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Review Article

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PROPERTIES OF SEAWEEDS. A REVIEW

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Abstract

Seas and oceans represent a big store for beneficial algae. The literature was searched for natural products from marine macro algae in the Rhodophyta, Phaeophyta and Chlorophyta with biological activity. The present review is focusing on the following topics: antiviral, antibacterial, anticancer, antimicrobial, antifungal and mosquito Larvicidal activity of seaweeds.

Key Words: Seaweeds, Antimicrobial, Antiviral, Anticancer, Larvicidal

INTRODUCTION

Marine algae are one of the largest producers of biomass in the marine environmental(Bhadury *et al*., 2004). Seaweeds are the eukaryotic organisms that live in salty water and recognized as a potential source of bioactive natural products. Seaweeds have been used since ancient times asfood, fodder,fertilizer and as source of medicine. Today seaweeds are the raw materials for much industrial production like agar, align and carrageenan but they continue to be widely consumed as food in Asiancountries (Mishar *et al*., 1993).In thesea, three types of plants occur and they are phytoplankton, seaweeds or marine algae and sea grasses. Phytoplankton's are microscopic and free floating form they are the primary producers of the sea. Seaweeds or marine algae macroscopic attached or freely floating plants. They form one of the important marine living renewable resources. They are primitive plants without any true root, stem and leaves.

Marine algae are classified into four groups namely Chlorophyceae (green algae) Phaeophyceae (brown algae) Rhodophyceae (red algae) and Cyanophyceae (blue green algae) based on the type of pigments, morphological anatomical and reproductive structures. Seaweeds are plant like ocean organisms that are botanically classified as microphysics marine algae. Edible seaweeds are often called "sea vegetables" seaweeds come in an amazing variety of beautiful shapes, colors and sizes and found in all of the world's oceans. They are most abundant in shallow rocky coastal areas, especially where they are exposed at low tide coastal people around the world have been harvesting and eating sea vegetables since the beginning of time. In the United States and Europe, increasing numbers of people are learning that eating sea vegetable can provide a broad range of health benefits. Seaweeds contribute to primary production of the sea and hence seaweed beds are considered highly productive and dynamic ecosystem.

Antiviral activity

Some sulphated polysaccharides from red algae show antiviral activities towards viruses responsible for human infectious diseases. Most notable are *Aghardhiella tenera* and *Nothogenia fastigiata* (Witvrouw *et al.,* 1994) tested a galactan sulphate from *Aghardhiella tenera* and (Damonte *et al.,* 1994 and Kolender *et al*., 1995) a xylomannansulphate from *Nothogenia fastigiata* against human immunodeficiency virus (HIV) Herpes simplex virus (HSV) types 1 and 2 respiratory syncytial virus (RSV). These polysaccharides are active during the first stage of the RNA virus replication when the virus adsorbs onto the surface of the cell (De Clercq, 1996,2000).

Algal polysaccharides and other compounds exhibits antiviral properties. *Condriaatropurpurea* shows antiviral activity against HSV type II (Palermo *et al.,* 1992). Kahalalide produced by a species of *Bryopsis* has also been noted for its effectiveness in some AIDS study cases and its anti HIV qualities are being further studied in clinical trials (Humann *et al*., and Haefner, 2003). Carrageen and emonstrate potential *invitro* antiviral activity. (Carlucci *et al.,* 1997) noted that carrageenan and partially cyclized from *Gigartinaskoltsbergii* have potent antiviral effects against different strains of HSV types 1 and 2 during the virus adsorption stage. Carrageenan's from cystocarpic and tetrasporophytic stages of *Stenogrammeinterrupta* show similar ant herpetic activity (Caceres *et al*., 2000).

Many species of algae have been investigated for antibacterial an antiviral properties the highly volatile fractions of the genera *Asparagopsis, Bonnemaisonia and Pcilonia* belonging to the family *Bonnemaisonia* a great variety of halogenated alkanes, saturated and unsaturated ketones, aldehyde, alcohols, epoxides' and halogenated derivatives of acetic and acrylic acids have been deducted for antibiotic activity against *Bacillus subtilis, Staphylococcus sp., Fusarium sp., and vibrio sp.,*was shown for the halogenated heptagons (Gary, 1993).

Antibacterial activity

The solvent extracts of 4 different seaweeds (*Sargassumvulgara, Sargassum aureus, Sargassum fusiforme and Padinapavonia)*used in the significant inhibitory action against Multidrug Resistant(MDR) bacteria. Among the 4 seaweeds screened for their antibacterial activity. The 100µl diethyl ether extract of brown alga *Sargassum fusiforme* and 50µl ethanol extract of *Sargassum vulare* showed more inhibitory activity against *Sargassum aureus*and *Kelbsiellapeneumonia* respectively.

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The phytochemical screening of seaweeds showed the presence of in dolestrepans acetogenis phenols fatty acids and volatile halogenated hydrocarbons in the selected species. The changes in ultrastructure of tested (MRD) bacteria *Sargassum aureu* and *Kelbsiellapneumonia* due to *Sargassum fusiforme and Sargassum vulgare* extract were investigated by transmission electron microscope which shows shrinking of protoplasm cytoplasmic vacuolation deformation in cell structure and distortion of outer cell boundary. (Shimaa *et al.,* 2016).

Lavanya and Veerappan,(2011) tested the *in vitro* antibacterial activity of six selected marine algae. Extracts of seaweed samples namely *Codiumdecorticatum, Caulerpascalpelliformis, Gracilariacrassa, Acanthophoraspicifera, sargassum wightii and Turbinaria conoides* were selected for antibacterial activity against selected for human pathogens such as species *vibrio parahaemolyticus, salmonella sp., Shewanella sp., Escherichia coli, Kelbsiella pnenmonia, Staphylococcus aureu, Enterococcus faecalis, Pseudomonas aeruginosa and Proteus mirabilis*. All the seaweeds extracts have shown moderate antibacterial activity<10mm of zone of inhibition, out of which only methanol extract has shown significant activity. The research showed that the higher antibacterial activity was found in *Acanthophoraspicifera* and the minimum was found in*Codiumdecorticatum.*

Anticancer activity

Luis villarrealomez *et al.,*(2010) evaluated the antibacterial and anticancer activities of extract from the seaweeds like *Egregiamenziesii, Codium fragile, Sargassum muticum, Endarachnebinghamiae, Centrocerasclavulatum and Laurenciapacifica*. They obtained the organic extract from bacteria, free algae and from surface associated bacteria, pathogenic strains of *Staphylococcus aurous, Kelbsiella pneumonia, Proteus mirabilis and Pseudomonas aeruginosa* were used to test antibacterial activity and HCT-116 colon cancer cells for anticancer activity. Thirty five bacterial strains were isolated from the surface of seaweeds and identified as the phyla Firmicutes, Proteobacteria and Antinobacteria by 16S rDNA sequencing. The strains *Centrocerasclavulatum, Sargassum muticum, Endarachnebinghamiae and Endarachnebinghamiae* showed anticancer activity with IC_{50}values of respectively. Likewise the extract from the seaweeds associated bacteria inhibited the growth of the Gram-Negative bacterium Proteus mirabilis.

Fucoidans obtained from brown algae *Eclonia cava*, *Sargassum hornery and Costariacostalla*, widely spread in the sea of the South Korea, play an inhibitory role in colony formation in human stoma and colon cancer cells. Hence these Fucoidans may be effective antitumor agents (Ermakova*et al.*, 2011). Hydrolyzed Fucoidan from sporophyll of *Undariapinnatifida* were used to determine the molecular weight and hydrolysis condition on cancer cell growth. Negative Fucoidan showed anticancer effect. A test showed the anticancer activity of fucoidan could be significantly enhanced by lowering the molecular weight. Only when they are depolymerizedby mild condition (Yang *et al*., 2008). Champiafeldmannii (Cf-pls) does not show any in vitro cytotoxicity the experimental exposure but showed in vitro antitumor effect. Cf-pls acts as immunomodulatory agent, raising the production of specific antibodies and increasing the production of ova specific antibodies. Cf-pls has some interesting anticancer activity could be associated with itsimmune stimulating properties (Lins *et al*., 2008)**.**

Antimicrobial activity

Selective utilization of marine algae as potential source of pharmaceutical agents has been increasing in recent years. Many of the seaweeds possess bioactive components, which inhibit the growth of some Gram positive bacteria and Gram Negative bacterial pathogens. The algal extracts were used as a curative and preventive agent for various diseases such as antibiotics, antihelminthic, cough remedies, antihypertensive, antitumor and antidiarrheal. Recently many researchers have embarked on the chemical investigation of marine algae with a special accent on their bioactive properties (Siddha *et al*., 1991).

Vijayabaskar and Shiyamala (2011) tested the methanol extracts of brown algae *sargassum wightii and Turbinaria ornate* against various Gram Positive and Gram Negative human pathogenic microbes. The finding envisages that methanol extracts of *Turbinaria ornate* could be utilized as a good source of antimicrobial agent in pharmaceutical industry. (Priyadharshine *et al*., 2011) evaluated the in vitro antimicrobial and hemolytic activity of marine macro algae *Ulva fasciata*methanol and aqueous extracts were tested against selected fish pathogens, *Aeromonashydrophila, pseudomonas fluorescent, Proteus sp., vibrio alginolyticus and Enterobacter sp., and fungal pathogens Rhizopus sp., Asperillusflavuus, Asperillus sp., Asperillusniger* and *Candida sp.,*. The extract was subjected to TLC to determine the presences of peptides and amide groups and the hemolytic activity was assayed. Maximum of 16 mm inhibition zone was observed against *Vibrio alginolyticus* and the minimum 12 mm against *Enterobacter sp.,* respectively. *Ulva fasciata* showed poor activity against the fungal pathogens. Showed the use of seaweeds as antimicrobial agents for pharmology or as a health promoting food for aquacultures. The screening confirmed that these seaweeds need further studies and used as possible source of antimicrobial compounds.

Antifungal activity

Screened the antifungal activities of six seaweeds namely the green seaweed *Cladophoraglomerata, Ulvalactuca and Ulva reticulate* the red seaweed *Gracilariacorticata and Keppaphycusalvarezii* and the brown seaweed *Sargassum wightii*against fungal pathogens *Aspergillusniger, Aspergillusflavus, Aspergillusfumigatus, Saccharomyces cerevisiae and Mucorindicus*. The zone of inhibition ranged between 56-58 mm in aqueous extract and 54-56 mm in methanol extract. The maximum activity (56mm) was recorded from 200 mg of aqueous extract of *Ulvalactuca* against *Aspergillusflavus* and minimum (8mm) by *Gracilariacorticata* against *mucroindics* 50 mg level where as the methanol extract showed the maximum activity (56mm) was recorded from 200mg of *Ulvalactuca against Asperillusniger* and minimum (4mm)by 50 mg of *Ulva reticulate* against *Aspergillus flavor.*Pandurangan Aruna *et al., (2011).*

The *invitro* antifungal activity of crude seaweeds extracts and those of three purified extract fractions with hexane, ethanol and water as well as the in vivo antifungal efficacy of the cured extract has been the main drive of this work for to exclude possible compounds which would have antimicrobial activity other than fatty acids, lipids, polysaccharides,

Table 1 Overview on biological activity by marine algae

Year	Name of the species	Biological activity	Authors
2017	*L.digitata and U.pinnatifida*	Antifungal activity	Uge De Corato *et al*., 2017
2016	*S. aureus*	Antibacterial activity	Shimaa *et al*.,2015
2012	*Ulva fasciata*	Larvicidal activity	Poonguzhali and Jasmin Laali Nisha 2012
2012	*Chaetomorpha antennina*	Larvicidal activity	Subermanium *et al*., 2012
2012	*G.lithophila*	Larvicidal activity	Poonguzhali and Jasmin Laali Nisha, 2012
2011	*D.dichotoma*	Larvicidal activity	Ravikumar *et al*., 2011
2011	*Acenthophora spicifers*	Antibacterial activity	Lavanya and Veerappan,2011
2011	*Turbinaria ornata*	Antimicrobial activity	Vijayabaskar and Shiyamala, 2011
2011	*U.fasciata*	Antimicrobial activity	Priyadharshinee*t al.,* 2011
2011	*U.lactuca and U. reticulate*	Antifungal activity	Pandurangan Aruna *et al.,* 2011
2010	*S.muuticum*	Anticancer activity	Luis Villarreal-Gomez *et al*., 2010
2000	*Nothogenia fastigiata*	Antiviral activity	De clercq, 2000
1994	*Aghardhiella tenera*	Antiviral activity	Witvroum *et al*., 1994
1993	*Bonne maisonia*	Antiviral activity andAntibacterial activity	Garg,1993
1992	*Condria atropurea*	Antiviral activity	Palermo *et al.,* 1992

polyphenols and phlorotannins. The findings coming from the in vivo experiments indicate that crude seaweed extracts had a variable degree of antifungal activity in relation to the different fungi/host systems tested here extract of *L.digitata and U.pinnatifiea,* followed by*P.umbilicalis,* showed the highest antifungal activity against*B.cinerea* on strawberries and *M.laxa*on peaches followed by *P. digitatum* on lemons. However *L.diggitata* extract should be selected as the best antifungal to among those tested here due to its higher competitiveness with respect to fenh examamid and imazalil. The antifungal activity of the crude seaweed extracts could be mainly attributed to their content of fatty acids rather than to those of phenolic compounds including, but also an increased peroxidase activity probably listed by the polysaccharides could be related to activation of ISR mechanism able to suppress grey could on strawberries by *B.cinerea*and brown rot on peaches by *M.laxa* (Ugo De Corato *et al*., 2017).

Larvicidal activity

Mosquito larvicidal and repellentactivities of phenolic acids of *Chaetomorpha antennina (Bory) Kuetz* against the third instar larvae of *Aedes aeypti* were investigated. The larval mortality was observed after 24 h exposure. Results of mosquitos' larvicidal tests revealed that insoluble bound phenolic acids and soluble conjugated phenolic acid fractions of *C.antennina* had an excellent inhibitory effect against *A. aegyti* (Subramanian *et al.,* 2012). The marine alga *U.fasciata* is a potential one for the eco congenial larvicidal development programmer as an alternate to chemical insecticides that are being currently used in mosquito vector control programs. This study poses the following suggestions *G.lithophila* which is promising seaweed locally available can be cultivated in coastal areas, the algal bioactive can be extracted by cost effective method high yield larvicidal activity was potent and safe to non-target cohabitants and the synergistic activity will defend the development of resistance in vector. The present study high lights that seaweed bio actives can be operationally used for mosquito control (Poonguzhali and Jasmin Laali Nisha., 2012).

The extract of *D.dichotoma* showed minimum level of LC_{50} value and LC_{90} value was observed. The study on the preliminary photochemical constituents showed the presence of saponin, steroids, terpenoid, phenols, protein and sugars. The ethanol extract of seaweeds of *D. dichotoma* possess active compounds fordevelopment of larvicidal activity (Ravikumar *et al.,* 2011).

Reference

Baba, M., Snoeck, R., Auuwels, R., De Clercq, E., 1988. Sulfated polysaccharides are potent and selective inhibitors of various enveloped viruses, including herpes simplex virus, and human immunodeficiency virus. Cytomegalovirus, vesicular stomatitis virus. *Antimicrob. Agents Chemother*, 32:1742174.

Bhadury, P. and Wriht, P.C., 2004. Exploitation of marine algae, biogenic compounds for potential antifouling applications. *Planta,* 219: 561-578.

Caceres, P.J., Carluci, M.J., Damonte, E.B., Mastushiro, B., Zuniga, E.A., 2000. Carrageenan's from Chilean samples of Steno Gramminterrupt a (phyllophoraceae): structural analysis and biological activity. *Photochemistry,* 53: 81-86.

Caruucci, M.J., Pujol, C.A., Ciancia, M., Noseda, M.D., Matulewicz, M.C., Damonte, E.B., Cerezo, A.S., 1997. Antiherpetic and anticoagulant properties of carrageenan from the red seaweed *Giggartina skottsbergii* and their cyclized derivatives: correlation between structure and biological activity. *Int. J.Biol.Macromol,* 20: 97-105.

De Clercq, E., 1996. Chemotherapy of human immunodeficiency virus (HSV) infection anti HSV agents targeted at early stages in the virus replicative cycle. *Biomed. pharmacotherapy*, 207-215.

De Clercq, E., 2000. Current lead natural products for the Chemotherapy of human immunodeficiency virus (HSV) infection. *Med .Res. Rev*, 20: 323-349.

Demonte, E.B., Neyts, J., Pujol, C.A., Snoeck, R., Andrei, G., Ikeda, S., Witvrouw, M., Reymen, D., Haines, H., Matulewicz, M.C., Cerezo, A., Coto, C.E., De Clercq, E., 1994. Antiviral activity of a sulfated polysaccharide from the red seaweed *Nothogenia fastigiata*. *Biochem. Pharmacology,* 47: 2187-2192.

Feldman, S.C., Reynaldi, S., Stortz, C.A., Cerezo, A.S., Damont, E.B., 1999. Antiviral properties of Fucoidans fractions from Leatherier differmis. *Phytome,*6:335-340.

Garg, H.S, 1993. Bioactive substances in marine algae, marine biotechnology. Plenum press, New York, 1-8.

Hamann, M.T., Otto, C.S., Scheuerm, P.J., Dunbar, D.C., 1996. Kahalalides: Bioactive peptides from a marine mollusk *Elysia rufescens* and its algal diet *Bryopsis Sp*. *J. Org. Chem.*61:6594-6600.

Kolender, A.A., Matulewic, M.C., Cerezo, A.S., 1995. Structural analysis of antiviral sulfated α-D-(13)-Linked mannans. *Carbohyd. Res*, 273:179-185.

Lavanya, R and Veerapan, N., 2011. Antibacterial potential of six seaweeds collected from Gulf of Manners of Southeast Coast of India. *Advances in Biological Research,* 5(1):38-44.

Luis, J., Villarreal-Gomez, Irma, E., Soria-Mercado, Graciela Guerra-Rivas and Nahara, E., Ayala-Sanchez, 2010. Antibacterial ant anticancer activity of seaweeds and bacteria associated with their surface. *Revistade Biologia Marinay Oceanografi,* 45:267-275.

Malhotra, R., Ward, M., Bright, H., Priest, R., Foster, M.R., Hurle, M., Blair, E., Bird, M., 2003. Isolation and characterization of potential respiratory syncytial virus reportor(s) on epithelic cells. *Microbes Infect*, 5: 123-133.

Mishra, V.K.F., Temelli, F., Ooraikul Shack lock and Craigie, J.S., (1993). Lipids of the red alga *Palmaria palmate*. *Botanica Marina,* 36(2):169-174.

Palermo, J.A., Flower, B.P., Seldes, A.M., 1992. Chondriamids A and B new indolic metabolites from the red alga *Chondria sp.Tetrahedron Lett,* 33:3097-3100.

Pandurangan Aruna, Periasamy Mansuya, Sekaran Sridhar, Jebamalai Suresh Kumar and Saranam Bahu, 2011. Pharmacognostical and antifungal activity of selected seaweeds from Gulf of Manner region. *Recent Research in Science and Technology*, 2: 115-119.

Poonguzhali, T.V. and Josmin Laali Nisha, L.L., 2012. Larvicidal activity of two seaweeds, *Ulva fasciata and Grateloupialithophila* against mosquito vector, *culexquinquefasciatus, Int. J. Curr*, Sci. 163-168.

Priyadharshine, S., Bragadeswaran, S., Prabhu, K and Sophia Rani, S., 2011. Antimicrobial and hemolytic activity of seaweed Extracts*Ulva fasciata* from Mandapam, Southeast coast of India. *Asian Pacific Journal of Tropical Bioedicin,* 37-39.

Shimaa, M., Shafay, E.I., Samh, S., Ali, Mostafa, M., El-Sheekh, 2016.antimicrobial activity of some seaweeds species from Red sea, against multidrug resistant bacteria. *Egyptian J. Aquatic. Research,* 42: 65-74.

Siddhanata, S.K., Ramavat, Kalpanamody and Chauhan, V.D., 1991. Biomedical potential of marine algae. *Journal of sea Research and Utilization,* 15: 149-157.

Spieker, R., 2002.Seaweed compounds anti-HSV efficacy will be tested in Southern Africa. *Lancet,* 359: 1675.

Sugawara, I., Itoth, W., Kimura, S., Mori, S., Shimada, K., 1989. Further characterization of sulfated homopolysaccharides as anti-HIV agents. *Experiential,* 45:996-998.

Ugo De Corato, Rocco Salimbeni, Agostine De Pretis, Nicolla Avella, Giovanni Patruno, 2017. Antifungal activity of crude extracts from brown and red seaweeds by a supercritical carbon dioxide technique against fruit postharvest fungal diseases. *Posthavet Biology and Technolog,* 131: 16-30.

Vijayabaskar, P. and Shiyamala, V., 2011. Antibacterial activities of Brown marine algae *(Sarggassumwightii and Turbinaria ornate*) from the Gulf of Manner. *Biosphere Reserve Advances in Biological Research,* 5(2): 99-102.

Witvrouw, M., Este, J.A., Mateu, M.Q., Reymen, D., Andrei, G., Snoeck, R., Ikeda, S, Pauwels, R., Bianchini, N.V., Desmyter, J., De Clercq, E., 1994. Activity of a sulfated polysaccharide extracted from the red seaweed *Aghardhiella tenera* against human immunodefiency virus and other enveloped viruses. *Antiviral Chem. Chemotherapy*, 5: 297-303.

Zeitlin, L., Whaley, K.J., Hegarty, T.A., Moench, T.R., Cone, R.A., (1997). Tests of vaginal microbicides in the mouse genital herpes model. *Contraceptio,* 56: 329-335.

Zhu, W., Ooi, V.E.C., Chan, P.K.S., Ang, Jr P.O., 2003. Inhibitory effect of extracts of marine algae from Hong Kong against Herpes simplex viruses. Proceedings of the 17th international seaweed symposium, Oxford University Press, 159-164.

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