CHAPTER 2

REVIEW OF THE LITERATURE

2.1 Taxa and Classification of *Acalypha indica* Linn., *Bridelia retusa* (L.) A. Juss. and *Cleidion javanicum* BL.

2.11 Taxa and Classification of *Acalypha indica* Linn.

Kingdom	:	Plantae
Division	:	Magnoliophyta
Class	:	Magnoliopsida
Order	:	Euphorbiales
Family	:	Euphorbiaceae
Subfamily	:	Acalyphoideae
Genus	:	Acalypha
Species	:	*Acalypha indica* Linn.

(Saha and Ahmed, 2011)

Plant Synonyms: *Acalypha ciliata* Wall., *A. canescens* Wall., *A. spicata* Forsk. (35)

Common names: Brennkraut (German), alcalifa (Brazil) and Ricinela (Spanish) (36).

2.12 Taxa and Classification of *Bridelia retusa* (L.) A. Juss.

Kingdom	:	Plantae
Division	:	Magnoliophyta
Class	:	Magnoliopsida
Order	:	Malpighiales
Family	:	Euphorbiaceae
Genus	:	Bridelia
Species	:	*Bridelia retusa* (L.) A. Juss.

Plant Synonyms: Bridelia airy-shawii Li.

Common names: Ekdania (37,38).

2.13 Taxa and Classification of *Cleidion javanicum* BL.

Kingdom	:	Plantae
Subkingdom	:	Tracheobionta
Superdivision	:	Spermatophyta
Division	:	Magnoliophyta
Class	:	Magnoliopsida
Subclass	:	Magnoliopsida
Order	:	Malpighiales
Family	:	Euphorbiaceae
Genus	:	Cleidion
Species	:	*Cleidion javanicum* BL.

Plant Synonyms: *Acalypha spiciflora* Burm. f. , *Lasiostylis salicifolia* Presl.
Cleidion spiciflorum (Burm.f.) Merr.

Common names: Malayalam and Yellari (39).

2.2 Review of chemical composition and bioactivities of *Acalypha indica* Linn., *Bridelia retusa* (L.) A. Juss. and *Cleidion javanicum* BL.

2.2.1 Review of chemical composition and bioactivities of *Acalypha indica* Linn.

Acalypha indica is used as a traditional medicine for treatment of rheumatoid arthritis and syphilitic ulcer (16). The juice of crushed leaves is mixed with a pinch of common salt and is applied externally on the scabies (15).

A. indica leaves and twings contain alkaloids, like acalyphine and acalyphamide, amides, quinine, sterols and cyanogenic glycoside. The whole plant contains kaempferol, sitosterol, triacetonamine (40), and amides (auranthiamide and its acetate succinimide), 2-Methylanthraquinone and tri-*O*-methylellagic acid were isolated from leaves of *A. indica*. Seven cyanopyridone derivatives and one corresponding seco compound have been isolated from the methanolic extract of the inflorescences and leaves of *A. indica* (41-46).

Four known kaempferol glycosides; mauritianin, clitorin, nicotiflorin and biorobin have been isolated from the flowers and leaves of *A. indica* (47). Their structures are presented in Fig. 2.1.

The leaves of *A. indica* was extracted using the modified Licken and Nickerson apparatus to afford the essential oil. Phytol was the major volatile component, followed by the flavonoids: naringin, quercitrin, hesperitin and kaempferol. Naringin was the major flavonoid found in this essential oil. The methanol extract of the whole plant contains fatty acids, such as eicosatrienoic acid methyl ester, hexatriacontane, 2,6,10-trimethyl undecatriene, trifluoroacetic acid and n-heptadecyl ester (48).

A. indica has been reported to possess several biological activities, eg. antimicrobial, antihelmintic and anti-inflammatory activities.

Different extracts (acetone, chloroform, hexane and methanol) of the leaf, stem and root of *A. indica* were evaluated for their antimicrobial activity. All the extracts showed antimicrobial activity against *Candida albican*, *Aspergillus niger* and *Escherichia coli* (49).

The hexane, chloroform and methanol extracts of *A. indica* (aerial parts) exhibited antibacterial activity against *S. aureus* and *P. aeruginosa*. They also showed antifungal activity against *T. mentagrophyte* and the chloroform and methanol extracts showed inhibition zones against *A. flavus* and *C. albican* (50).

The petroleum ether extract of *A. indica* showed antimicrobial activity against *Aeromonas hydrophilla* and *P. aeruginosa* (51). The aqueous residues of this plant also exhibited antibacterial activity against *A. hydrophilla* and *Bacillus cereus* (52).

Different extracts (hexane, chloroform, ethyl acetate and methanol) of leaf of *A. indica* showed antibacterial activity against *S. epidermidis, B. cereus, S. faecalis, K. pneumonia* and *P. vulgalis* (53).

The petroleum ether and ethanol extracts of the whole plant were found to be the most effective in causing anti-implantation and anti-estrogenic activity (23).

Four different extracts of whole plant of *A. indica* were tested for post-coital antifertility in female albino rats. Of these only the petroleum ether and ethanol extracts had significant activity. The activity was reversible on withdrawal of the extract (23).

The ethanol leaf extract of *A. indica* possessed potent snake venome neutralizing properties (19).

The alcoholic root extract of *A. indica* exhibited significant antihelmintic activity when compared to the reference drug albendazole (36). The ethanolic extract of this plant also possessed wound healing activity (17).

The methanol extract of the whole plant showed potential analgesic and anti-inflammatory actions in rats and mice (54).

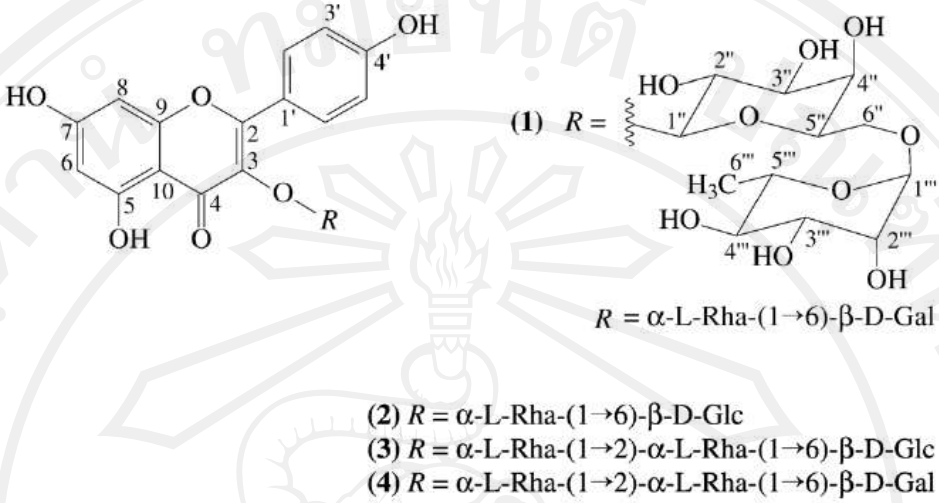


Figure 2.1: Structures of some active chemical compounds of *A. indica* **1** (*Biorobin*), **2** (*Nicotiflorin*)**, 3** (*Clitorin*) and **4** (*Mauritianin*).

2.2.2 Review of chemical composition and bioactivities of *Bridelia retusa* (L.) A. Juss.

B. retusa bark is used as a traditional medicine for treatment of dysentery (30). Its roots applied externally to cure wound (26,27).

B. retusa bark contains tannins (16-40%) which exhibited antiviral, hypoglycaemic and hypotensive properties (pharmacological studies) (28). Mixture of the bark of *Bauhinia racemosa* and *Bridelia retusa* is given orally to women to develop sterility and used as traditional medicine in India, as a contraceptive (29).

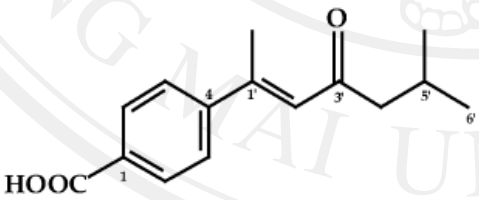
Eight compounds were isolated from the stem bark of *B. retusa*: bisabolane sesquiterpenes, (E)-4-(1,5-dimethyl-3-oxo-1-hexenyl)benzoic acid, (E)-4-(1,5-dimethyl-3-oxo-1,4-hexadienyl)benzoic acid, (R)-4-(1,5-dimethyl-3-oxo-4-hexenyl) benzoic acid, (–)-isochaminic acid, (R)-4-(1,5-dimethyl-3-oxohexyl)benzoic acid (artodomatuic acid), 5-allyl-1,2,3-trimethoxybenzene (elemicin), (+)-sesamin and 4-isopropylbenzoic acid (cumic acid). Their structures are shown in Fig. 2.2. These compounds showed antifungal activity against *Cladosporium cladosporioides* (55).

B. retusa fruit contains β-sitosterol, galic acid and ellagic acid (56).

An isoflavone was isolated from the benzene fraction of the ethanolic leaves extract of *B. retusa*. This compound showed antimicrobial activity against human pathogenic bacteria viz. *S. aureus, B. subtilis, E. coli, S. typhi, S. dysenteriae* and *P. aeruginosa* (28).

The chloroform of the fruit extract showed inhibition zones against *S. aureus, E. coli* and *P. aeruginosa* but the methanolic extract showed antibacterial activity against *S. aureus* and *P. aeruginosa*. The methanolic extracts of the leaves and stems exhibited antibacterial activity against *S. aureus*, and only the methanolic extract of the leaves showed an inhibition zone against *P. aeruginosa* (50).

The methanolic leaf extract of *B. retusa* significantly potentiated the cellular immunity by facilitating the foot pad thickness responses to the sheep red blood cells in sensitized rats with a dose of 200 mg/kg. The study stated that *B. retusa* showed a significant stimulation of the cell mediated immunity and had no effect on the humoral immunity (57).



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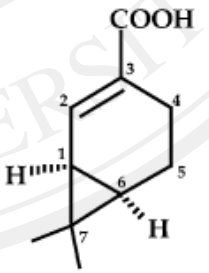

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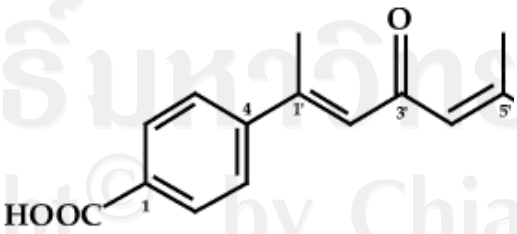

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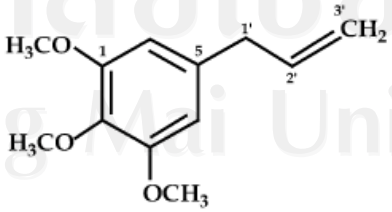

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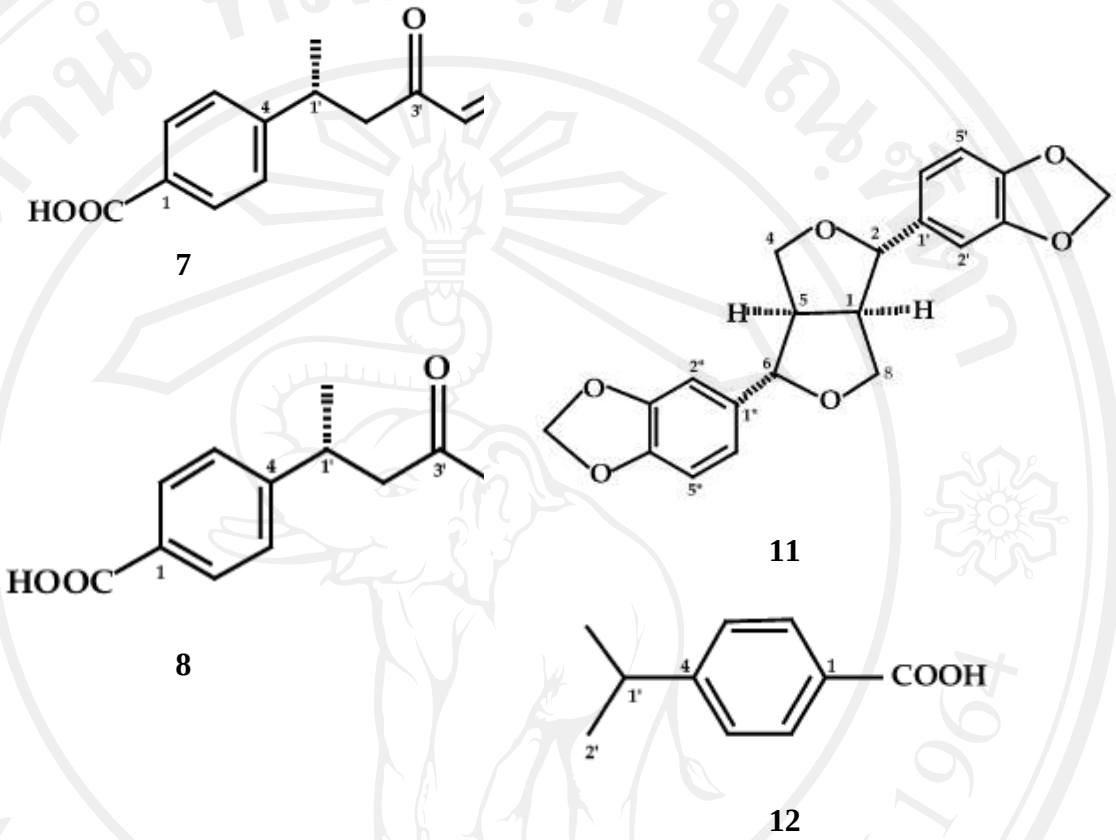


Figure 2.2: Structures of **5** ((E)-4-(1,5-dimethyl-3-oxo-1-hexenyl) benzoic acid)**, 6** ((E)-4-(1,5-dimethyl-3-oxo-1,4-hexadienyl) benzoic acid), **7** ((R)-4-(1,5-dimethyl-3-oxo-4-hexenyl) benzoic acid), **8** ((R)-4-(1,5-dimethyl-3-oxohexyl)benzoic acid (ar-todomatuic acid)), **9** ((−)-Isochaminic acid), **10** (5-allyl-1,2,3-trimethoxybenzene (elemicin)), **11** ((+)-sesamin) and **12** (4-isopropylbenzoic acid (cumic acid)).

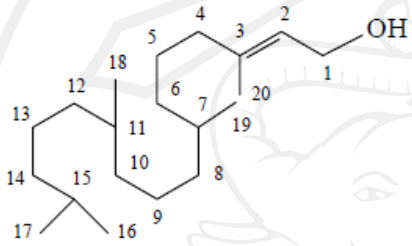
2.2.3 Review of chemical composition and bioactivities of *Cleidion javanicum* BL.

In the Philippines, decoction of its leaves is reputed to cause abortion, whereas a decoction of the bark is given internally as stomachic. *C. javanicum* stem is used as an analgesic, antipyretic and diaphoretic (33).

Its seeds were used for the treatment of constipation (34).

Phytochemical investigations of *C. javanicum* revealed the presence of tilianin, diosmetin 7-O-glucopyrananoside, 24S-methyl-5a-lanosta-9(11), 25-dien-3b-ol, trans-

phytol and anol glucopyranoside from the leaves of this plant (58). Their structures are shown in Fig. 2.3. Other constituents of the roots were spiciflorin, columbin, scopoletin, 3,30,4-O-trimethylellagic acid, acetylaleuritolic acid, acetyloleanolic acid and its methyl ester, taraxerol, taraxerone, β-sitosterol, stigmasterol, 3,5-dimethoxy-4-hydroxybenzoic acid, vanillic acid, trans-4-propenylphenol (anol) glucoside and 5-hydroxymethylfurfural (59). Their structures are shown in Fig. 2.4.



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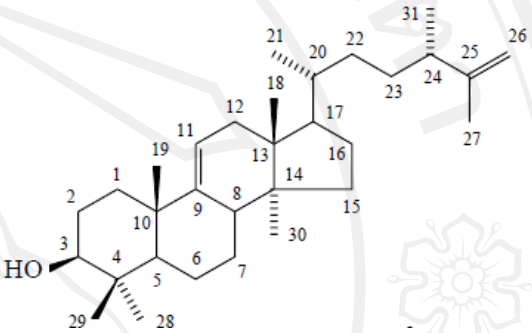

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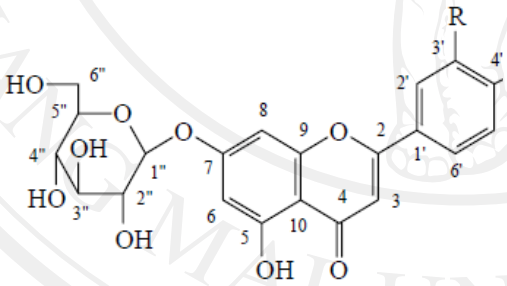

15: R = H

16: R = OH

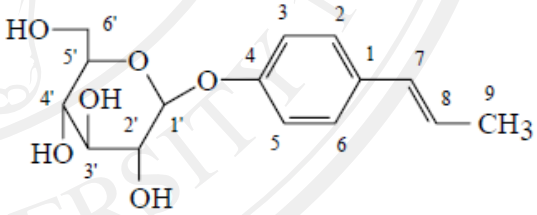

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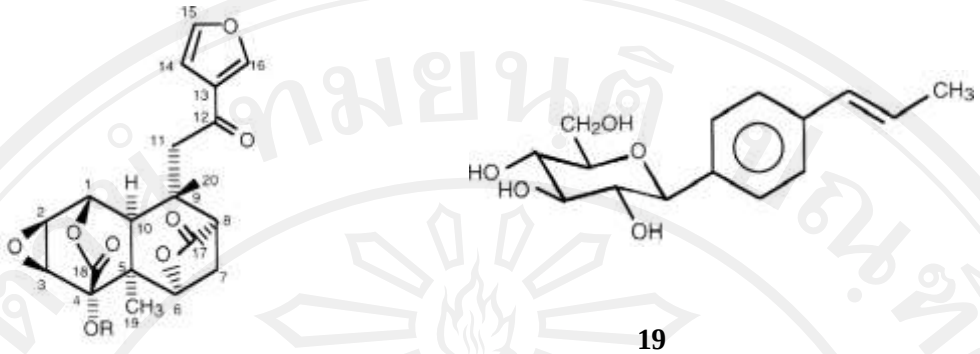
Figure 2.3: Structures of **13** (trans-Phytol), **14** ((24S)-24-Methyl-5α-lanosta-9(11),25-dien-3β-ol), **15** (Acacetin-7-O-β-D-glucopyranoside) , **16** (p-Propenylphenol-β-D-glucopyranoside) and **17** (Diosmetin-7-O-β-D-glucopyranoside).



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18 R = H

Figure 2.4: Structures of **18** (Spiciflorin), **19** (Anol glucoside)**.**