ABSTRACT

Herbal medicines have been used throughout the world from ancient time. Mangroves are a collection of plants growing in saline coastal areas are the richest source of secondary metabolites which possess wide range of bioactive properties. Numerous mangrove plants have been used in folklore medicines due to the presence of these bioactive components. Most of the mangroves identified are possessing antimicrobial properties. Apart from the medicinal properties, they also protect the vulnerable coastlines from wave action by holding the soil together and prevent coastal erosion.

Key words: Herbal medicines, Mangroves, Pharmacological, Phytochemical

INTRODUCTION

Plants are the richest source of drugs of traditional system of medicines, modern medicines, nutraceuticals, food supplements, folk medicines, pharmaceutical intermediates and chemical entities for synthetic drugs. The use of plants and plant products as medicines could be traced as far back as the beginning of human civilization [1]. Plants have been looked towards as the source of various anti pathological compounds that can be efficiently extracted and put to use for the benefit of mankind. They are considered to be the store house of various alkaloids, steroids, phenols, tannins etc., which has profound influence in the treatment of various common diseases afflicting other living microorganisms. There have been many benefits of using plants as the source of many drugs. They are relatively safer and the ease of extracting it is more than their synthetic counterpart. The combination of various useful secondary metabolites adds up to the reason why plant extracts were chosen as the source of various medicines in the late 1990 [2].

Mangroves are an unique set of trees flourishing in the salty regions especially in the delta region or places near the shore. The uniqueness lies in their pneumatophores or breathing roots which enable them to respire when the soil is too clogged with salty water. Besides this, the mangroves act as a store house of a plethora of secondary metabolites which they have to produce in large amounts provided the conditions that they are living in [3]. Mangroves are salt tolerant plants of tropical and subtropical interior regions of the world. These highly adapted
Plants have many peculiar features than their terrestrial and aquatic counterparts. The mangrove ecosystem covers only 0.037% of the world’s surface or 0.12% of the earth’s land area [4]. Mangroves have many peculiar features than the other terrestrial plants. The word “mangrove” can also be used to describe the habitat as well as the species of trees and shrubs that grow in that habitat. Plants in mangals are diverse but all are able to exploit their habitat that lives at or near the water’s edge in protected marine habitats [5]. Mangroves are mainly defined as an inter tidal wetland ecosystem formed by a very particular association of animals and plants which multiply ornately in the coastal areas and river estuaries throughout the low lying tropical and subtropical latitudes. These wetland ecosystems are among the most productive and sundry in the earth and more than 80% of marine catches are directly or indirectly dependent on mangrove and other coastal ecosystems universally [6]. These plants are usually found in tropical climates because they need consistently warm conditions for development and survival and therefore south India can be considered as one of the best place in India for the establishment of mangroves [7,8]. Mangroves provide many ecological, environmental and socioeconomic benefits to mankind. However, biodiversity rich mangrove ecosystem is fast declining all over the world. In the state of Kerala, the extent of undistributed mangroves is reduced to just 150 hectares and mostly distributed in Eranakulam, Kanuur and Kozikode districts [9]. Mangroves are usually grown on the edges where rain forests meet oceans with stressful habitat involving daily changes in the pH of soil and water, humidity, salinity, temperature and tidal cycles may be possible reasons for many of these plants to synthesize a large number of different bio active phytochemicals, many of which have been found to have extensive use in industry and human health care. Due to their medicinal values, different parts of these plants have been used for ages by the local people as folk medicine for curing many diseases [10].

Mangroves possess very important ecological function such as control of coastal erosion and protection of coastal land, stabilization of sediment and natural purification of coastal water from pollution. Apart from prawn fisheries, many other species of economic importance are also associated with crabs, shrimp, oysters, lobsters and fish. Mangrove provides food and a wide variety of traditional products and artifacts for mangrove dwellers. The mangrove leaves are useful contributors to the nutrient system of the mangrove environment. It is known that mangrove leaf contain minerals, vitamins and aminoacids, which are essential for the growth and nourishment of marine organisms and livestock. The common chemical constituents present in the mangroves are aliphatic alcohols, aliphatic acids, aminoacids, alkaloids, carbohydrates, carotenoids, hydrocarbons, free fatty acids including poly unsaturated fatty acids, lipids, pheromones, phorbol esters, phenolics, and related compounds, steriods, triterpenes, glycosides and tannins. Chemical such as aminoacids, carbohydrates and proteins are products of primary metabolism and are vital for the maintenance of life processes, while other constituents like alkaloids, phenolics, steroids, are the products of secondary metabolism and have toxicological, ecological and pharmacological importance [10-12].

In this review an attempt has been made to compile the information regarding pharmacological and other important aspects of the various species of mangroves.

*Rhizophora apiculata* [4,13-15]

It is commonly known as *red mangroves* belongs to Rhizophoraceae family, which is medium to tall trees with dark glossy green leaves and reddish midrib. Tannins are known to exists in this species and have been reported to possess medicinal value to overcome bacterial and viral infections. The condensed tannins present in this species also have remarkable antioxidant properties.
Avicennia marina [4,16]
It is commonly known as gray mangrove or white mangrove belongs to Verbanaceae family. It is a shrub which attains height up to 4 meters. Leaves are elliptic, thick, yellowish green and silver gray. Studies have shown that the species exhibit antioxidant and antimicrobial activity. The different solvent extracts of the different parts of the plant were capable of scavenging a wide range of free radical and the stem was found to be the best antioxidant among them. The pharmacological profile of this species could be due to the presence of polyphenolic compounds and flavonoids. Hence the plant can be used as a promising source of natural antioxidant.

Acrostichum aureum [4,17-22]
It is commonly known as Swamp Fern or Mangrove Fern belongs to Pteridaceae family. Leaves are shiny and typically dark green in colour. There are several ethanomedicinal uses of this species. The rhizomes are used to treat wounds, non healing ulcers and boils. The roots of the plant are used in treating syphilitic ulcers. The entifer plant can be employed in treating sore throat, chest pains, elephantiasis, purgative and febrifuge. Leaves of the species are utilised in treating cloudy urine in women and also to stop bleeding. The anti inflammatory activities of the root of the plant were evaluated in carrageenan induced inflammation rat models. Results showed that the plant exhibit significant activity and was comparable to the standard drug indomethacin. The ethanol extract of the whole plant was found to be potent antioxidant and the results showed that the extract was effective in scavenging DPPH. The analgesic activity of the whole plant was also evaluated by tail flick latency and writhing number methods. The results showed that the plant possess analgesic activity. Ethanol and acetone extracts of the whole plant showed potent anti implantation activity. The water soluble fraction of ethanolic extract was found to have prevented pregnancy in female rats during administration on day 1-7 post coitus. The fraction was not having oestogenic and anti oestrogenic activities. The methanolic extract from the leaves of the plant showed selective cytotoxic activity against different cancer cell lines.

Pemphis acidula [23-25]
The plant is commonly known as bonsai mangrove. The antibacterial activity of the methanol, ethanol and water extracts of the leaves and bark were evaluated against human pathogens like Pseudomonas aeruginosa, Klebsiella pneumonia, Vibrio parahaemolyticus, Staphylococcus aureus and Vibrio cholera. The plant possessed higher antibacterial potency. Studies have shown that the plant contains galloyl, flavonol and glycosides and the biological and pharmacological activity of plant could be due to the presence of theses active principles.

Acanthus ilicifolius [4,26-35]
It is commonly known as Holly-leaved acanthus or Sea Holly or Holly mangrove from Acanthaceae family. The plant is reported to contain alkaloid and glycosides. In traditional medicine, the plant is used in the treatment of diseases from snake bite to skin diseases. The plant has been used in treating rheumatism, asthma, paralysis, psoriasis and leucorrhoea. The plant also possess anti inflammatory, antioxidant, antileishmanial, osteoblastic, hepatoprotective, anticancer, anti ulcer, and antimicrobial activities. Phytochemical screening of Acanthus ilicifolius leaf extracts revealed the presence of proteins, resins, steroids, tannins, glycosides, sugars, carbohydrates, saponins, sterols, terpenoids, phenols and alkaloids. Whole plant extract was reported to have analgesic and anti inflammatory actions. Methanolic fraction of the Acanthus ilicifolius leaf extract produced significant and dose dependent inhibition of rat paw edema. Alcoholic extract of the plant was found to be effective against tumor progression and carcinogen induced skin papilloma formation in mice. The plant is also reported with
antioxidant activity. The free radical hypothesis supports that antioxidants can effectively inhibit carcinogenesis and observed properties may be attributed to antioxidant principles present in the plant.

A chemical compound called 2-Benzoxazolinone was obtained from the leaves of the plant, which exhibited significant antileishmanicidal activity against Leishmania donovani. The plant possesses bioactive compounds that have potential for use as antibacterial. Roots showed activity against leukemia virus in erythro leukemic Swiss mice.

**Sonneratia caseolaris** [4,36]
The plant is commonly known as *Apple mangrove or crabapple mangrove* from Lythraceae family. Bark and fruit extracts from the plant have shown to have an antioxidative and cytotoxic effects. Whereas the flower extract shows an antimicrobial activity against certain bacteria. According to traditional folklore it is used as an astringent and aniseptic. Methanol extract of the plant also found to be having bactericidal activity against multi drug resistant pathogens. The antimicrobial action could be due to the flavonoids in this plant.

**Nypa fruticans** [37]
The plant is commonly known as *mangrove palm*. It is a mangrove from Arecaceae family well known for its traditional uses by the local practitioners against different ailments in southern region of Bangladesh. The antihyperglycemic and antinociceptive activity of the methanolic extract of the methanol extract of the leaf and stem were evaluated. The antihyperglycemic activity was done in glucose loaded hyperglycemic mice and antinociceptive activity was tested in acetic acid induced writhing in mice. The results showed that the plant possess significant antihyperglycemic and antinociceptive activity.

**Barringtonia racemosa** [4,38-44]
It is a type of mangrove plant which is known as *food poison tree* from Barrintoniaceae family. The fruits of the plants are used as the medicine for the treatment of pain, inflammation and rheumatic conditions, ear ache and parturition. The aromatic seeds are used to treat colics and ophthalmia. The roots of *Barringtonia racemosa* had been reported to have an antibacterial activity against several strains of both gram positive and gram negative bacteria. The plant is also reported to be a potential candidate for the development of phytobased antitumor agent. A study also verified the efficacy of *Barringtonia racemosa* methanolic seed extract since it was found that the species exerted an even better antitumor effect than vincristine. Significant antinociceptive and analgesic activity of *Barringtonia racemosa* had been reported from aqueous bark extract. The analgesic activity had been demonstrated upon hot plate and formalin test in experimental male mice without producing any unwanted side effects or toxicity. The antifungal activity of methanolic extracts of *Barringtonia racemosa* leaves, sticks and barks had been verified to have antifungal activity against *Fusarium* sp., *Trichoderma koningii* etc. The anti tuberculosis activity of the plant was also reported by evaluating the extract in *Mycobacterium smegmatis*.

**Rhizophora mucronata** [4,45]
The plant is commonly known as *red mangrove* from Rhizophoraceae family. The bark and leaves of the plant was assessed against urinary tract infection causing bacterial pathogens. The test pathogens were isolated from patients with signs of urinary tract infection and were identified up to species level by studying their morphological, physiological and biochemical characteristics. For the study disc diffusion method was followed using methanol and ethanol extracts. Among these two extracts, methanolic extract of the plant was found to very effective.
Sonneratia apetala [4,46,47]
It is also known as mangrove apple belongs to Sonneratiaceae family. It is grown as a tree or shrub along seaward fringes and intertidal areas. This plant has been traditionally used to treat hepatitis. The literature also reports that the leaves of the plants are used for dysentery, sprain and bruises, in the treatment of eye trouble, open sores in children ears and also in heart troubles. The antimicrobial activity of the plant was carried out on *Staphylococcus aureus*, *Bacillus subtilis*, *Staphylococcus warneri*, *Escheretia coli*, *Klebsiella pneumonia*, *Pseudomonas putida*, *Pseudomonas aerugenosa*, *Proteus microbilis* and *Candida albicans*. The activity was carried out by agar well diffusion method. The antibacterial activity was determined by measuring the diameter of inhibition zone around the well filled with the extract. The results showed that the ethanolic extract of the plant possess good antibacterial activity against both gram positive and gram negative microbes. The plant was also subjected to antifungal activity by using Sabouraud dextrose agar well diffusion method and the results shows test sample has significant antifungal activity.

Heritiera fomes [4,48-50]
It is commonly known as sundari from Sterculiaceae family. The plant is used by the rural tribal people as traditional medicine and possesses a variety of pharmacological activities. Leaves, roots and stems are used for the treatment of gastrointestinal diseases, skin diseases, stomachache, diabetes and lack of appetite. The leaf extract of the plant was also reported as antinociceptive agent, antioxidant and antimicrobial agent. The potential of these activities may be due to the presence of phytoconstituents reported in the phytochemical test like; reducing sugars, saponins, alkaloids, glycosides, tannins, steroids, flavonoids and gums.

Sesuvium portulacastrum [51]
The plant is commonly known as sea purslane. It is one of the fastest growing, herbaceous mangrove of the family Aizoaceae. The plant demonstrated a broad spectrum of antibacterial activity against gram positive and gram negative bacteria. The activity may be due to the phytoconstituents like alkaloid, coumarin, flavonoid, steroid and tannins in the methanolic extract. Bioactive substances from this plant can therefore be employed in the formulation of antimicrobial agents for the treatment of various bacterial infections.

Sonneratia alba [4,52-54]
The plant is commonly known as Sweet scented apple mangrove. It is a mangrove plant from Sonneratiaceae family. Members of this family are a rich source for tannins which are known for its antimicrobial activity. The plant was also reported with antidiabetic activity. The bark extract of the plant possess antioxidant, cytotoxic and antimicrobial activity.

Cerriops tagal [4,55-58]
It is commonly known as yellow mangrove from the family Rhizophoraceae. A new dolabrane-type diterpene, tagalsin, together with six known analogues were isolated from the plant. Cytotoxicity of the isolated compounds were evaluated against HeLa human cervical carcinoma cancer cell line. The plant was found to be very effective. Four triterpenes were also isolated from the plant which was effective in inhibiting cell proliferation and growth of H-7402 and HeLa. The effect of an ethanolic extract and its fractions on H-2-deoxyglucose uptake by cultured L6 rat muscle cells showed enhancement of glucose uptake comparable with insulin and metformin. Results suggest the n-hexane soluble fraction might be a potential source of new antihyperglycemic compounds. Investigated the anticancer activity of tagalsins A-G isolated from the roots of C. tagal. Tagalsins A- G induced apoptosis through
activation of caspase-3 enzyme. Tagalsin A was the most active. Results suggest a potential for the development of anticancer agents with novel mechanisms of actions.

*Aegiceras corniculatum* [4,59]  
It is commonly known as *black mangrove or river mangrove* from Myrsinaceae family. The plant is distributed in coastal and estuarine areas of Southeast India. Excluding scientific knowledge of *A. corniculatum* against diabetes an up growing endocrinial disorder. Diabetes was induced in adult rats of the Wistar strain by intraperitoneal injection of alloxan monohydrate. The experimental rats were administered with leaf suspension of *A. corniculatum* post orally using an intragastric tube. On completion of the 60-day treatment, a range of biochemical parameters were tested including liver hexokinase, glucose-6phosphatase and fructose 1, 6 bisphosphatase in the liver of control and allaxon-diabetic rats. As a result, *A. corniculatum* leaf suspension showed moderate reduction in blood glucose, glycosylated hemoglobin, a decrease in the activities of glucose-6 phosphatase and fructose 1, 6-bisphosphatase, and an increase activity of liver hexokinase achieved through the oral administration of extract on 100 mg/kg. The present findings support promising results in terms of antidiabetic activities of the plant.

*Avicennia officinalis* [4,60]  
It is commonly known as *Indian mangrove or grey mangrove* from Verbaneceae family. Phytochemical screening and pharmacological evaluation of Avicennia officinalis leaves extract revealed the antibacterial, cytotoxic and analgesic activities of the plant. These pharmacologic actions are dose dependent. The probable pharmacological action could be due to the polyphenols present in the extract. It can be said that the plant extract is very useful and effective and may be potential sources of novel bioactive compounds.

*Kandelia candel* [4,61]  
The plant is commonly known as *narrow leaved kandal* from Rhizophoraceae family. The antioxidant activities of 70% acetone extract from the hypocotyls of the mangrove plant *Kandelia candel* and its fractions of petroleum ether and ethyl acetate, water, were investigated by the 1,1-diphenyl-2-picrylhydrazyl (DPPH) free radical scavenging and ferric reducing/antioxidant power (FRAP) assays. The results showed that all the extract and fractions possessed potent antioxidant activity. There was a significant linear correlation between the total phenolics concentration and the ferric reducing power or free radical scavenging activity of the extract and fractions.

*Scaevola taccada* [4,62]  
The plant is commonly known as *fan flowers or half flowers* from Goodeniaceae family. The plant is quite widely used in traditional medicine throughout its native range, particularly for the treatment of skin conditions. There has been little research into the plant but it has been shown that the leaves contain saponins and coumarins. In the literature, there is also the occasional mention of the presence of an alkaloid 'scaevolin'. An acetonitrile extract of the leaves has shown selective antiviral activity against herpes simplex virus 1 and 2 and vesicular stomatitis virus. Diluted sap from the leaves or sap from the ripe berries is used in folk medicine to clear opacity of the eye and in the treatment of eye infections. The sap may also be directly applied to sore. The juice squeezed from young stems and ripe fruits is applied directly to bites and stings. The leaves are used as a poultice for headache. The leaves are traditionally used for treating skin ailments, swellings, elephantiasis, scrotal swellings, oedema, chill and indigestion. The root is applied as an antidote after eating poisonous fish or crab. A decoction is used in the treatment of beriberi and in certain syphilitic affections, also
in dysentery. The roots are considered a good therapy for cancer. The root is used externally to treat skin affections. The bark is applied for abscesses, menstrual complaints and bone fractures.

**Excoecaria agallocha** [4,63]
The plant is commonly known as *milky mangrove or blinds your eye mangrove or river poison mangrove*. A study was conducted to find the preliminary data for the development of alternative treatments to chemical microbicides for the control of plant diseases from natural plant extracts. Leaves of *Excoecaria agallocha* were extracted by various extracting procedures, using different solvents for testing the antimicrobial activities against important microorganisms using agar well diffusion method. Chloroform and methanolic extracts were found to be effective against these organisms, whereas hexane extracts were inactive.

**Bruguiera gymnorrhiza** [4,64]
The plant is commonly known as *orange mangrove* from Rhizophoraceae family. *B. gymnorrhiza* L. Leaves exert a stabilizing effect on hepatocyte cell membrane and promote repair of injure hepatic tissues through its radical scavenging pathways and there by acts as a potent hepatoprotective agent.

**Bruguiera cylindrical** [4,65]
The plant is commonly called as *orange mangrove* from Rhizophoraceae family. The leaf extract of the plant was evaluated in the Chemoprevention of Gastric Cancer against Benzo (a) pyrene induced gastric cancer in albino mice. The drug was found to be safe and effective. Administration of *B. cylindrica* significantly reduced the incidence of stomach tumours, modulated lipid peroxidation and enhanced antioxidant status in the stomach, liver and blood. From the results of our study, we suggest that *B. cylindrica* extract may exert its chemopreventive effects by modulating lipid peroxidation and enhancing the antioxidant status in the stomach, liver and erythrocytes.

**Lumnitzera racemosa** [4,66]
The plant is commonly known as *black mangrove or white flowered black mangrove* from Combretaceae family. The hepatoprotective and *in vitro* antioxidant activity of *Lumnitzera racemosa* leaf extract were studied in carbon tetrachloride induced hepatotoxicity in rats. Sylimarin was used as the reference standard in the study and the results showed that the leaf extract possesses potent hepatoprotective effect. It might be due to the presence of phenolic groups, terpenoids and alkaloids and *in vitro* antioxidant properties.

**CONCLUSION**
The pharmaceutical properties of mangrove trees provide a wide domain for medicinal use, requiring further studies for possible drug development. In recent years the screening of mangrove plants for the search of medicinally active components is gaining more importance. The mangrove ecosystem has been used for the extraction of variety of plant and animal products by traditional methods for the benefit of local people. For such activities the mangrove ecosystem should be conserved and managed in such a way that ensures the productivity. As mangroves provide a variety of benefits this ecosystem is needed for better conservation. They should be preserved as much as possible for their multiple values as sources of economic, ecological, scientific, and cultural benefits for the present and future generations.
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REFERENCES
4) Kaladharan P and Asokan PK. Mangroves of Kerala, Calicut Research Centre of CMFRI, West Hill, Kozhikode, Kerala.


60) Plant Resources of Southeast Asia. http://proseanet.org/


