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Review Article

GELIDIELLA ACEROSA: A PRÉCIS.

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ABSTRACT

Seaweeds are the macrophytic algae that grows mostly in shallow waters and are highly beneficial. *Gelidiella acerosa* belongs to the division rhodophyta and is found in shallow waters of intertidal and upper sub tidal zone. It yields the best quality agar and is also used as an ingredient in milk products, jams, marmalades, calorie free cooking and ice-creams. Since it has been reported to contain high percentages of proteins, lipids, carbohydrates, polysaccharides, phenols and flavonoids, it has shown wide applications in pharmaceutical industry. *Gelidiella acerosa* is reported to possess many pharmacological activities such as anticancer, cytotoxicity, antimicrobial, antioxidant, anticholinesterase, antifertility and anticoagulation activities.

Keywords: *Gelidiella acerosa*, Rhodophyta, antioxidant, anticancer, antimicrobial, taxonomy.

INTRODUCTION

Seaweeds are a collection of plant kingdom referred as algae. Seaweeds, also known as marine alga, are categorized as Rhodophyta (red algae), Phaeophyta (brown algae) or Chlorophyta (green algae) depending on their nutrient, pigments and chemical composition. Almost 841 species of marine algae are found in both inter-tidal and deep water regions of the Indian coast[1]. They contain innumerable inorganic and organic substances valuable for human health[2]. Recent reports have publicized that the seaweeds have been conventionally used for the treatment of many diseases.

Seaweeds are measured as a source of bioactive compounds and a prodigious variety of secondary metabolites categorized by a broad spectrum of biological and pharmacological activities[3]. Green and brown algae have been classified with the compounds having antifungal and antimicrobial activities[4].Seaweeds are of great interest in the biomedical area, mainly due to their contents of bioactive substrate which show great potential as antimicrobial, anti-inflammatory, antiviral[5] and anti-tumoral drugs[6,7]. The anti-cancerous, anti-obesity and anti-proliferative effects have been shown by the in vivo studies from the components of seaweeds[8, 9].

Many substances obtained from marine algae such as alginate, carrageenan and agar as phycocolliods have been used for decades as pharmaceutical products[10].

Gelidiella acerosa (Forsskal) is a genus of red algae with high economic value found in sub tidal areas in many parts of India and other countries. (Figure 1)

Taxonomic Hierarchy[11]

Kingdom - Plantae
Subkingdom - Biliphyta
Division - Rhodophyta
Subdivision - Eurhodophytina
Class - Florideophyceae
Subclass - Rhodymeniophycidae
Order - Gelidiales
Family - Gelidiellaceae
Genus – Gelidiella
Species - *Gelidiella acerosa*

Figure 1: *Gelidiella acerosa* in its original marine habitat

Distribution and Habitat

Gelidiella acerosa is found in the Indo-pacific and Atlantic oceans, growing at a depth of 0-47m. It grows in exposed or shaded areas, inhabited in shallow waters of intertidal and upper sub tidal zone, attached to calcareous substrates such as rocks covered by crustose algae, coralline rocks, and on sandstones or shells of molluscs. It is also found in tide pools with relatively high changes in water temperature, pH, salinity, and degree of exposure to air are influenced by tides[12]. It is an abundantly growing seaweed in Coastal areas of south India. It occurs in inter tidal region of Gulf of Mannar, Southeast coast of India. Tropical climate is favorable for its growth[13].

Morphological Characteristics

The plants of *Gelidiella acerosa* are elastic, cartilaginous or prostate, which grow along shorelines on dead corals or rocks in the intertidal zones with strong wave activity. These plants are of reddish to purple colour in shaded upper and lower intertidal regions while greenish brown to yellowish brown in upper intertidal areas and shallow waters. The branches are decumbent, erect and prostate and are pinnately arranged. Ramuli are the filiform lateral branchlets which are 1-6 mm long, acuminate and upcurved. Second degree ramuli may develop from the few lateral branches. The creeping stolen give rise to the rhizoids which are attached to the thalli which in turn forms a clump or wiry mats. Branches may grow up to 9 cm in length. [12]

Chemical Constituents

Gelidiella acerosa was analyzed for the proximate composition and the presence of the protein, carbohydrate and the lipid content was recorded [14].

Sulfated polysaccharides (SPs) were also isolated from red seaweed *G. acerosa*. The quantitative analyses of reported sulfates and total sugars were also done [15]. The presence of crude SPs yields from the samples of *G. acerosa* collected from Gujarat coast, India were also reported [16].

The phytochemical screening of the different solvent extracts of *G. acerosa* shows the presence of alkaloids, tannins, terpenoids and cardiac glycosides. The benzene extract of the *Gelidiella acerosa* was subjected to the GC-MS profile and it contained a mixture of sesquiterpene and monoterpene hydrocarbons such as Eicosane, diisooctyl ester and 9-octadecenoic acid etc.[17]

Uses

Gelidiella acerosa is widely used as food for human consumption as gelling agent for making agar-jellies, as salads, dessert gels, Some ingredients in milk products, jams, marmalades, calorie free cookery ingredient and ice-creams. It is also used as an important raw ingredient in the production of agar used in pharmaceutical industries, paints, varnishes, electric bulbs, photographic films[12]. It is also used as a valuable antioxidant for treating ROS mediated diseases[18] and as a useful post-coital contraceptive[19, 20]. The best quality agar was produced by *Gelidiella acerosa* occurring in the Gulf of Mannar region in the southeast coast which was found to be suitable for bacteriology for production of bacterial culture, preparing agar plates in electrophoresis and in molecular biology in another laboratory applications[21].

Pharmacological Activities
Anticancer Activity

H. H Chaminda Lakmal et al, have evaluated the anticancer activity of the different seaweed species of rhodophyta (*Gelidiella acerosa, Chondrophycus ceylanicus and Gracilaria corticata*), phaeophyta (*Sargassum cassifolium*) and chlorophyta (*Chaetomorpha crassa* and *Caulerpa racemosa*) against different cell lines like a mouse melanoma (B16F10) , human lung carcinoma (A549) and human promyelocytic leukemia (HL-60) in-vitro and the results from the MTT assay confirmed that all the extracts were not cytotoxic and showed a high cell viability. The methanolic extract of *Gelidiella acerosa* showed a moderate cancer cell growth inhibitory effect against HL-60 cells[22].

K. Duraikannu et al., (2014), evaluated the anticancer activity of the methanolic extracts of *Acanthophora spicifera* and *Gelidiella acerosa* by the intra-peritoneal inoculation of the Dalton's Ascitic Lymphoma (DAL) cells in the Swiss albino mice. It was concluded from the study that the methanolic extracts of both the algal species not only reduced the cancer cell count and tumor weight but also increased the packed cell volume along with the life span of the treated mice groups.[23]

Post Coital Contraceptive Activity

Ratnasooriya et al. (1994), have reported the post coital contraceptive mechanism of the extracts of the three rhodophyta species: *Gracilaria corticata, Gelidiella acerosa* and *Jania species.* It was concluded from the results that the extracts of the *Gelidiella acerosa* exhibits post coital contraceptive activity due to post implantation loss resulting in the fetal death[19].

Antifertility Activity

Naqvi et al., (1980), have reported 25 seaweeds extracts from the Indian coast and have screened them through various pharmacological tests like antiviral, antibacterial, antifungal, antiprotozoal and antifertility activities. *Gelidiella acerosa* showed 100% antifertility activity[24].

Human Sperm Motility Stimulating Activity

Premakumara et al. (2001), evaluated the human sperm motility stimulating activity of a sulfono glycolipid (S-ACT-1) isolated from the red algae *Gelidiella acerosa*, in vitro. It was concluded that the human sperm stimulating activity of S-ACT-1 had a bell-shaped dose response curve for all the incubation periods since the activity was dose-dependent[25].

Antioxidant Activity

Suganthy et al., (2013), evaluated in vitro antioxidant potential and metal chelating activity of various solvent fractions of *Gelidiella acerosa*. It was concluded that among all the solvent fractions, benzene extract showed the highest nitric oxide, 1, 1-diphenyl, 2-picrylhydrazyl (DPPH) radical and hydrogen peroxide scavenging activity when compared to standard. Dichloromethane fraction showed the higher total anti-oxidative capacity and reducing power. Highest ferrous ion chelating activity was observed in benzene and ethyl acetate fractions. Dimethylsulfoxide (DMSO) fraction showed the highest hydroxyl radical scavenging effect. Moreover, dichloromethane and benzene fraction showed the highest total polyphenolic content[26].

Pandima Devi K et al., (2008), carried out the evaluation of methanolic extracts of seaweeds for antimicrobial and antioxidant activity. Ten edible seaweeds with wide pharmaceutical applications were evaluated for the antioxidant and antimicrobial activity against food borne pathogens. The results indicated that *Gelidiella acerosa* has the highest antioxidant activity. High phenolic contents were assessed in both *Gelidiella acerosa* and *Haligra species* which associated to their respective antioxidant and antimicrobial activities[27].

Cytoprotective Activity

Ilavarasi Kalaiselvan et al., (2015), have evaluated the protective effect of methanolic extract of *Gelidiella acerosa* in Peripheral Blood Mononuclear Cells (PBMC) against 2, 3, 7, 8-Tetrachlorodibenzo-p-dioxin (TCDD) induced toxicity, by assessing the Cytoprotective, antioxidant and anti-apoptotic

activities. The results of antioxidant assays recommended that the extract relapsed TCDD induced toxicity by causing a variation in the levels of antioxidant enzymes. The results of protein carbonyl content and lipid peroxidation assay showed that extract protects PBMC from TCDD induced macromolecular damage. Preliminary phytochemical analysis demonstrated the high levels of terpenoids and cardiac glycosides in the extract. LC-MS analysis of the extract revealed the presence of antioxidants including mannoheptulose, caffeic acid and phytol which could be recognized for the observed protective effect against TCDD induced toxicity[28].

Cytotoxicity and Genotoxicity

Syad Nisha et al., (2014), evaluated the anticholinesterase and antioxidant activities of the marine red algae *Gelidiella acerosa* and *Sargassum wightii*. Comet assay was used for genotoxicity evaluation in PBMC while Trypan blue exclusion and MTT assays were used for the cytotoxicity assessment in both the PBMC and RBCs. It was clearly concluded that the benzene extract of *Gelidiella acerosa* did not illustrated any marked cytotoxic effect in the PBMC and erythrocytes. The PBMC treated with the extract have revealed fewer or no damage due to the non-genotoxic effect of the extract[29].

Anticholinesterase Activity

Syad Nisha et al., (2012), evaluated the effects of various extracts of *Gelidiella acerosa* on butyrylcholinesterase (BuChE) and acetylcholinesterase (AChE) activities. Characterization by GC-MS examination and the phytochemical screening of the compounds present in the extracts were performed. The spectrophotometric methods were used to investigate the inhibitory effects of both AChE and BuChE and the results established the presence of high amounts of terpenoids in the benzene extract of *Gelidiella acerosa* along with the considerable inhibitory activity against both the AChE and BuChE[17].

Antibacterial Activity

R. Nobel Surya Pandidurai et al., (2014), evaluated and compared the in-vitro antibacterial activity of *Enteromorpha intestinalis* and *Gelidiella acerosa* using different solvent system. Crude bioactive compounds were obtained from the dried seaweeds extracts using acetone, methanol:chloroform (1:1) and diethyl ether. These extracts were then tested by disc diffusion method against 12 human bacterial pathogens. The maximum zone of inhibition against *Vibrio cholera*, *Bacillus subtilis*, *Proteus mirabilis* and *Streptococcus pneumonia*, were reported by methanol:chloroform extracts[30].

Antifungal Activity

Vivek M et al. (2011), evaluated the antifungal activity of silver nanoparticles (Ag-NPs) as the reducing agents by exploiting the aqueous extract of *Gelidiella acerosa* for their synthesis. The techniques like Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), UV-Visible Spectroscopy and X-Ray Diffraction (XRD) validated the formation of the Ag-NPs, which were polydispersed, spherical and in turn were capped with biomolecules, thus responsible for the reduction of the silver ions. Fungal species like *Mucor indicus* (MTCC 3318), *Trichoderma reesei* (MTCC 3929), *Humicola insolens* (MTCC 4520) and *Fusarium dimerum* (MTCC 6583) were used for the investigation of the antifungal activity and the results concluded the significant antifungal activity of the Ag-NPs in contrast of the standard drug (Clotrimazole) [18].

Anticoagulation Activity

Queiroz et al., (2014), evaluated a sulfated polysaccharidic fraction from *G. acerosa* on coagulation proteases and thrombosis, along with the assessment of their in-vivo toxicity. Ga-IV-PR was tested on coagulation proteases in the presence of antithrombin along with a model of venous thrombosis in rats as the thrombogenic stimulus using thromboplastin and had an isolated effect on normal human coagulation compared with heparin. At higher doses, this fraction deteriorated the antithrombotic effect. Thus *G. acerosa* proved to be safe antithrombotic agent as it does not biochemically changed its matrix polysaccharide composition[15].

CONCLUSION

Marine resources have a vast potential to be exploited for the benefits of the mankind. *Gelidiella acerosa*, a rhodophyta is reported to possess a variety of phytoconstituents including phenols, flavonoids, alkaloids, tannins and terpenoids etc. which in turn account for its enormous pharmacological activities. Further investigations should be carried out to recognize and establish other potential phytoconstituents and pharmacological activities like anti diabetic, anti-obesity, wound healing activity and anti-viral etc. from different solvent extracts of the seaweed *Gelidiella acerosa*.

ABBREVIATIONS

Gelidiella acerosa (*G. acerosa*), Sulfated polysaccharides (SPs), Sulfono glycolipid (S-ACT-1), peripheral blood mononuclear cells (PBMC), 2, 3, 7, 8-tetrachlorodibenzo-p-dioxin (TCDD).

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