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Review Article

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MEDICINAL POTENTIALS AND BIOACTIVE COMPOUNDS FROM MANGROVES - A REVIEW

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Abstract

Disease is as old as life itself and man has always been in search of agents to cure diseases. Medicinal plants and herbs have been used for the eradication of disease and human suffering since antiquity. Plants that possess therapeutic properties or exert beneficial pharmacological effects on an organism are generally known as "medicinal plants". Many indigenous medicinal plants are being discovered everyday. Medicinal plants used in traditional medicine should be collected at the right time, the right season and the right stage of their growth so that the constituents can be optimally harvested. Several medicinal plants have been used us dietary adjunct and in the treatment of numerous diseases without proper knowledge of their function. Although phytotherapy continues to be used in several countries, few medicinal plants have received scientific and medical scrutiny. Moreover, a large number of medicinal plants possess some degree of toxicity. It is reported that one third of medicinal plants used in the treatment of diabetes are considered to be toxic. Some recent studies showed the medicinal value of mangroves and associated plants persist to provide invaluable treatment modalities, both in modern and traditional systems of medicine. This Review article focusses the medicinal properties of mangroves.

Key Words: Mangroves, Medicine, Compounds, Therapy, Potential.

INTRODUCTION

Traditionally more than 100 numbers of mangroves and mangrove associated plants were used for the treatment of diabetes, but only a very few number of plants are evaluated and documented (Bandaranayake, 2002). The antidiabetic activities of leaves of mangrove plants *Rhizophora mucronata* and *Ceriops decandra* had been documented and the gut perfusion studies on long. Evans rats reported the mode of action of the leave of *Rhizophora mucronata* in hypoglycemic conditions (Ramanathan *et al*., 2008, Nabeel *et al*., 2010; Gaffar *et al*., 2011). Microorganisms have potential to cause human diseases. Most of the time viruses, bacteria and fungi act as major pathogenic organisms. The discovery of antibiotics in the early twentieth century provided an increasingly important tool to combat bacterial diseases. As antibiotics are increasingly used and misused, the bacterial strains become resistant to antibiotics rapidly. Therefore, screening of antibacterial activity of medicinal plants is very important since vast number of medicinal plants have been used for centuries as remedies for human diseases. Among them extracts from different parts of mangroves and mangrove associates are widely used throughout the world (Abeysinghe *et al*., 2003).

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Moreover, a large number of medicinal plants possess some degree of toxicity. It is reported that one third of medicinal plants used in the treatment of diabetes are considered to be toxic (Marles *et al*.,1994, Bnouham *et al*., 2006). The leaves of *A. corniculatum* are reported that it have rich in flavonoids with proven anti-inflammatory and antioxidant property (Banerjee *et al*., 2008; Gurudeeban *et al*., 2012).

Mangrove forests are among one of the world's most productive tropical ecosystems and are highly potential because the ecosystem is always under stress which leads to the production of certain compounds for their survival. India harbors some of the best mangrove forests of the world which are located in the alluvial deltas of the major rivers such as the Ganga, Mahanadi, Godavari, Krishna and Cauvery also on the bay of Andaman and Nicobar Islands. It covers about 6,479 sq km along the 7,516.6 km long coast line including Islands territories (Upadhyay *et al*., 2008).

The mangroves are mainly limited to intertidal areas between the high water levels of neap and spring tides. Plant species from true mangroves belong to at least 20 different families. The uses of mangroves are often quote in scientific and popular articles (Bandaranayake, 1998; Vannucci, 1989) and fall in two major categories.

- Very important ecological functions 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.

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Traditionally, the mangroves have been exploited for firewood and charcoal and their uses include construction of dwellings, furniture, boats and fishing gear and production of tannis for dying and leather production. Also, preliminary studies have demonstrated that the mangrove plant extracts have antibacterial activity against pathogenic bacterials strains; *Staphylococcus sp*; *Escherichia coli;* and *Pseudomonos sp.* and antibiotic resistant bacterials strains; *Staphylococcus sp,* and *Proteus sp.* (Ishibashi *et al*., 1993). Microorganisms have potential to cause human diseases. Most of time viruses, bacteria and fungi act as major pathogenic organisms. The discovery of antibiotics in the early twentieth century provided an increasingly important tool to combat bacterial diseases. As antibiotics are increasingly used and misused, the bacterial strains become resistant to antibiotics rapidly. Therefore, screening of antibacterial activity of medicinal plants have is very important since vast number of medicinal plants have been used for centuries as remedies for human diseases. Among them extracts from different parts of mangroves and mangrove associates are widely used throughout the world. For instance, stem of *Avicennia marina* is used for ulcers and bark of *Bruguiera sexangula* is used for antitumors. (Bandaranayake, 1998).

The major families and genus of mangroves having wide medicinal properties are Acanthaceae (*Acanthus hirsutus, Acanthus ilicifolius*); Myrsinaceae (*Aegiceras corniculatum*); Avicenniaceae (*Avicennia officinalis*); Lecythidaceae (*Barringtonia racemosa*); Leguminosae (*Caesalpinia mimosoides*); Rhizophoraceae (*Ceriops decandra*); Clusiaceae (*Calophyllum inophyllum*); Euphorbiaceae (*Excoecaria agallocha*); Arecaceae (*Nype fruticans*); Pandanaceae (*Pandanus foetidus*); Fabaceae (*Pongamia pinnata, Derris scandens*); Tamaricaceae (*Tamarix indica*); Convolvulaceae (*Ipomoea imperati, I.pescaprae*); and Sterculiaceae (*Heritiera littoralis*). (Revathi *et al.,* 2013).

Chemistry of Mangroves

The common chemical; constituents present in the Mangroves are aliphatic alcohols and acids , amino acids and alkaloids, Carbohydrates, carotenoids, hydrocarbons, free fatty acids including poly unsaturated fatty acids (PUFAS), lipids, pheromones, phorbol esters, phenolics and related compounds, Steroids, triterpenes and their glycosides, tannis other terpenes. The additional newer components like gums and glues to alkaloids and saponins and other substances of interest to modern industry and medicine. Chemicals such as amino acids, carbohydrates and proteins are products of primary metabolisms and are vital for the maintenance of life process, while others like alkaloids, phenolics, steroids, terpenoids are products of secondary metabolisms and have toxicological, pharmacological and ecological importance.

Medicinal Application

Medicinal plants continue to provide valuable therapeutic agents, both in modern medicine and in traditional systems. Mangroves are woody plants growing at the interface between the land and sea in tropical and subtropical latitudes, where they exist under conditions of high salinity, extreme tides, strong winds, high temperature, and muddy, anaerobic soils. Mangroves have highly developed morphological and physiological adaptations to the extreme conditions of their environment. Thus, it is possible that the mangroves contain a bioactive compound that may be of potential use in the long term treatment of diabetics and other major disorders and diseases (Goksel and Mehmet, 2008; Kathiresan and Bingham, 2001, Kathiresan, 2000).

Pharmacological Activity

Medicinal plants contain substances that can be used for therapeutic purposes or which are used as precursors for the synthesis of useful drugs. (Soforowa,1993). Potential of higher plants as source of new drugs is still largely unexplored. Among the estimated 2,50,000-5,00,000 plants species, only a small percentage has been investigated phytochemically and the fraction submitted to biological and pharmacological screening is even smaller. Thus, any phytochemical investigation of a given plant will reveal only a very narrow spectrum of its constituents. Historically, pharmacological screening of compounds of natural or synthetic origin has been the source of in numerable therapeutic agents. Random screening as tool in discovering new biologically active molecules has been most productive in the area of antibiotics (Kroschwitz, 1992).

Extensive research has been undertaken on the natural product discovery and screening of biological activities of the mangrove plant species. (Patra andThatoi, 2011). There are several antimicrobial compounds discovered from the mangrove plants species with wide range of bioactivities such as antibacterial, antifungal, antiplasmodial, antiprotozoal, etc.

Patra and Thatoi (2011) extensively reviewed in details about the different activities of mangrove plants and their associates. Besides, isolation and characterization of the bioactive compounds from these plants are also studied extensively. Now each individual component is well studied to develop the compounds as drug that can be easily available in the market. To date, several experiments have conducted for isolation and characterization of the potential bioactive molecule from mangrove plants. All antimicrobial compounds that have been discovered, mainly classified under the flavonoids, phenols, saponins, alkaloids, etc. Now

different classes of antimicrobial compounds are significantly tried to synthesize chemically so that amount of compounds can be found and well characterized for their pharmaceutical validation and drug development.

It is estimated that today, plant materials are present in, or have provided the models for 50% Western drugs. Many commercially proven drugs used in modern medicine were initially used in crude from in traditional or folk healing practices, or for other purposes that suggested potentially useful biological activity. The primary benefits of using plant derived medicines are that they are comparatively safar than synthetic alternatives, offering profound therapeutic benefits and more affordable treatment (Robbers *et al.,* 1996).

Antimicrobial Properties

All plants are reported to have active compounds which are of medicinal importance. The beneficial medicinal effects of plants and their parts are the result of the compinationof different secondary products present in them. In plants, these bioactive compounds are basically secondary metabolites such as alkaloids, steroids, tannis and phenol compounds that are biosynthesized and deposited in specific parts or in all parts of the plant. These compounds are more complex and specific which are found in certain taxa. The heterogeneity of these secondary compounds is also seen in some wild species. The medicinal actions of plants are unique to a particular plant species or group due to their different chemistry of compounds. They are ubiquitous in nature and are characteristically known to be highly reactive. Vitamin K is complex naphthoquinone. Its antihermorrhagicactivity may be related to its ease of oxidation in body tissues. In addition to supply stable free radicals, quinones are well known to complex irreversibly with nucleophilic amino acids in proteins and often lead to inactivation of the protein and stop its function. For this reason, the potential range of quinone antimicrobial compounds is considered to be effective.(Critchfield *et al.,* 1996).

Mangroves are assemblages of halophytic woody plants that inhibit tropic and subtropic estuarine or brackish habitats. About 75% of the world's tropical coastline is covered with mangroves. These estuarine environments are strongly dynamic in nature. Fresh water, from numerous channels and creeks and tidal saline water alternatively washes these very special coastal wetlands. Being flashed by the saline water twice a day, the evergreen floral community occupying these environments is well adjusted to water stress, possesses mechanisms that allow water consumption versus salinity gradient, has broad and specified root systems has marked tendency to vivipary and exhibits xerophytic adaptation techniques. Mangroves, as a matter of fact, are composed of diverse collection of taxonomically un correlated plant species containing both shrubs as well as trees. However, despite of being taxonomically unrelated, these plants express resemblance in physical feature and structural adaptation to their habitat as a result of confluent evolution. Though, all members of mangroves can grow well at minimum temperature average is 20^0C. Each mangroves species may very in their salinity tolerance, degree both in their salinity tolerance and the degree to which salinity may be necessary to maintain their growth and competitive dominance. Due to their distribution along inter tidal coastlines; mangroves are subjected to salt stress. To survive in such stressful habitat, mangroves possess salinity tolerant adaptive 2 mechanisms. Restriction of salt entrance into plants and salt secretion through special salt glands in leaves are common adaptive measures (Bharathi, *et al.,*2014).

Mangroves are biochemically unique, producing a wide array of novel natural products. Mangrove and mangrove associates contain biologically active antiviral, antibacterial and antifungal compounds. The effects of mangrove extracts on some microorganisms including *Shigella sp; Staphylococcus sp; Pseudomonas sp.* has been reported in some studies in the area of pharmacology.(Abeysinghe and Pathirana, 2006). Also different type of solvents including ethanol, Chloroform and ethyl acetate have been used for extraction (Ravikumar, 2010).

Importance of Mangrove Plant

As mangrove plants are adapting in unique kind of habitat with low oxygen, limiting salt intake and nutrient intake, their role in synthesizing the high potential secondary metabolites are major biotechnological as well as biomedical importance. Mangroves are associated with marine habitat and thus some of the adaptation activities are seen in this plant, which provoke them to synthesize different molecules for defending themselves from different stresses created by the environment.(Bandaranayake, 2002). These molecules are later reported as the most promising molecules for health benefit. During the growth, they produce different chemical constituents to overcome the adverese environmental stress conditions, which are laterally classified as alkaloids, saponins, phenols and tannis that possess different antimicrobial activities. The local people residing in and around the mangrove forests have been using these plants for their different therapeutic purpose. From that traditional knowledge, now these mangrove plants are of great interest in the scientific world for the development of potential bioactive compounds and herbal drugs.

There are two basic factors that justify the study of the chemical constituents of mangrove plants. First, mangroves are one of the easiest tropical forest types to generate. They have the ability to grow where no other vascular plants can grow efficiently (Bandaranayake, 2002, Patra *et al.,* 2011). The

mangroves exist under stressful conditions of moisture, high and low tides of water and abundant living microorganisms and insects. They thrive in a very peculiar environment and marine systems. They possess stable modifications to establish water and salt economy. There are also some alterations in other physiological process such as carbohydrate metabolism or polyphenol synthesis; and due to these reasons they may have chemical compounds that protect them from these destructive elements. Second, on the contrary, numerous mangrove plants are been used in traditional medicine. And recently, extracts from mangroves and mangrove dependent species have proven activity against human, plant and animal pathogens, however, only limited investigations have been carried out to identify the metabolites responsible for their bioactivities (Bandaranayake, 2002, Patra *et al.*,2011).

The use of mangroves falls into two categories, firstly the use of the mangrove ecosystem as a whole or its conversion to other uses, and secondly, the use of products from the mangrove ecosystem. Traditionally, people have used mangroves for the benefit of the local community, but increasing populations have led to an increasing non sustainable abuse of the resources. Mangroves are used in flavouringagents, textiles, mats, paper, housing, baskets, boats and tapa cloth and also used as staple food. The Indigenous people of Australia and Srilanka use extracts from mangrove plants as valuable sources of days.

Table 1 Distribution of major mangrove forests around the world (Sarker *et al.,* 2010).

Region	Country
South and south East Asia	The Sundarbans Bangladesh and India ; Pichavaram India; BalochistalPalastan;Estuarine mangroves Thailand; Srilanka; The Philippines, East china Taiwan; Japan; Malaysia; Eastern Indonesia Borneo and Java.
Middle East Australia	Arabian peninsula; Red sea; Gulf (Bahrain, Qatar, UAE and Oman); Western and Eastern Australia; South pacific islands; Pupua New Guinea; Solomons islands.
North and South America and the Caribbean.	Florida and Bahamas USA; Mexico; Puetro Rico; Eastern Venezuela; Trinidad; Guiana Brazil.
Africa.	North West of Africa stretching from Mauritania to Sierra Leone; West of Africa from Liberia to Nigeria; South West Africa from Nigeria to Angola; East of Africa from Somalia to Tanzonia; Mozambique; Madagascar and south Africa.

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