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Review Article

A Review: Study of Chemical Content, Bioactivity of Mangrove Fern Plants (*Acrostichum aureum* L.)

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Abstract: The purpose of this review is to provide knowledge about Mangrove Fern (*Acrostichum aureum* L.). This plant contains various chemical constituents such as phenolics, antioxidants, flavonoids, saponins, phenols, steroids, and active compounds of flavonoids in the form of kaemferol, quercetin. Phthalic acid ester compounds such as (2-methoxycarbonyl- 5-methylpentyl- 2 methylhexyl phthalates). Sterols in the form of phytosterols, such as stigmasterol, β-sitosterol, campesterol, cycloartenol, and 24-methylene cycloartenol. Terpenoids such as sesquiterpenes (2R, 3S) -sulfate petrosine C and (2R, 3S) -sulfated petrosine C. Pharmacologically these plants have been reported as cytotoxic, antioxidant, anti-inflammatory, antitumor, analgesic, antiviral, antibacterial, and antiparasitic. In this review, mangrove fern has active compounds and pharmacology have been reported disease. However, it is necessary to do further research on sea ferns to determine the active compounds and another bioactivity.

Keywords: Mangrove fern (*Acrostichum aureum* L.), chemical content, bioactivity.

INTRODUCTION

Mangrove ferns (*Acrostichum aureum* L.) are the only ferns that are included in the mangrove group, with *Pteridaceae* families living mostly in the tropical region, such as Japan, Taiwan, India, Malaysia, Fiji and China including Indonesia. Mangrove ferns can do well on the seashore. These mangrove plants can also be referred to as "mangroves Forrest". Mangrove fern can be known as the area of swamp nails, mangrove ferns that can live in swamps. Mangrove fern have bioactivity on a minor or major scale, namely as anti-inflammatory, antioxidant, analgesic, antiviral, cytotoxic [1].

Acrostichum aureum and *Rhizophora apiculata* are a common mangrove species in Malaysia. Allelochemical interaction of the mangrove species was speculated to play an important role in dominance in the harsh mangrove environment [2]. This countries used Mangrove fern as traditional medicine by using the roots and leaves of mangrove fern as a remedy for wounds, ulcers, and to stop the bleeding. In Bangladesh, people use the leaves of Mangrove ferns for the treatment of cloudy urine in women [3]. In Fiji, Mangrove ferns are used as a sore throat, chest pain, elephantiasis, laxatives, and analgesics. In India, the leaves of Mangrove fern are used as an antidote for snake venom [1].

Several studies have reported the chemical constituents of Mangrove ferns such as phenolics, flavonoids, antioxidants [4]. Furthermore, the ethanol extract of Mangrove fern contains steroids, saponins, phenols, proteins, glycosides, and terpenoids. Meanwhile, Mangrove ferns petroleum ether extract contains saponins, phenols, proteins, glycosides, terpenoids, methanol extract of Mangrove fern contains steroids, saponins, flavonoids, phenols, proteins, glycosides, and terpenoids [5]. Also, the isolation of endophytic bacteria from sea nail leaves against *Aureimonas Flava* sp. These bacteria belong to Gram-negative bacteria are aerobic and coccus shaped [6]. Other studies also report that *Acrostichum aureum* Linn. from Sunderbans India can analysis of rizosphere microbiomes such as *Proteobacteria*, *Acidobacteria* and *Plancomycetes* using qiime method. sample collected using regional amplicons gen 16S rRNA V3-V4 to identify many microbals in rhizosphere [7].

DATA COLLECTION

The authors were made this article by conducting literature studies. The source or the literature is primary data that was collected from official books and international journals in the last twelve years (2009-2020). The works of literature were

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collected from trusted online journal sites such as a digital library, ScienceDirect, Pub Med, NCBI, Researchgate, Google scholar, and other E-resource with keyword "mangrove fern plants (*Acrostichum aureum* L.)" and "chemical constituents and bioactivities".

MANGROVE FERN (*Acrostichum aureum* L.)

Fig-1: Mangrove Fern (Acrostichum aureum L.) [8]

Taxonomy classification of Mangrove fern (*Acrostichum aureum* L.) [9]

Kingdom	: Plantae
Subkingdom	: Tracheobionta
Phylum / Division	: Pteridophyta
Class	: Filicopsida
Ordo	: Polypodiales
Family	: Pteridaceae
Genus	: Acrostichum
Species	: aureum
Common	: Leather Fern, Sea Fern, Mangrove Fern, Swamp Fern.

DISCUSSION

Chemical Constituents

Chemical content of Mangrove Fern such as phenol which has bioactivity in various diseases of atherosclerosis, diabetes, cancer, and brain dysfunction. Also, the phenol plant origin can contribute to providing color and is used as a sensory in fruit and vegetables [10]. Flavonoids act as prevention of fat accumulation in the body to prevent obesity that causes diseases such as heart disease and diabetes mellitus, antioxidants can counteract free radicals in the body. Several studies have reported that Mangrove fern have bioactivity such as cytotoxicity [11], antioxidant [12], anti-inflammatory [13], anti-tumor [14], analgesic [15], antiviral [16], antibacterial [17] and antiparasitic [18]. The active compounds contained in Mangrove Fern according to previous researchers are flavonoids [19] phthalic acid [20], several types of sterols [14], terpenoids and several other chemical substances such as *patriscabratine* and *tetracosan* [19]. Flavonoids such as kaempferol (1), quercetin (2). Phthalic acid ester compounds such as (2-*methoxycarbonyl*- 5-*methylpentyl*- 2 *methylhexyl phthalate*).Sterols are in the form of phytosterols, such as stigmasterol (1), beta-sitosterol (2), campesterol (3), cycloartanol (4) and 24-methylene cycloartanol (5). Terpenoids are sesquiterpenes (2R, 3S) -sulfatet pterosin C (1) and (2R, 3S) -sulfated pterosin C (2).

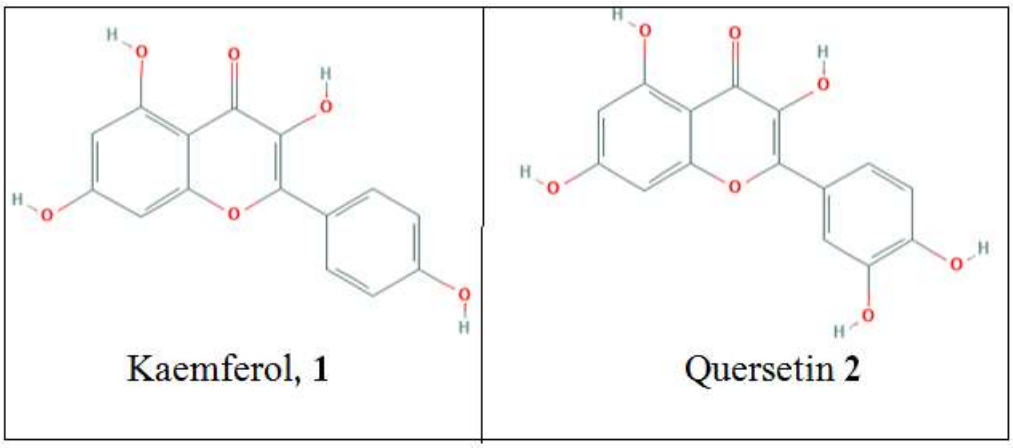

Fig-2: The active compound flavonoid of Mangrove Fern [21, 22]

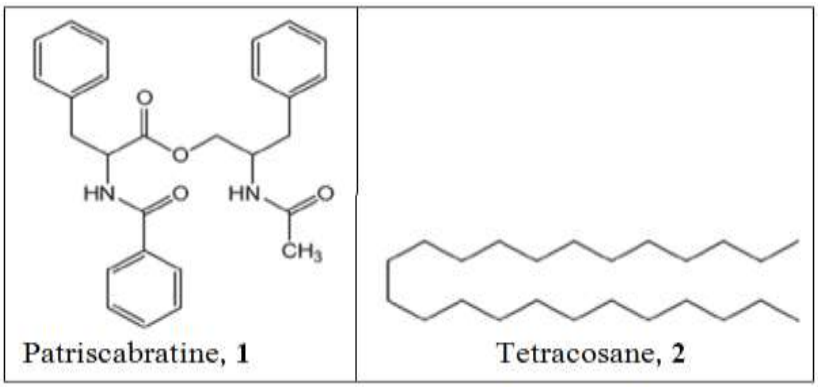

Fig-3: Other active compounds of Mangrove Fern [19]

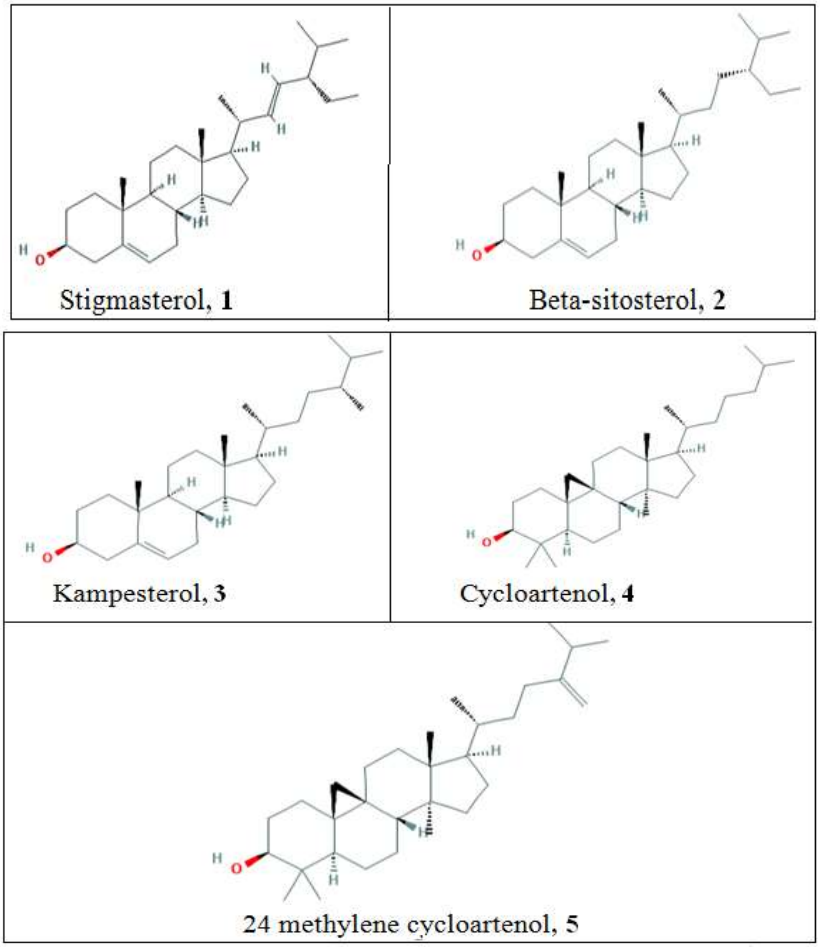

Fig-4: Mangrove fern phytosterol active compound [23-26, 21]

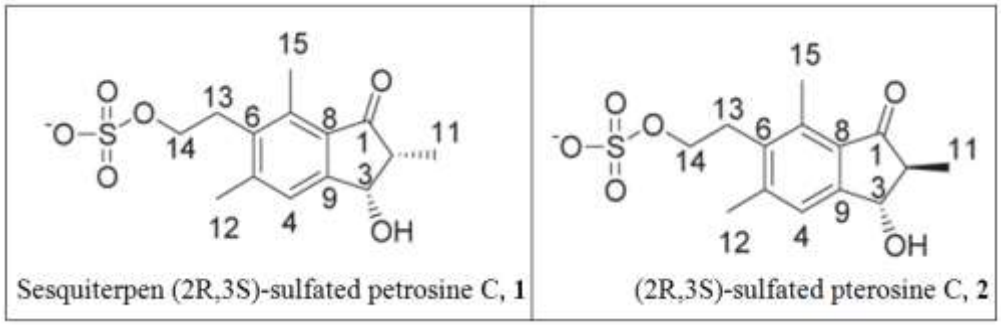

Fig-5: The active compounds of marine nail terpenoids [20]

Bioactivity of *Acrostichum aureum*

Cytotoxic

In the cytotoxic test, it has been reported that Mangrove Fern leaves have cytotoxic activity using the *MTT assay* method. The methanol extract of Mangrove fern with IC_{50} values > 2.5 mg - 1 ml was able to inhibit the growth of AGS cells, NIH3T, HT29, MDA-MB4-35S. Mangrove fern methanol extracted *in vitro* by *MTT assay* method and *Annexin V-FITC apoptosis*. Tetracosane cytotoxic active compound with (IC_{50}: 128.7 µm) as a cytotoxic drug for colon cancer cells (HT-29). *Patriscabratine* with (IC_{50}: 133.66 µm) inhibits growth in gastric cells (AGS), breast cancer cells MDA-MB-123 with (IC_{50}: 69.8 µm), MCF-7 with (IC_{50}: 197.3 µm), but it was showed no cytotoxic effects on (NIH3T3) and (HT-29) [19].

There were two new compounds sesquiterpenes (2R, 3S) -sulfate pterosin C (1) and (2R, 3S) -sulfate pterosin C (2) can inhibit human cancer cell line (AGS, HT-29, MDA-MB-231, and MCF-7) and NIH3T3 cell lines using the MTT assay. The two compounds indicated IC_{50} values in the range 23.9- 68.8 µm. The lowest IC_{50} was 23.9 µm against gastric cells of AGS adenocarcinoma, which had an apoptosis effect on AGS cells. This cytotoxic activity is due to the presence of a sulfate group at C-14 and a configuration at C-2 [20].

Antioxidants

The antioxidant activity of mangrove fern ethanol extract was reported by using the DPPH (1,1-Diphenyl-2- picrylhydrazyl) method IC_{50} 41.96 µg / ml with ascorbic acid as a comparison of IC_{50} 16.36 µg/ml [15]. Nurhasnawati *et al.,* 2019 reported that antioxidant activity with the DPPH method (highest IC_{50} 29.5303 ppm), total phenolic levels (366.4573 ± 2.2117 mg GAE g-1) using the Folin-ciocalteu method, flavonoid levels with the colorimetric method (228,6087 ± 2.2548 mg QE g-1) [27].

In addition, this study was also reported that petroleum ether extract, benzene extract, ethyl acetate extract, ethanol extract, and methanol extract of Mangrove fern acted as antioxidants using the DPPH (1,1-Diphenyl-2- picrylhydrazyl) method. Among the solvent extracts tested, benzene extract 800 µg DPPH (118.56%), IC_{50} in methanol extract (36.54µg / ml). The compounds that play a role in antioxidant activity are flavonoids and phenolic [28].

Another study reported that sea nail antioxidants also played a role in reducing levels of pond waste pollutants in shrimp by increasing catalase activity, superoxide dismutase, peroxide and glutathione transferase activity with waste parameters (BOD) (73%), (COD) (39%)) and NO_3 (55%) [29].

Anti-inflammatory

The anti-inflammatory activity of Mangrove fern was tested *in vivo* using the male albino rat edema test as an observation. Ethanol extract of the root of nail reportedly has potential anti-inflammatory at a dose of 200-400 mg/kg body weight with a maximum inhibition% at 65.90% compared with 66.66% indomethacin drug delivery within 24 hours [13].

Another study reported that seawater extract had ethanol-induced gastroprotective effects on the stomach. Pretreatments of 100, 200, and 400 mg/kg were able to reduce the repair of pathological damage caused by alcohol in mice [12].

Antitumor

Mangrove fern was reported to have antitumor activity. Mangrove fern sterol fractionation using gas chromatography (GC) and mass. At (24-methylcolest-5-en-3β-ol) campesterol with a retention time of 26,167 minutes. The peak spectrum fragments are seen at .315 and 289 m / z which are characteristic of 3β-hydroxy α-5. Furthermore, GC-mass spectrum on stigmasterol with a retention time of 26 948 minutes, in fragments that many visible spectrum peaks at 327 and 301 m / z on 3β-hydroxy-5-α-sterol. GC-mass spectrum on ɤ-sitosterol with a retention time of 28,498 minutes, in many ion spectrum fragments seen in 3-β-hydroxy-ɤ-5-sterol. The GC-mass spectrum is comparable to cycloartenol with a retention time of 31,259 minutes, in the peak spectrum fragments at 408 and 393 m / z that lose H2O molecules. The GC-mass spectrum of 24-methylene-cycloartenol with a retention time of 33,570 minutes, in the peak spectrum fragments at 422 and 407 m / z with loss of H2O molecules similar to the structure of cycloartenol. Active compounds from Mangrove fern leaves that have the potential to be anti-tumor are phytosterols (stigmasterol, ɤ-sitosterol, campesterol, cycloartenol, and 24-methylene cycloartenol). Line Cell Predictor (CLC-Pred) antitumor phytosterol against adenocarcinoma followed by carcinoma and mesothelioma [14].

Analgesic

Mangrove fern has been reported to have acted as an analgesic by the wriggling test method in mice induced by acetic acid. Analgesics work peripherally through activation of peritoneal receptors that will induce stretching in test animals. The stretching method in mice induced by the subsequent release of endogenous substances. Some endogenous substances such as serotonin, bradykinin, histamine, prostaglandin (PG) are released by acetic acid and are responsible for producing pain by speeding up nerve end receptors. These mice stretching method can be seen how big obstacle after calculated percent for each test group and the comparison control group. The percentage of inhibition of ethanol extract of Mangrove fern at a dose of 250 mg was 28.68% and a dose of 500 mg was

46.77% compared to the control group of diclofenac sodium with a dose of 25 mg of 69.16% [15].

Antiviral

This study reported that in vitro a new compound phthalic acid ester, (2-methoxycarbonyl-5-methylpentyl-2 methylhexyl phthalate) sea nail was used as an antiviral. Phthalic acid has indicated antiviral activity against (DENV-2), (hPiV3), and (CHIKV). The strongest activity was against the human parainfluenza virus with (EC_{50} 29.3 µm) slightly higher than BCX 2798 positive control with (EC_{50} 44 µm). Cellulose acetate was also evaluated for antiviral activity. It was found to be first and inactive. Both of these compounds are non-toxic to Vero and LLC-MK2 cells [16].

Antibacterial

The activity of methanol extract of sea nail as antibacterial has been reported. Disc diffusion method with an inhibitory diameter of 1.3 mm was able to inhibit the growth of the bacterium *Vibrio parahaemolyticus* (Pc 29) (isolated from mud crabs) (*Scylla serrate*) [17]. However, according to the research of Lai *et al.*, 2009, the antibacterial activity of the methanol extract of sea nail leaves was not an inhibition zone in the disc paper area [30].

Antiparasitic

Mangrove fern was reported to have an antiparasitic activity of 56% in sheep infected with Haemonchus contortus worms by counting eggs per gram by reducing the number of fecal eggs on day 0 (pre-treatment) and days 5, 7, 9 (post-treatment) [18].

CONCLUSION

Mangrove fern *(Acrostichum aureum* L.) has active flavonoid compounds such as kaemferol and quercetin. Phthalic acid esters such as (2-methoxycarbonyl-5-methylpentyl- 2 methylhexyl phthalate), sterols (phytosterols) such as stigmasterol, β-sitosterol, campesterol, cycloartenol, and 24-methylene cycloartenol. Terpenoids such as sesquiterpenes (2R, 3S) -sulfate pterosin C and (2R, 3S) -sulfated pterosin C that has bioactivities such as cytotoxics, antioxidants, anti-inflammatory, anti-tumor, analgesic, antiviral, antibacterial, and antiparasitic. However, it is necessary to do further research on sea ferns to determine the active compounds and another bioactivity.

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