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Brown Alga *Padina*: A review

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Abstract
Owing to its exceptional potential and efficiency to produce various biochemical, novel compounds and metabolites, *Padina* has received a great attention from the researchers all over the world. *Padina* is commonly available brown alga from the marine coastal regions. *Padina* can be utilized as food, fodder, plant growth promoter and bio-fertilizer. The brown alga is well known and being utilized for its antimicrobial, insecticidal, antioxidants, antibiotics, anti-inflammatory, hypo-allergenic, hepatoprotective and antidiabetic activities. The macroalgae like *Padina* play important role in environmental monitoring and management of coastal marine ecosystems. They can be considered as biological indicators and can also be utilized in the phytoremediation; for the management of contaminants in coastal marine ecosystems. The outcome of this short review will help the workers in this field to understand the agricultural, medicinal, economic and environmental importance of this brown alga.

Keywords: seaweeds, brown macroalgae, bio chemicals

Introduction
In many parts of Asian countries, the macroalgae are well recognized as an important source of food. In this modern world the macroalgae are increasing attention as a valued food source [1]. There are about 221 macroalgal species have been reported so far for their commercial uses throughout the world [2]. The important commercial utilization of algae is as human food, fodder, fertilizer, drugs, in paper production and in various other industries among which largely confined to extraction of phycocolloids and some fine biochemicals. Macroalgae have also been used for the production of industrial aquaculture that increases its value as an important natural resource [3]. A few species of *Padina* have been used traditionally as a food source in many coastal parts of the world, commonly known as a gelatin-like sweetmeat [4]. *Padina* is also reported as a substitute for salts for the patients of high blood pressure [5] and for the treatment of some other diseases like goiter and scrofula [6]. Macroalgae or 'seaweeds' are one of the important natural resources from marine ecosystems. Usually they are found attached to the bottom in relatively shallow coastal waters. Algae are very rich in biologically active compounds [7, 8, 9, 10].

Systematic Position of *Padina*
Division: Phaeophyta
Class: Phaeophyceae
Order: Dictyotales
Family: Dictyotaceae
Genus: *Padina*

Structure and Description of *Padina*
Thalli (fronds) of *Padina* are flabellate, with a thin deposit of lime giving brown or whitish appearance. Thalli are often conspicuously zonate, attached by compacted rhizoidal holdfast; stipe often invested by rhizoids. Blades are two to several celled thick with zones, marked by concentric rows of hairs, sometimes divided into narrow spatulate segments. Side to which blades are inrolled is called the upper surface of the blades (Fig. 1). Life cycle of *Padina* is diplo-haplontic and isomorphic. Gametophytes may be dioecious or monoecious and the reproductive cells i.e. sporangia, gametangia are scattered on blades or sometime in sori between the hair bands of thalli [11].

Fig 1: Natural habitat and fronds of *Padina sp.* (photograph taken at Red Sea coast of Haql, Tabuk, Saudi Arabia)

Ecology and Distribution
Padina is ubiquitous, various species are found in a diverse range of habitats; from intertidal to subtidal zones. Clear waters to a depth of 15-20 m are abundant of *Padina* sp. They grow attached to solid substrates or epiphytically on some large seaweed like *Sargassum* spp. They are more abundant during the months of full sunshine. *Padina* is well distributed throughout the tropics and very easy to recognize due to resemblance of its structure with peacock tail [11]. *Padina* is geographically distributed in South America and Southeast Asia and the tropics to cool temperate waters. There are about 43 species of *Padina* recognized so far [12, 13].

Padina in biosynthesis of nanoparticles:
Nanoparticles like AgNPs and PtNPs are gaining considerable importance due to their attractive

physicochemical properties for many applications. Synthesis of nanomaterials using seaweeds and their diverse applications is a topic of research interest in modern era. Among the noble metals, nanoparticles are of great importance for their catalytic, antimicrobial, haemolytic, cytotoxic and antioxidant properties with less toxic effects. AgNPs can be synthesized by the reduction of aqueous solutions of silver nitrate (AgNO3) with powder and solvent extracts of *Padina* [14]**.** Similarly PtNPs are synthesized from the aqueous extract of *Padina* [15].

Bio chemicals/Biomolecules in *Padina*

A qualitative and quantitative estimation of terpenes and sterols from brown algae *Padina* revealed the presence of 19 terpenes and 5 sterols in this plant. [16]. *Padina* showed high content of ashes (30-48%), carbohydrates (25- 39%) and total dietary fiber (27-39% on dry basis), 5-7% of protein, 1.6-1.8% of lipids [12]. Fatty acids, containing 14–22 carbon atoms have also been identified from various *Padina* species [17, 18]. Seaweeds are also a source of polysaccharides, minerals and vitamins. Various uses of seaweeds are in cosmetics for the protection from radiation and pharmacological use as antioxidants, antibiotics, anti-inflammatory, hypo-allergenic, antibacterial and antidiabetic [19].

Antimicrobial activities of *Padina*

Macroalgae belonging to the genus *Padina* produces antibacterial compounds that are important to inhibit the growth of various pathogens in human and other animals. *Padina* has a great potential to produce novel antibacterial compounds alone or in an association with antagonistic bacteria [20].

Antioxidant activities of *Padina*

Seaweeds are well known for their medicinal importance and reported by several workers from all over the world [21, 22]. They are potential source of biologically active metabolites that are not found in other organisms and are used in pharma and drug industry. These antioxidant compounds are produced in their body tissues in response to adverse environmental conditions in which they live [23]. *Padina* extracts can be used for the treatment of hepatotoxicity as they are of hepatoprotective, hypolipidemic, antioxidant and anti-inflammatory nature [24].

Insecticidal activities of *Padina*

The marine algae or seaweeds are one of the most important natural resources of marine ecosystems. Applications of *Padina* extracts showed significant nymphal mortality as compared to many other plant species. It can also control the mating period, fecundity and hatchability of insects. Hence the use of this brown alga as eco-friendly bio-insecticide can be a good alternative for the pest management to protect various economically important crops [10].

***Padina* as a bio stimulant**

Brown seaweed *Padina* can also be used as an organic fertilizer. Aqueous extract of *Padina* are rich in macronutrients like nitrogen (N), phosphorus (P) and potassium (K) that are essential for plant growth and development [25]. A lower concentration of Padina extracts affects the germination rate, cell division and protein pattern, when applied as a bio stimulant. The seaweeds can be exploited as bioorganic eco-friendly fertilizer to stimulate the growth of various economically important crops instead of using synthetic chemical fertilizers that are harmful for the environment as they can undergo biological magnification. The use of modern agriculture in conjunction with traditional farming practices is the sustainable solution for the future. It is suggested by various workers that the brown seaweeds liqiuid fertilizer (BSLF) can be used at low concentrations for the enhancement of seed germination, accumulation of biochemical constituents in various crop plants [26].

***Padina* in environmental monitoring**

Algae play important role in environmental monitoring and management. They are the primary producers in all aquatic ecosystems. They provide the energy for the functioning of aquatic ecosystems. They respond rapidly, even to a minor change in their environmental. *Padina* has been reported for its high adsorbing potential to the various pollutants onto its fresh and dried biomass. They are good indicators for dynamics in various factors like light, temperature, nutrients and many other contaminants in aquatic environment. *Padina* (Phaeophyta) showed a decrease in specific growth rate and Chlorophyll contents with increasing Cd concentrations indicating Cd pollution. The macroalgae like *Padina* are ecologically important as they can be considered as biological indicators for environmental contamination and in remediation of coastal marine ecosystems [27, 28, 29, 30].

Conclusion

Among 8,000 species of seaweeds along the world's coast, commercially important algae are represented by 350 species. Algal flora is an integral part of marine ecosystem and serves as good source of food, fertilizers, fodder, antioxidants, dietary fibres, drugs, vitamins, minerals, polyphenols, proteins, carbohydrates, agar, carrageenan, alginate and paper production. The industrial and economic utilization of macroalgae like *Padina* is confined to extraction for various fine bio chemicals and novel products for the human health, food and drug industries. Macroalgae are attracting and increasing attention of the new world for its use as valued food source. Therefore, a regular monitoring of these economically and medicinally important marine algae is an urgent need of the hour for their proper utilization for the mankind.

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