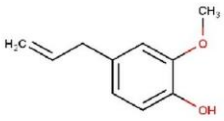
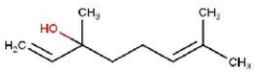
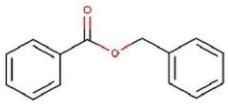
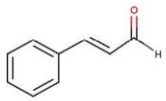
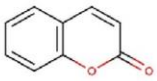


Figure 10: Phytochemical compounds present in *C. longa* A: α-turmerone; B: β–turmerone; C: aromatic-tumerone; D: aromatic-curcumene and E: alpha-santalene.

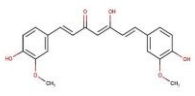
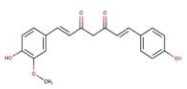
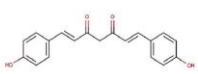
Based on previous study, the major phytochemical compounds that were identified in *C. longa* were α-turmerone ($C_{15}H_{22}O$) and β–turmerone [44] (Figure 10A, B-respectively). This study has also reported the presence of aromatic-turmerone, aromatic-curcumene and alpha-santalene (Figure 10 C, D, E-respectively) in dry rhizome oil [44]. The pharmacological properties of aromatic-turmerone are antimicrobial, larvicidal and antioxidant properties [45]. Turmerone possesses a variety of pharmacological activities such as antioxidant, anti-inflammatory, anti-tumor, anti-proliferative and anti-depressant activities [46].

Table III: Phytochemical compounds present in *C. verum* and their pharmacological properties

Compounds	Structure	Pharmacological properties
Eugenol		• Anaesthetic • Anti-ulcer • Antispasmodic • Antioxidant • Anti-inflammatory
Linalol		• Analgesic • Anaesthetic • Antispasmodic • Anti-allergic • Anti-inflammatory
Benzyl benzoate		• Antitumor • Antispasmodic • Myorelaxant • Hypotensive • Antiasthmatic
Cinnamaldehyde		• Antimicrobial • Antidiabetic
Coumarin		• Anticoagulant

The major phenolic compounds identified in *C. longa* were curcuminids which can be divided into three types; curcumin (curcumin I), demethoxycurcumin (curcumin II) and bisdemethoxycurcumin (curcumin III) [45]. These curcuminoids play an important role as anti-tumor agent [45] and are responsible for the yellow colour of turmeric [47]. Based on Nisar et al., [47] curcumin can be defined as yellow orange crystalline substance that is insoluble in water. Table IV shows curcuminoid derivatives and its pharmacological activities.

Table IV: Curcuminoid derivatives and its pharmacological activities

Compounds	Structure	Pharmacological activities
Curcumin		• Antibacterial • Anti-HIV • Antioxidant • Anti-inflammatory • Antitumor
Demethoxycurcumin		• Antioxidant
Bisdemethoxycurcumin		• Antioxidant

3.2 Phytochemical properties

3.2.1 *F. deltoidea*

F. deltoidea contains a lot of antioxidant compounds that possess various phytochemical properties such as antiangiogenic and anticancer properties. Angiogenesis is known as development of new blood vessels and has important roles in pathogenesis of various human diseases including cancer, psoriasis, arterial plaque formation, ocular neovascularization, gastrointestinal ulcers, rheumatoid arthritis, and diabetic retinopathy. Shafaei et al. reported that the antiangiogenic effect of *F. deltoidea* extract was due to the presence of relatively high contents of ursolic acid, phenolics and flavonoids. The selective cytotoxicity towards colon and breast cancer cell lines, and anti-angiogenic effect indicated the potential anti-cancer effect of *F. deltoidea* extracts [13]. Investigation on the cytotoxicity of aqueous and ethanolic plant extracts of *F. deltoidea* on human carcinoma cells revealed that both extracts could cause apoptosis at a concentration of 1000 µg/ml. An aqueous extract of *F. deltoidea* promoted cell detachment while the ethanolic tried to inhibit cell proliferation through DNA fragmentation [48].

Apart from that, the methanol extract of *F. deltoidea* showed potential as an antidiabetic agent by inhibiting the hepatic glucose production and promoting glucose utilization [49]. Farsi et al. evaluated the enzymes inhibitory effect and antioxidant properties of different fractions of methanolic extract obtained from *F. deltoidea* leaves. The n-butanol fraction revealed significant α-glucosidases and α-amylase inhibitory effects (IC50 values of 15.1 and 39.42 µg/ml, respectively) along with the remarkable antioxidant activity when compared to the other fractions and indicated that *F. deltoidea* could be a potential source of promising anti-diabetic drug [49]. Adam and colleagues evaluated the potential of five extracts and three fractions of *F. deltoidea* to enhance basal and insulin-stimulated glucose uptake into the Chang liver cell line and found that all *F. deltoidea* extracts and fractions except for ether extract possessed the ability to enhance either the basal or insulin-stimulated glucose uptake into this cell line [50]. One of the therapeutic techniques to control postprandial hyperglycaemia is by the inhibition of carbohydrate hydrolysing enzymes such as α-glucosidases and α-amylase [49]. Another study assessed on the ability of the crude extracts and fractions of *F. deltoidea* as antidiabetic agent to inhibit yeast and

mammalian α-glucosidase as well as α-amylase. The results suggested that the crude extracts and fractions of *F. deltoidea* inhibited both yeast and rat intestinal α-glucosidases in a dose-dependent manner. However, the extracts and fractions of *F. deltoidea* did not inhibit porcine pancreatic α-amylase [51].

Study by Abdullah et al. suggested standardization of extracts of different varieties of *F. deltoidea* for anti-inflammatory activity using three *in vitro* assays: lipoxygenase, hyaluronidase, and TPA-induced oedema. The results of the different extracts from three varieties of the plant showed anti-inflammatory activities [52]. Evaluation of the antinociceptive activity of *F. deltoidea* aqueous extract by using three models of nociception; acetic acid-induced abdominal writhing, formalin and hot plate test revealed that *F. deltoidea* leaves' aqueous extract contained pharmacologically active constituents that possessed antinociceptive activity justifying its traditional therapeutic use in treating conditions related with painful conditions [53]. Study on the anti-inflammatory activity of the aqueous extract of *F. deltoidea* in rats using a carrageenan-induced paw oedema test, a cotton pellet-induced granuloma test, and a formalin test showed that there was significant anti-inflammatory activity in every test with a dose-response effect [54].

3.2.2 *A. Paniculata*

Study by Al-Henhena and colleagues revealed that *A. paniculata* possesses antioxidant, anti-proliferative and antimetastatic properties and act as free radical scavengers as the ethanol extract of *A. paniculata* interferes with the intermediate biomarker for colon cancer development. They also suggested that *A. paniculata* has the potential to be a new anti-cancer therapeutic agent due to its diterpenoid and flavonoid contents. Previously, diterpenoids showed potent effect on the inhibition of HT29 (colon cancer cell line) proliferation [55]. Previous researchers also have discovered the antioxidant and gastro protective activities of aqueous and ethanol extracts of *A. paniculata* in Sprague Dawley rats by pre-treating the rats with the extracts where they used carboxymethyl cellulose as negative control and omeprazole as the positive control. The results showed that there was a significant dose dependent reduction in gastric lesions with increased pH and mucus content of stomach in the rats pre-treated with omeprazole and both the extracts [56]. They concluded that antioxidant is the main factor that protects the cells from damage caused by oxidative stress [56]. A study on *A. paniculata* aerial parts in 20 patients with type 2 diabetes mellitus for 12 weeks exhibited antidiabetic effects with no significant adverse effects on the patients [57]. Previous study reported that andrographolide and ethanol extract of *A. paniculata* possessed antidiabetic, hypolidemic and antioxidant properties in adult streptozotocin-nicotinamide type 2 diabetes mellitus (STZ-NA T2DM) rats [58].

Malahubban and team discovered the antibacterial activities of ethanol, methanol and aqueous extracts of *A. paniculata* against *Salmonella enterica*, *Esherichia coli*, *Staphylococcus aureus* and *Bacillus cereus*. Methanol extract was found to be the most effective against all the bacteria compared to other extracts due to its polarity [59]. Uridine diphosphate glucuronosyltransferase (UGT) is an enzyme required in glucuronidation process. Ahmad and colleagues studied the effects of *A. paniculata* extract on UGT activity and suggested that the ethanol extract of *A. paniculata* at 500 µg/mg protein significantly reduced the UGT activity [60]. Recent study on the effect of *A. paniculata* extract in Malaysia on the activity of cDNA-expressed UGT isoforms was conducted where the results showed that it inhibited UGT1A and UGT2B isoenzymes. This suggests that *A. paniculata* has the potential for drug-herbal extract interactions in the therapeutic setting [61]. Ethanol extract of *A. paniculata* was reported to influence the restoration of different enzyme levels of serum glutamine pyruvate transaminase (SGPT), serum glutamine oxaloacetate transaminase (SGOT), gamma-glutamyl transpeptidase (GGTP) and serum alkaline phosphatase (SALP) after carbon tetrachloride- (CCL4-) induced liver injury [62, 63]. Study on the effect of andrographolide and the leaf extract of *A. paniculata* against tetrachloride (CCL4-) induced hepatic microsomal lipid peroxidation *in vitro* was completely protected by the leaf extract but not by andrographolide, indicating that the hepatoprotective effect is not solely due to the presence of andrographolide [63, 64]. Other compounds of *A. paniculata* extracts such as neoandrographolide and dehydroandrographolide have also been reported to possess hepatoprotective effect [63].

3.2.3 *Clinacanthus nutans*

C. nutans plants possess variety of pharmacological properties including anti-venom, anti-inflammatory, analgesic, antidiabetic, anti-

rheumatism, antiviral and antioxidant properties. Investigation of *C. nutans* (chloroform, methanol and water) extracts on diphenyl-1-picrylhydrazyl (DPPH), galvinoxyl radical, nitric oxide, and hydrogen peroxide scavenging assays revealed that *C. nutans* extracts contained antioxidant agents that were capable of negating free radicals [35]. However, the antioxidant activities of the extract varied for each test due to the solubility of the extracts in different testing systems and the stereo selectivity of the radicals [35].

Saad and colleagues investigated the ethanolic extract of *C. nutans* on the standard free radical, 2,2-diphenyl-1-picyrl-hydrazyl (DPPH) and the result showed that *C. nutans* possessed antioxidant activity [65]. Recent study suggested that *C. nutans* has anticancer properties as the IC50 value was potent enough to inhibit the growth of cancer cells [66]. Moreover, *C. nutans* contains low levels of polyamine and has anti-proliferative effect on human lung adenocarcinoma cell line (A549 cell) [66]. Another study by Murni and team led to the finding of anti-proliferative effect of *C. nutans* on human ovarian cancer cell line (SKOV-3), breast cancer cell line (MCF-7) and human colorectal adenocarcinoma (HT-29) [67]. Yahaya et al. (2015) claimed *C. nutans* as a plant with high medicinal values that possessed potential anticancer, antioxidant, antidiabetic, immunomodulatory, wound healing, anti-inflammatory and analgesic activities [68].

3.2.4 *Cinnamomum verum*

For many years, *C. verum* has been used widely all around the world in culinary as spices as well as in therapeutic treatments. Previous studies on the bark and leaves of *C. verum* have reported various important pharmacological properties such as antidiabetic, antinociceptive, astringent, diuretic activities and antifungal activities (69). An earlier study suggested that a compound cinnamtannin B1, isolated from the stem bark of *C. verum* might have insulin-like activity. Cinnamtannin B1 can be used as a drug to initiate insulin receptor signalling by stimulation of phosphorylation that will be useful in the treatment of type 2 diabetes [70].

Another study by Azahari and team suggested that the extract of cinnamon showed insulin-mimicking effects in adipocytes. They revealed that cinnamon enhances the glucose uptake, reduces the lipid breakdown and resembles insulin activity [71]. The oils, leaves and barks of *C. verum* also showed highest antimicrobial activities against *Candida albicans*, *Candida parapsilosis*, *Candida tropicalis*, *Candida glabrata*, *Cryptococcus neoformans*, *Aspergillus fumigatus*, *Trichophyton rubrum*, *Trichophyton mentagrophytes*, *Trichophyton tonsurans*, *Microsporum gypseum*, *Microsporum audouinii* and *Microsporum canis*. Bark and leaf oils of *C. verum* showed strong antimicrobial activity due to the presence of cinnamaldehyde and eugenol [72]. *C. verum* exhibited activities against neurological disorders such as Parkinson's and Alzheimer's and possessed antioxidant, anti-inflammatory, antidiabetic, antimicrobial, anti-cancer, lipid-lowering and cardiovascular-disease-lowering compounds [73].

3.2.5 *Curcuma longa*

The phytochemical compounds present in *C. longa* possess cardio-protective, anti-inflammatory, anti-tumor, antifungal, immunomodulatory, antioxidation, antimutagenic activities, has a protective effect against aflatoxin B1 (AFB1) induced toxicity, antibacterial activities and anti-human immunodeficiency virus activity [74]. Previous study showed that curcumin from *C. longa* has the capability to delay the inflammatory response and reduced the occurrence of the joint inflammation symptoms [75]. Zahidah and team concluded that oral consumption of curcumin at the dose of 100 mg/ml/kg/day for 28 days (collagen-induced arthritis CurcuminT) and 42 days (collagen induced arthritis CurcuminC) have a potential in delaying and improving joint abnormality and injury in Sprague-Dawley rats with collagen induced arthritis.

Hussan and his team suggested curcumin as an alternative agent for oestrogen for prevention of postmenopausal osteoporosis [76]. A study regarding curcumin from *C. longa* showed that that curcumin exhibited cytotoxic effect towards acute myeloblasticleukaemia (HL-60), breast adenocarcinoma (MCF-7), chronic myelogenicleukaemia (K-562) and cervical epithelial carcinoma (HeLa). This study suggested that curcumin can act as a potential cancer controlling agent by the induction of apoptosis in breast cancer [77]. Another study showed that ethanolic extract of *C. longa* exhibited anthelmintic properties at 200 mg/ml against *Haemonchus* larvae and can be used as a substitute for levamisole [78]. Khaliq et al. in their review suggested that the extracts of *C. longa* showed hypoglycaemic and hypolipidaemic effects and

that further studies were needed to investigate the mechanisms for their hypoglycaemic potential. *C. longa* also reduced the blood glucose level and had useful effects against diabetic complications [79].

4 CONCLUSIONS

Medicinal plants are still being utilised by traditional practitioners as folk medicines as remedies in treating various diseases rather than using the conventional medicines. This is due to the presence of beneficial chemical compounds that have healing properties in addition to combating microbial infections and other diseases. This review article highlights on the phytochemical properties present in five medicinal plants in Malaysia. Most of the medicinal plants have activities such as antimicrobial, anticancer, antidiabetic and anti-inflammatory properties though some have their own traditional functions as an afterbirth tonic and as an additive in energy drinks. The current research trends in Malaysia involve exploring the herbal plants in terms of anticancer, antidiabetic, anti-inflammatory, antimicrobial, anti-proliferative, antioxidant and antinociceptive properties. Hence, the phytochemical properties that are exhibited by these medicinal plants should be focused in finding new drugs in economical ways.

CONFLICT OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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