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Natural Compounds from Algae and *Spirulina platensis* & its Antimicrobial Activity

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ABSTRACT: The present paper reviews the literature on recent ethno medicinal uses algae and *Spirulina platensis* from (1975-2012).The paper covers the latest development on the utilitarian properties of algal extract .Their application as the component of pharmaceuticals, feed for humans, antifungal, antiviral, antibacterial, antiplasmodial discussed. This review is an attempt to consolidate the latest studies and critical research in this field and to showcase the immense competence of microalgal uses as a potential and promising source of novel compounds.

KEYWORDS: Microalgae; *Spirulina platensis*; Ethno-medical use.

INTRODUCTION

Algae include a large heterogeneous assemblage of relatively simple plants that have little in common except for their characteristic autotrophic mode of nutrition. They are among the oldest extant organism on earth, dating back in the fossil record to nearly 3.5 billion years ago, the cyanobacteria (BGA) have evolved to produce an impressive array of biologically active compounds which was studied by (Benson, 2008). Algae have provided a source of inspiration for novel drug compounds for large contributions to human health and well being. Algal compounds are of great interest as a source of safer or more effective substitutes than synthetically produced antimicrobial agent. The algal derived medicines are widely used because they are relatively safer than the synthetic alternatives, they are easily available and cheaper. The first generation of drugs was usually simple botanicals employed in more or less their crude form. Following the industrial revolution, a second generation drugs emerged based on scientific processing of the algal extract to isolate their "active principle". The use of extracts and phycochemical with known antimicrobial properties can be of great significance in therapeutic treatments. The drugs contained in the algae are known as "active principle".

Natural Products as Ancient Medicine

For thousands of year's natural products have played a very important role in health care and prevention of diseases. The ancient civilizations of the Chinese, Indians and North Africans provide written evidence for the use of natural products for curing various diseases. The earliest known written document is a 4000 year old Sumerian clay tablet that records remedies for various illnesses. For instance, mandrake was prescribed for pain relief, turmeric possesses blood clotting properties, roots of the endive plant were used for treatment of gall bladder disorders, and raw garlic was prescribed for circulatory disorders. These are still being used in several countries as alternative medicines.

The exploitation of biologically active secondary metabolites for useful applications, including therapeutic drugs, is far from new. Since ancient times, nature has been recognized as an important source of potential drugs; examples of early uses and benefits of natural products for human can be found in most major civilizations (Newman *et al*., 2000; Constantino *et al*., 2004). The use of natural products for medical purposes slowly developed into the scientific field of pharmacognosy. However, this was not until the early 1800's when the active principles from plants were isolated and characterized. Among the first active principles isolated were morphine (I.1), atropine (I.2), colchicines (I.3) and caffeine (I.4). Morphine, atropine, and caffeine are today listed as core medicines in the World Health Organization's "Essential Drugs List", which is a list of minimum medical needs for basic health care systems. Natural products are outstanding in the diversity of their chemical structures and biological activities. In contrast, the `chemical diversity produced by the pharmaceutical industry using methods such as synthetic combinatorial chemistry,

seldom shows as potent or diverse biological activities (Berdy, 2005; Newman and Cragg, 2007). The advantage with natural products is that they have been developed and perfected upon millions of years of evolutionary pressure to be biologically active.

Current perspective of the taxonomic distribution of natural products in marine Cyanobacteria

Till date, a total of 533 natural products have been reported from marine cyanobacteria. The taxonomic distribution of these secondary metabolites is remarkably uneven. First, these 533 natural products are attributed to a total of only 13 different genera. Second, over 90% of all these molecules are attributed to only five different genera. This uneven taxonomic distribution can be considered rather remarkable when considering the creative sampling endeavors used to obtain these cyanobacteria from geographically and environmentally diverse habitats. However, the trend of attributing NPs to Lyngbya appears to continue. Almost 75% of all secondary metabolites isolated from marine cyanobacteria during 2010 were attributed to collections of *Lyngbya*.

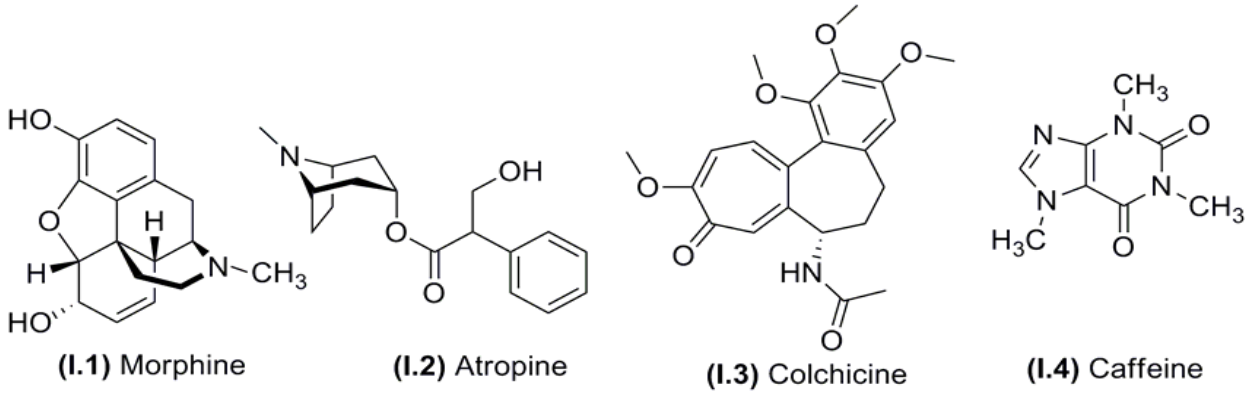

Figure 1 Some examples of natural products isolated in the early 18th century

Table : Taxonomic and environmental distribution of secondary metabolites isolated from Cyanobacteria.

Genera	Habitat	No. of Secondary metabolites
Anabaena	Fresh-water	28
Aphanizomenon	Fresh-water	5
Aulosira	Terrestrial (soil)	1
Calothrix	Terrestrial (soil)	2
Cylindrospermopsis	Fresh-water	4
Cylindrospermum	Fresh-water/terrestrial	2
Fischerella	Fresh-water	4
Geitlerinema	Marine	3
Leptolyngbya	Marine	6
Lyngbya	Marine	326
Microcystis	Fresh-water	50
Microcoleus	Marine	8
Nodularia	Fresh/brackish-water	3
Nostoc	Fresh-water/terrestrial	84
Oscillatoria	Marine	82
Phormidium	Marine	18
Plectonema	Fresh-water	2
Prochloron	Marine	1
Prochlorothrix	Fresh-water	3
Rivularia	Marine	7
Schizothrix	Marine	39
Scytonema	Fresh-water/terrestrial	14
Stigonema	Fresh-water/terrestrial	4
Symploca	Marine	26
Synecococcus	Marine	35
Westiella	Soil	2

Data obtained from Marine Literature, 2011

ANTIMICROBIAL ACTIVITY OF ALGAE

An alga shows properties like antiviral, antifungal, antibacterial, anticancer, antiplasmodial etc. More of these compounds should be subjected to animal and human studies to determine their effectiveness in whole organism systems. Also, alternative mechanisms of fungal skin infection prevention and treatment should be included in initial activity screening. Attention to these issues could usher in badly needed new era of chemotherapeutic treatment of skin infections and other diseases by using algal derived antimicrobials. The research work is going on worldwide related to the property of algae. A perusal of literature indicates that many investigators have been reported fungi static and bacteriostatic properties of extracts of algae.

Antimicrobial activity of algae against pathogenic microbes

Algae	Activity against Target Microbes	Reference
Carollina officinalis	*S. aureus, Salmonella chotereasius, M. smegmatis ,C. albicans, E. coli*	Sims *et al*., 1975
Nostoc muscorum	*C. albicans, P. aeruginosa, S. aureus, C. pseudotropicalis, Hormoconis resinae*	Bloor and England., 1989
Stoechospermum marginatum	*B. subtilis, S. aureus ,P. aeruginosam, A. flavus, A. fumigatus, T. mentagrophytes. T. rubrum, C. albicans, Shigella* sp.	Shaikh *et al*., 1990
Five marine algae	*Bacillus subtilis, Candida albicans*	Crasta *et al*., 1997
Nostoc commune	*B. cereus, S. epidermidis, E. coli*	Jaki *et al*., 1999
Laurencia okamurai, Dasyascoparia,Grateloupia,Filicinna, Placomium telfairiae	*F. oxysporium, Alternaria* sp., *E. coli A. niger, B. subtilis, P. solancearium*	Zheng *et al*., 2001
Red,green,brown macroalgae	*B. subtilis, S. aureus, Enterococcus faecium, C. albicans, A. fumigatus, Mycobacteriu smegmatis*	Gonzalez *et al.*, 2001
Ulva Fasciata, Caulerpa cupressoides Caulerpa prolifera, Gracilaria Domingensis, Gracilaria sp., *Amansia multifida*	*B. subtilis , Staphylococcus epidermidis, S. aureus , Citrobacter freundii, E. coli, E. aerogenes , K. pneumoniae , Morganella morganii , P. aeruginosa ,Salmonella typhi, S. typhimurium , Salmonella enteritidis Salmonella cholera, Vibrio cholerae*	Lima- Filho *et al*., 2002
Red algae	*S. epidermis, K. pneumonia, Salmonella* sp.	Vairappan *et al*., 2003
Gracilaria tikvahiae, Ulva lactuca, Ulva fasciata and *Sargassum fluitans.*	*S. aureus , Candida albicans*	Oranday *et al*., 2004
Fisherella sp., *Stigonema* sp.	*E.coli*	Ghasemi *et al*.,2004
Synechococcus leopoliensis	*S. aureus*	Noaman*et al*.,2004
Two green algae	*Proteus vulgaris, B. cereus, E. coli, A. niger, A. flavus, R. nigricans*	Kumar *et al*.,2006
Red Sea corals	*Actinobacteria, Vibrio* sp.	Kelman *et al*.,2006
Jania rubens	Five Gram-positive, four Gram-negative bacteria and *Candida albicans*	Karabay-Yavasoglu *et al*., 2007
*Fisherella*sp.	*E. coli, P. aeruginosa, E. aerogenes*	Asthana *et al*., 2006
Blue green algae	*Staphylococcus aureus*	Bhateja *et al*., 2006
Oscillatoria sp.	*E. coli, B. subtilis, S. aureus, S. alba, S. faecalis, C. albicans, A. flavus*	Shanab,SMM., 2007
Oscillatoria sp., *S.platensis*	*E .coli, Pseudomonas* sp., *Enterobacter* sp., *Salmonellatyphi*	Kulandaivel *et al*., 2007
Corallina officinal, C. barbata, Dictyota dichotoma, Halopteris filicina, C. spongiosus F.verticillatus, Ulva rigida	*S. aureus, Micrococcus luteus, E. faecalis, E. aerogenes, E. coli*	Taskin *et al*., 2007
Chroococcus	*S. aureus, S. epidermis, B. subtilis,*	Ghasemi *et al*., 2007

disperse,Chlorella vulgaris,Chlamydomonas reinhardtii	*S .typi., P.aeruginosa,C. kefyr, A. niger, A. fumigatus, C.albicans*	
82 marine macroalgae	*B. subtilis*, *B. cereus, C. albicans*	Salvador *et al*., 2007
Ulva lactuca	*B. subtilis, B. cereus*, *S. aureus*, *Micrococcus luteus, Klebsiella pneumoniae, Serralia marcescencs*	Abd El-Baky*et al.,* 2008
Synechocystis and *Synechococcus*sp.	*Clavibacter michiganensis, C. albicans*	Martins *et al*.,2008
Gracilaria changii	*C.albicans*	Sasidharan *et al*., 2008
Phormidium sp.	*C. albicans, E. coli, A. niger, S. aureus*	Rodriquez *et al*., 2008
Dictyota acutiloba	*S. aureus, Enterobacter* sp, *P. aeruginosa, S. typhi, B. subtilis, C. alicans*	Solomon and Santhi , 2008
Trichothecium erythraeum	*A. flavus, A. niger, B. cinera, T. rubrum, P. aeruginosa, P. vulgaris, S. typhi, E. faecalis, S. aureus, B. subtilis*	Thillairajeshkar *et al*., 2009
Gracilaria salicornia and Hypnea flagelliformis	*S. aureus, E. coli, C. albicans, A. niger*	Saeidnia *et al.,* 2009
Gracilaria edulis, *Calorpha peltada* and *Hydroclothres* sp.	*E. coli*, *S. aureus, S. faecalis, B. cereus, E. aerogenes*	Kolanjinathan*et al*.,2009
Falkenbergia hillebrandii	*E. faecalis*, *Salmonella typhi, Shigella* sp.	Manilal *et al*., 2009
Cystoseira mediterranea, U. lactuca, Codium sp.	*E. coli, S. aureus, E. faecalis K. pneumonia , E. faecalis*	Ibtissam *et a*l., 2009
Asparagopsis taxiformis, Sargassum vulgare	*E.coli, P.aeruginosa, B. cereus, S.aureus ,S. typhimurium*	Abd El Mageid *et* al., 2009
Valonopsis pachynema	*B. subtilis, E. coli, E. aerogenes, K. pneumoniae, P. aeruginosa, S. aureus, A. niger ,C. albicans*	Bai *et al.,* 2010
Pithophora Oedogonia	*B.subtilis, S.aureus, S.typhi, E.coli, Helicobacter pyloris*	Singh and Chaudhary, 2010
Oscillatoria princeps, Lyngbya majuscule	*P.aeruginosa, B. subtilis, A.niger, C.albicans*	Mathivanan *et al* ., 2010
Microcystis aeruginosa	14 bacterial and 20 fungal species	Khalid *et al*., 2010
Gracillaria ferugosnii	*K. pneumonia, P.aeruginosa, B.subtilis, S.aureus*	Bai *et al*., 2010
Caulerpa racemosa,Grateloupia lithophila	*S.aureus, B. subtilis, E. coli K. pneumoniae S. epidermidis, P. aeruginosa*	Srivastava *et al*., 2010
U. lactuca, C. glomerata,U.reticulate, G. corticata, Kappaphycus alvarezi	*A.fumigatus, A. flavus, S.cerevisae, Mucor indicus*	Aruna *et al*., 2010
Anabaena flos aquae, Oscillatoria anguitissi	*B.cereus ,B. subtilis, A. hydrophila, V. fluvialis*	Khairy and El-Kassas., 2010
Ulva fasciata, Chaetomorpha antennina	*S.aureus, E. coli,P. aeruginosa,B.subtilis ,E.aeruginosa,Citrobacter* sp., *S. epidemis, Proteus* sp., *Salmonella paratyphi*	Premalatha *et al*., 2011
Turbinaria conoides Padina Gymnospora and *Sargassum tenerrimum*	*B. subtilis, Klebsiella* sp., *Aspergillus niger*	Manivannan *et al*., 2011
Skeletonema costatum	*E. coli, K .pneumoniae, P.vulgaris, S.aureus, S.typhi*	Shanmugapriya and Ramanathan, 2011
Sargassum wightii ,Turbinaria ornata	*B. subtilis, E. coli, E. faecalis, P.aeruginosa, Aeromonas hydrophila, P vulgaris, K. pneumoniae, Shigella flexneri , S. aureus*	Vijayabaskar and Shiyamala, 2011

Gelidium Acerosa	*A. flavus, A. niger, A. fumigatus, C.albicans, C.tropicalis*	Elsie *et al*., 2011
D.Olivaceous, C. humicola, Chlorella vulgaris	*S.aureus, E.coli*	Uma *et al*., 2011
Chlorococcum humicola	*V.cholerae, K. pneumoniae, S. typhimurium, B.subtilis, C.albicans, A.niger, A.flavus*	Bhagavathy *et al*., 2011
Chlamydomonas reinharditi	*B.subtilis, P.aeruginosa, K. pneumonia, A.niger, A.flavus, C.albicans*	Renukadevi *et a*l., 2011
Anabaena sp.	*P.aeruginosa, S.typhi, K. pneumoniae*	Chauhan *et al*., 2011
Phormidium , Lyngbya	*S.epidermis, S.auerus, B. bravis, B.subtilis, S. aureus,E.coli, Shigella fleximium*	Priyadarshini *et al*., 2012

Chemical Investigation of some of the algal species

Algae	Chemical constituent	Medicinal Importance	Reference
Hapalosiphon fontinalis	Hapaindoles	Antibacterial ,Antifungal	Moore, *et al*.,1987
Stoechospermum marginatum	Diterpenoids, fatty acids, sterols	Antifungal	Shaikh *et al*., 1990
Tolypothrix	Hassallidin A	Antifungal (glycosylated lipopeptide)	Neuhof *et al*., 1991
Tolypothrix tijpanasiensi	Tjipanazole	Antifungal	Bonjounklian *et al*.,1991
Scytonema sp.	Phytoelecxin	Antifungal	Patterson, 1994
Chlorella sp.	Chlorellin	Antibacterial	Pratt*et al*., 1994
(*Sargassum wightii*)	Dioctyl phthalate	Antibacterial	Sastry and Rao, 1995
Microcystics aeruginosa	Kawaguchipeptin B (Cyclic undecapeptide)	Antibacterial	Ishida *et al*., 1997
Fischerella musciocola	Fischerellin B	Algicide	Papke *et.al*., 1997
Nostoc spongiaeforme	Tenucyclamides A-D		Banker and Carmeli, 1998
Lyngbya majuscule	Tannikolide	Antifungal	Singh *et. al*., 1999
Rhodococcus sp.	Rhodopeptins	Antifungal	Chiba *et al*., 1999
Nostoc commune	Diterpenoid	Antibacterial	Jaki *et al*., 1999
Lyngbya majuscule	Lyngbyabellin A	Antimcirobial	Luesch *et al*., 2000
Nostoc sp.	Nostocyclamide M	Allelopathic effect	Juttner *et al*., 2001
Lyngbya bouilloni	Lyngboulloside	A novel glycosidic macrolide	Tan *et al*., 2002
Lyngbya confervoides	Lobocyclamides A-C libopeptides	Antifungal	Macmillan *et al*., 2002
Halimeda macroloba	Clinosterol,Triterpenoid	Antilarval	Thomas, *et al*., 2003
Oscillatoria redekei HUB051	Fatty acid	Antibacterial	Mundt *et al*., 2003
Fucus vesiculosus	Polyhydroxylated fucophlorethol	Antibacterial	Sandsalen *et al*., 2003
Symploca sp.		Cyanotoxin	William,2003
Red algae (*Grateloupaia turuturu*)	Isethionic acid and floridoside	Antilarval	Hellio *et al*., 2004

Fischerella ambigua	Parsiguine	Antimicrobial compound	Ghasemi *et al.*, 2004
Brown algae(*Ishige okamurae*)	di-n-octylphthalate	Antifouling	Cho *et al*., 2005
Nine microalgal species	Triacylglycerol C_{24}-C_{28} Polyunsaturated fatty acid		Mansour *et al*., 2005
Green algae *(Ulva conglobata)*	Sulphated polysaccharide	Anticoagulant	Mao *et al*., 2006
Oedogonium capillare	Labdane diterpenoid	Antibacterial	Rosa Martha Perez-Gutierrez ,2006
Oscillatoria sp.	Venturamides A and B	Antimalarial	Linington., 2007
Green algae (*Ulva fasciata)*	Polyunsaturated fatty acid	Algicidal	Alamsjah *et al*., 2007
Cyanobacteria *Oscillatoria* species	Tetraamine,sperime, Saturated and unsaturated fatty acid	Antifungal Antibacterial, antialgal	Shanab, 2007
Callophycus serratus	Callophycoic acid and Callophycols	Antibacterial,antimalarial, anticancer	Lane*et al*., 2007
Fischrella muscicola	Fischrellin B	Algicide	Papke *et al.,*1997
Scytonema sp.	Sesquiterpene	Antimicrobial	Mo *et al*., 2009
Lyngbya sp.	Biselyngbyaside		Teruya *et al*., 2009
Sargassum siliquastrum	Majobanchromal	Antioxidant	Cho *et al.,* 2009
Microcystis sp.	Aeruginazole A	Antibacterial	Ravel and Carmeli., 2010
Red algae (*Carollina pilulifera*)	5,8,11,14,17-eicosapentaenoic acid and di-n-octylphthalate	Algicidal	Oh *et al*., 2010
Gloiopeltis furcata	Polysaccharide		Guangli *et al*., 2010
Laurencia papillosa	Cholestana and aldehyde derivative	Antifungal	Alarif *et. al*., 2011
Green algae (*Ulva clathrata*)	Sulphated polysaccharide		Hernandez-Garibay *et al.*, 2011
Anabaena laxa	Endoglucanase	Antifungal	Gupta *et al*., 2011
Green alga (*Caulerpa cupressoides*)	Sulphated polysaccharide	Anticoagulant Antioxidant	Costa *et al*., 2012
Gracilaria	Bioactive metabolites	Antibacterial, Antifungal, anti-inflammatory, cytotoxic,antiviral	Almeida *et al*., 2011
Anabaena azotica	γ- hexachlorocyclohexane	Lindane removal	Zhang *et al*., 2012

Antimicrobial activity of *Spirulina platensis*

Spirulina platensis is one of the most important micro-alga showing antimicrobial activity against many pathogenic bacteria and fungi. *Spirulina* is one of the several algal genera that have attracted special attention due to their importance as human foodstuff and there *in vitro* or *in vivo* functional properties. Among these genera, *S. platensis* has been extensively cultivated to obtain a protein rich material of nutritional or industrial use (blue pigment). It possesses many medicinal properties. Therefore, it is used as social and preventive medicine also. It has been recommended by medicinal experts for better health. Here are some of the works done earlier by the scientists related to antimicrobial activity of *S.platensis* shown in table below:

Solvents used for extraction	Antibacterial	Antifungal	Reference
Methanol, dichloromethane, petroleum ether,ethylacetate	Four Gram +ive and Six Gram –ive bacteria	*C.albicans*	Ozdemir, *et al.*, 2004
Ethanol	*S.aureus, E.coli*	*A.niger, C.albicans*	Santoyo *et al.*, 2006
Acetone, ethanol, diethyl ether	*K.pneumonia,Enterobacter* sp., *E.coli, S.typhi*		Kulandaivel *et al.*, 2007
Hexane, ethyl acetate, dichloromethane, methanol	*E. coli, S. typhi, P. aeruginosa K. pneumoniae*		Kaushik and Chauhan., 2008
Diethyl ether, acetone, ethanol, methanol	*B. subtilis, P. aeruginosa, E.coli, S.aureus*	*A. flavus, F. moniliforme, C. albicans*	Rania and Taha., 2008
Methanol, Ethanol, Propanol, Water	*K.pneumoniae,P.vulgaris, E.coli, S.aureus*		Mala *et al*., 2009
Methanol	*S.aureus,E.coli, P.aeruginosa*		Parisi *et al*., 2009
Ethanol	*S.typhi, Shigella frexneri, E.coli,*	*C.albicans*	Uyisenga *et al.*, 2010
Methanol		*A.flavus*	Souza *et al.*, 2011
Hexane, Ethyl acetate, Ethanol, Butanol, Acetone, Methanol, Chloroform	*S.epidermis, A.liquefaciens*	*C.glabrata*	Sivakumar and Santhanan, 2011
Ethanol	*S.aureus, E.coli, P.aeruginosa, Klebsiella* sp.		Sudha *et al.*, 2011
Methanol	*B.subtilis, E.coli, P. vulgaris*	*C.albicans*	Medina-Jaritz *et al*., 2011
Ethanol and Water	*Vibrio alginolyticus*, *Pseudomonas fluorescens*, *P. aeruginosa*, *Aeromonas hydrophila*, *A. salmonicida*,	*Aspergillus niger*, *Penicillium javanicum*, *Candida albicans* and *Trichoderma viride*	Ramamurthy and Raveendram 2012
Methanol, ethanol, aqueous	*P. Fluorescence, P.Aeruginosa, P.Putida, V. Alginolyticus, Vibrio Flavalis, V. Fisheri, E.Coli*		Pradhan, *et al.*, 2012

Chemical investigation of *Spirulina platensis*

From the various sources of Literature extensive studies have been done on chemical investigation of *Spirulina platensis i.e*., discussed in the following table.

Chemicals Isolated	Activity	Reference
Poly β-Hydroxybutyrate		Vincenzini *et al*., 1990
Exopolysaccharide	Primary metabolite	Filalimmouhim *et al*., 1993
γ- Linolenic		Cohen *et al.*, 1993
Linolenic acid		Mahajan and Kamath *et al*., 1995
Sulphated polysaccharide Calcium spirulan	Anti-herpes virus and Anti-HIV	Hayashi, 1996
Phycocyanin	Antioxidant	Hirata *et al*., 2000
Pycocyanin	Anticancer	Liu *et al*., 2000
Protean extract	Antioxidant	Estrada, 2001
Glycoliid		Xue *et al*., 2002
Phycobilprotein		Herrero *et al.*, 2005
Gamma-linolenic acid	Antioxidant	Colla et al., 2007
Selenium containing Phycocyanin	Antioxidant	Huang *et al.*, 2007
Lipids, tocopherols	Antifungal (*A.niger, C. albicans, A.flavus*)	Ramadan *et a*l., 2008

	Antibacterial-*S.aureus, P.aeruginosa,B.subtilis*	
Extracellular polysaccharide	Pharmaceutical importance	Trabelsi *et al*., 2009
Hydrocarbon and Lipids		Munifah *et al*., 2009
Alkaloid (eckol) Phloloroglucinol derivative	Anti-oxidant	Katherine *et al*., 2010
Methylcobalamin	Human food formulation	Kumudha *et al*.,2010
c-phycocyanin	Anti-inflammatory	Rabadiya *et al*., 2010
C-phycocyanin	Antibacterial (*E.coli, K. pneumonia, P. aeruginosa, S.aureus*)	Sarada et al., 2011
Extracelluar polysaccharide	Antibacterial (*S. typhimurium,S. aureus, E. coli, P. aeruginosa*)	Challouf *et al*., 2011
C-phycocyanin	*C.albicans, A.niger,A.flavus, Penicilllium species, Fusarium* sp.	Murugan *et al*., 2012
Insulin	Anti-diabetic	Anwer *et al*., 2012

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REFERENCES

Abd El Mageid, M. M., Salama, N. A., Saleh, M.A.M. and Abo Taleb, H. M., (**2009).** Antioxidant and antimicrobial characteristics of Red and Brown algae extracts. *4th Conference on recent technol. in Agri*. 818-827

Abd El-Baky, H.H., El Baz, F.K. and El- Baroty, G.S., (**2008).**Evaluation of marine alga *Ulva lactuca* L. as A source of Natural Preservative ingredient.*Am. Eurasian J. Agric. Environ. Sci.*, **3**:434-444.

Alamsjah, M.A., Hirao, S., Ishibashi, F., Oda, T. and Fujita, Y., **(2007).** Algicidal activity of polyunsaturated fatty acids derived from *Ulva fasciata* and *U. pertusa* (Ulvaceae, Chlorophyta) on phytoplankton. *J.Appl. Phycol*., **20:**713-720

Alarif, W.M., Al-lihaibi, S.S., Abdel-lateff, A. and Ayyad, S.E., **(2011)**.New antifungal cholestane and aldehyde derivative from the red algae *Laurencia papillosa. Nat. Prod. Commun*.,**6(12):** 1821-1824.

Almeida, C.L.F.D., Falcao, H.D.S., Lima, G.R.D.M., Montenegro, C.D.A. Lir, N.S., Athayda-filho, D.E.D., Rodriques,L.C., De-Souza, M.D.F.V., Barbosa-filho, J.M. and Batista, L.M., (**2011)**. Bioactivities from marine algae of the genus *Gracilaria. Int. Journal Mol. Sci*., **12(7):** 4550-4573

Anwer, R., Khursheed, S. and Fatima T., **(2012)**.Detection of immune active insulin in *Spirulina*.*J. Appl. Phycol.*,**24**: 583-591

Aruna, P., Mansuya, P., Sridhar, S., Kumar, J.S. and Babu S., **(2010)**. Pharmacognostical and antifungal activity of selected seaweeds from Gulf of Mannar region.*Rec. Res. Sci. and tech.*,**2(1):** 115-119

Asthana, R.K., Srivastava, A., Singh, A.P., Singh, P. and Nath, S.P.,(**2006).** Identification of an antimicrobial entity from the Cyanobacterium *Fischerella* sp.isolated from bark of *Azadirachtaindica* (Neem) tree. *J. Appl. Phycol.,***18**: 33-39

Bai R N., (**2010)**. Evaluation of *Gracilaria ferugosnii* for phytochemical analysis and antibacterial activity.*Plant archives.*,**10(2**):711-713.

Banker, R. and Carmeli, S.,(1998). Tenuecyclanides A-D, cyclic hexapeptides from the cyanobacteria *Nostoc spongiaforme* Var. tenue. *J. Nat. Prod*.,**61(10)**:1248-1251

Benson J M. (**2008).** Cyanobacterial toxins.**Drugs**.

Berdy, J. **2005.**Bioactive Microbial metabolites.*J.Antibiotics.*,**58**: 1-26

Bhagavathy, S., Sumathi P. and Bell, J.S.,**(2011)**. Green algae *Chlorococcum humicola*-a new source of bioactive compounds with antimicrobial activity. *Asian Pac. J. Trop. Med*., S1-S7.

Bhateja,P., Mathur, T., Pandaya,M., Fatma,T. and Rattam, A. **(2006).** Activity of blue green algae microalgae extracts against invitro generated S.aureus with reduced susceptibility to Vancomycin. *Fitoterapia*., **77(3)**: 233-235.

Bloor, S.and England, R.R.,(**1989).**Antibiotic production by the cyanobacteria *Nostoc muscorum. J. Appl. Microbiol. and Biotech.,* **1(4):**367-372

Bonjounklian, R., Smitka, T.A., Doolin, L.E., Molloy, R.M., Debono, M., Shaffer, S.F., Moore, R., Stewart, J.B. and Patterson, G.M.L., (**1991)**.Tjipanazoles new antifungal agents from blue green algae *Tolypothrix tjipanasensis*.*Tetrahedron.*,**47**: 7739- 7750.

Challouf, R., Trabelsi, L., Dhieb, R.B., Abed, O.E., Yahia, A., Ghozzi, K., Ammer, J.B., Omram, H. and Ouada, H.B., **(2011).** Evaluation of cytotoxicity and biological activities in extracellular polysaccharides released by cyanobacterium *Arthospira platensis. Brazilian Archives Biol and Technol.,* **54(4):** 831-838.

Chauhan A., Chauhan, G., Gupta,P. C., Goyal, P. and Kaushik, P., **(2011)**. In vitro antibacterial evaluation of *Anabeane* sp. against several clinically significant microflora and HPTLC analysis of its active crude extracts. *Indian J. Pharmacol.***42(2):** 105-107.

Chiba, H., Agemalus, H., Dobashi, K. and Yoshioka, T., (**1999).** Rhodopeptins, a novel cyclic tetrapeptides with antifungal activities from *Rhodococcus* sp. structure elucidation. *J. Antibi.***52(8):** 700-709.

Cho, J. K., Cho, J.S., Kang, S. E., Kim, J. K., Shin, W.H. and Hong, Y.K., (**2005)**. Isolation of antifouling active pyroglutamic acid,

triethyl citrate and di-n-octylphthalate from the brown seaweed *Ishida okamurae*.*J. Appl. Phycol*., **17**:431-435

Cho, S.H., Cho, J.Y., Kang, S.E., Hong, Y.K. and Ahn, D.H., (**2009).** Antioxidant activity of majobanchromanol, a novel chromene isolated from brown algae *Sargassum siliquastrum. J. En. Biol*.**29 (4):** 479-484.

Cohen, Z., Reungjitchachawali, M., Siandung, W. and Tanticaroen, M.,**(1993).** Production and partial purification γ-linolenic acid and some pigments from *Spirulina platensis. J. Appl. Phycol.,* **5**:109-115.

Colla, L. M., Badiale-Furlong, E. and Costa, J.A.V., (**2007**). Antioxidant properties of *Spirulina(Arthrospira) platensis* cultivated under different temperatures and nitrogen regimes. *Brazilian Archives of Biol. and Technol*., **50(1):** 161-167

Constantino, V., Fatturusso, E., Meena, M. and Taglilatele-Scafati, O.,(**2004).** Chemical diversity of bioactive marine natural products: an illustrative study. *Current Med. Chem*., **11**: 1671-1692.

Costa, M.S.S.P., Costa, L.S., Cordeira, S.L., Almeida-lima, J., Dantas-Santos, N., Magalhae, K. D., Sabry, D.A., Albuquergue, I.R.L., Periera, M.R. and Leita, E.L., **(2012)**. Evaluating the possible anticoagulant and antioxidant effect of sulphated polysaccharide from the tropical green algae, *Caulerpa cupressoides*.*J. Appl. Phycol*., **24:**1159–1167.

Crasta, P.J., Raviraja, N.S. and Sridhar, K.R., (**1997).**Antimicrobial activity of some marine algae of southwest coast of India. *Indian J. Mar. Sci*., **26:** 201-205.

Elsie B.H., Dhanarajan, M.S. and Sudha, P,N., **(2011)**.*In vitro* screening of secondary metabolites and antimicrobial activities of ethanol and acetone extracts from red seaweed *Gelidium acerosa*. *Int. J. Chem. Res*. **2 (2):** 27-29.

Estrada, P., Bermejo-Bescos, P. and Villar del Fresno, A.M., **(2001)**. Antioxidant activity of differrent fractions of *Spirulina platensis* protean extract.*Farmaco.*,**56:**497-500

Filalimmouhim, R., Cornet, J.F., Fontane, T., Fournt, B. and Dubertret, G.,**1993**. Production, Isolation and primary characterization of the exopolysaccharide of the Cyanobacterium *Spirulina platensis*.*Biotech.letters*. **15 (6):** 567-572

Ghasemi,Y., Moradian, A., Mohagheghzadeh,A., Shokravi, S. and Morowvat, M.H.,**(2007).** Antifungal and antibacterial activity of the microalgae collected from paddy fields of Iran: characterization of antimicrobial activity of *Chroococcus disperses*. *J. Biol. Sci*., **7:** 904-910.

Ghasemi,Y., Tabatabaei, Y., Shafiee, A., Amini, M., Shokravi, S.H. and Zarrini, G., **(2004)**. Parsiguine, A novel antimicrobial substance from *Fischerellaambigua*.*Pharmacol. Biol*., 2: 318-322.

Ghasemi,Y., Tabatabaei, Y., Shafiee, A., Amini, M., Shokravi, S.H. and Zarrini, G., **(2004)**. Parsiguine, A novel antimicrobial substance from *Fischerellaambigua*.*Pharmacol. Biol*., 2: 318-322.

Gonzalez,D., Val, A., Platas, G. and Basilio, A.,(**2001)**. Screening of antimicrobial activities in red, green and brown macroalgae from Gran Canaria (Canary Islands, Spain*).Int.Microbiol*.,**4**: 35-40.

Guangli, Y.U., Yannan, H.U., Yang, B., Zhao, Xia., Wang, P, Guoli, J.I., Jiandong, W.U. and Hucshi, G., **(2010).** Extraction, Isolation and structural characterization of polysaccharide from a Red alga *Gloepeltis furcata. J.Ocean University China*.,**9(2):** 293-197.

Gupta, V., Natarajan, C., Kumar, K. and Prasanna, R., **(2011).**Identification and characterization of endoglucanases for fungicidal activity on *Anabaena laxa* (Cyanobacteria).*J. Appl. Phycol*., **23**:73-81.

Hayashi, K., Hayashi, T. and Kojima I., **(1996)**. A natural sulphated polysacchide, calcium spirulan,isolated from *Spirulina platensis*: In vitro and ex vivo evaluation of an anti-Herpes simplex virus and anti-human immune deficiency virus activities. *AIDS Res.Hum. Retroviruses.*,**12**: 1463-1471.

Hellio, C., Simon-Colin, C., Clare, A.S. and Deslandes, E., **(2004)**. Isethionic acid and floridoside isolated from the red algae, *Grateloupia turuturu* inhibit settlement of *Balanus Amphitrite cyprid* larvae. *Biofouling.*,**20(3):** 139-145.

Hernandez-Garibay, E., Zertuche-Gonzalez, J.A. and Pacheco-Ruiz, I., **(2011)**.Isolation and chemical characterization of algal polysaccharide from the green seaweed *Ulva clathrata* (Roth) C. Agardh.*J.Appl. Phycol*., **23:**537-542

Herrero, M., Simo, C., Ibanez, E. and Cifuentes, A., **(2005).** Capillary electrophorsis-mass spectrometry *Spirulina platensis* obtained by pressurized liquid extraction. *Electrphoresis*.,**26**:4215-4224

Hirata, T., Tanaka, M., Ooike, M., Tsunomura, T. and Sakaguchi, M., **(2000)**. Antioxidant activities of phycocyanin prepared from *Spirulina platensis. J. Appl. Phycol*., **12**: 435-439.

Huang, Z., Guo, B. J., Wong, R.N.S. and Jiang, Y., **(2007).** Characterization and antioxidant activity of selenium containing phycocyanin isolated from *Spirulina platensis. Food chem*., **100**: 1137-1143.

Ibtissam, C., Hassane, R., Martinez, L.J., Francisco, D.S.J., Antonio, G.V.J. and Hassan, B.,**(2009)**. Screening of antibacterial activity in marine green and brown macroalgae from the coast of Morocco.*Afr. J. Biotech*., **8 (7):** 1258-1262.

Ishida,K., Matsuda,H., Murakami,M. and Yamaguchi, k., **(1997).** Kawaguchipeptin B, an antibacterial cyclic undecapeptide from the Cyanobacterium *Microcystis aeruginosa. J.Nat. Prod.,* **60(7)**: 724-726.

Jaki, B.B., Orjul, J.J. and Sticher, O.,(1**999)**. A novel extracellular diterpenoid with antibacterial activity from the cyanobacteria *Nostoc commune. J. Nat.Prod.,* **62 (3):**502-503.

Juttner, F., Todorova, A.K., Walch, N., Von-Phillipsborn, W., **(2001).** Nostocyclamides M: a cyanobacterial cyclic peptides with allelopatic activity from *Nostoc* 31. *Phytochem*., 57(4): 613-619

Karabay-Yavasoglu,N.U., Sukatar, A., Ozdemir, G. and Horzum, Z., **(2007).** Antimicrobial activity of volatile components and various extracts of the red alga *Jania rubens*. *Phytother. Res*., **21:** 153-156

Katherine, M.A., AL-Fatony, Z. and Sudrajat, H**., (2010)**.Isolation and structure elucidation of new alkaloid from the Indonesian Blue-green alga *Arthospira platensis. J. Iran. Chem. Res*., **3**:37-40.

Kaushik, P. and Chauhan, A.,**(2008)**. In vitroantibacterial activity of laboratory grown culture of *Spirulina platensis. Ind. J. Microbiol*.,**48**: 348-352

Kelman,D., Kashman, Y., Rosenberg, E., Kushmaro, A. and Loya, Y., **2006.**Antimicrobial activity of Red Sea corals.*Mar. Biol.***149:** 357-363

Khairy, H.H. and El-Kassas, H.Y. **(2010).**Active substances from some blue green algal species used as antimicrobial agents. *Afr. J. Biotech*., 9(9):2789-2800.

Khalid, M.N., Shameel, M., Ahmed , V. U., Shahzad, S. and Lghani, S. M.,**(2010)**. Studies on the bioactivity and Phycochemistry of

Microcystis aeruginosa (Cyanophyta) from Sindh.*Pak. J.Botany.*, **42(4):** 2635-2646.

Kolanjinathan, K., Ganesh, P.and Govindarajan, M.,**(2009)**. Antibacterial activity of ethanol extracts of seaweeds against fish bacterial pathogens. *Eur. Rev. Med. Pharmacol. Sci.*,**13(3):** 173-177.

Kulandaivel, S., Prakash, R., Anitha, R. and Arunnagendran N.,**(2007)**. Antibacterial activity of *Spirulina platensis* and *Oscillatoria* sp. *J. Plant and Appl. Microbiol.,* **1(1):** 127-129.

Kulandaivel, S., Prakash, R., Anitha, R. and Arunnagendran N.,**(2007)**. Antibacterial activity of *Spirulina platensis* and *Oscillatoria* sp. *J. Plant and Appl. Microbiol.,* **1(1):** 127-129.

Kumar, P., Angadi, SB. and Vidyasagar, G.M.,(**2006).**Antimicrobial activity of blue- green algae.*Indian J. Pharma.Sci* ., **68(5):** 647-648.

Kumudha, A., Kumar, S.S., Thakur, M.S., Ravishankar, G.A. and Sarada, R., **(2010)**. Purification, identification and characterization of methycobalamine from *Spirulina platensis. J.Agri. Food. Chem.,***58(18):** 9925-9930.

Lane, A.L., Elizabeth, S.P., Mark, H.K., Anne, P.C., Kenneth, H., Craig, F.R., Frazblau, S.G., Rock, K.L., Pruclhomme, J., Aalbersberg, W. and Julia, K.,(**2007).**Callophycoic acids and callophycols from the Fijian Red Algae *Callophycus serratus. J. Org. Chem*., **72 (19)** 122-127

Lima-Filho, J.V.M., Carvalho, A.F.F.U. and Freitas, S.M., (**2002)**.Antibacterial activity of extracts of six macroalgae from the Northeastern Brazilian Coast.*Brazilian J. Microbiol*., **33**: 311-313.

Linington, R.G., Gonzalez, J., Urena, L.D., Romera, L.I., Ortego-Barria, E. and Gerwick, W.H., **(2007).** Venturamindes A and B; antimalarial constituents of the panamania marine cyanobacteria *Oscillatoria* sp. *J. Nat. Prod*., **70(3):** 397-400

Liu,Y., Lizhi, X., Cheng, N., Lin, L. and Zhang, C., **(2000).**Inhibitory effect of phycocyanin from *Spirulina platensis* on the growth of human leukemia k562 cells. *J. Appl. Phycol*., **12:** 125-130

Luesch, H., Yoshida, W.Y., Moore, R.E., Paul, V.J.andCorbett, T.H., **(2001)**. Total structure determination of apratoxin A, a potent novel cytotoxin from the marine cyanobacterium *Lyngbya majuscula.Am. Chem. Soc.*, **123(23):**5418-23.

Macmillan, J.B., Ernst-Russel, M.A., De-Roop, J.S. and Molinski, T.,**(2002)**. Lobocyclamide A-C, lipopeptides from a cryptic cyanobacterial mat containing *Lyngbya confervoides. J. Org. Chem.,***67(23):** 8210-8215

Mahajan, G. and Kamath, M., **(1995).** γ- Linolenic production from *Spirulina platensis. Appl. Microbiol. and Biotechnol*., **43(3):** 466-469.

Mala, R., Sarijini, M., Saravanababu, S. and Umadevi, G., **(2009)**. Screening for antimicrobial activity of crude extracts of *Spirulina platensis*. *J. cell and tissue Res*., **93(3):** 1951-1955.

Manilal, A., Sujith, S., Selvin, J., Shakir, C. and Kiran, G.S., (2009).Antibacterial activity of Falkenbergia hillebrandii (Born) from the Indian coast against human pathogens. Phyton, 78: 161-166.

Manivannan, K., Karthikai, D.G., Anantharaman, P. and Balasubramanian, T., **(2011)**.Antimicrobial potential of selected brown seaweeds from Vedalai coastal waters, Gulf of Mannar.*Asian Pacific J. Trop. Biomed.,* 114-120

Mansour, M.P., Frampton, D.M.F., Nichols, P.D., Volkman, J.K. and Blackburn, S.I., **(2005).** Lipid and fatty acid yield of nine stationary microalgae Application and unusual C_{24}-C_{28} polyunsaturated fatty acids. *J. Appl. Phycol.*,**17**: 287-300.

Mao, W., Zang, W., Li, Yu.and Zhang, H., **(2006)**. Sulphated polysaccharide from marine algae *Ulva conglobata* and their anticoagulant activity. *J.Appl. Phycol*., 18: 9-14.

Marine literature database.,**2011**. (http://www.chem.canterbury.ac.nz/marinlit/marin lit. html).

Martins, R.F., Ramos, M.F., Herfinda, L., Sousa, J.A., Skarven, K. and Vasconcelos, V.T.,(**2008).**Antimicrobial and cytotoxic assessment of marine cyanobacteria *Synechocystis* and *Synechococcus*. *Mar. Drugs*.,**6**: 1-11.

Mathivanan, K., Ramamurthy, K. and Rajaram R.,**(2010).**Antmicrobial activity of *Oscillatoria priceps* and *Lyngbya majuscule* against pathogenic microbes.*Int. J. Curr. Res*., 97-101.

Medina-Jaritz, N.B., Perez-Solis, D.R., Ruiloba de Leon, F. and Olvera-Ramirez, R., **(2011)**. Antimicrobial activity of aqueous and Methanolic extracts from *Arthrospira maxima*. *Formatex*.,1267-1271.

Mo, S., Kronic, A., Pegan, S.D., Franzblau, S.G. and Orjala, J., **(2009)**. An antimicrobial guideline-bearing sesterpene from the culture cyanobacteria *Scytonema* sp., **72(11):** 2043-2045

Moore, R.E., Cheuk, C., Yang, X-QG., Patterson, G.M.L., Bonjouklian, R., Smitka, T.A., Mynderse, J.S., Foster, R.S., Jones, N.D., Swartzendruber, J.K. and Deeter, J.B., **(1987)**.Haplindoles.Antibacterial and antimycotic alkaloids from the cyanophyta *Hapalosiphon fontinalis. J. Org. Chem.,***52**: 1036-1043

Mundt,S., Kreitlow,S. and Jansen,T., **(2003).**Fatty acids with antibacterial activity from cyanobacteria *Oscillatoria redekei* HUB 051.*Appl. Phycol*., **15**:263-267.

Munifah, I., Amini, S. and Sugiyono.,**(2009).**Isolation and characterization of hydrocarbon and lipid from marine algae *Spirulina platensis. J. Mar. and Fisheries Postharvest and Biotech.*,**4**: 29–35

Murugan, T., Manikantavelu,T. and Saranraj, P., **(2012)**. Growth and bio-pigment production of three microalgal species in organic and inorganic media and determination of generation time: Acomparative study. *Int. J. Pharma. and Biolo. Archives*.,**3(1):** 101-105.

Neuhof, T., Schmieder, P., Preussel, K., Dieckmann, R., Pham, H., Bartl, F., Von Dohren, H., (2005). Hassallidin A, a glycosylated lipopeptide with antifungal activity from the cyanobacterium *Hassallia* sp. *J Nat Prod*.,68(5):695-700.

Newman, D. J. and Cragg, G. M., (**2007).** Natural products as sources of New drugs over the last 25 years. *J. Nat. Prod.*,**70**: 461-477.

Newman, D.J., Cragg, G.M. and Snader, K. M., (**2000)**. The influence of natural products upon drug discovery.*Nat. Prod. Rep*., **17**: 215-234.

Noaman,N.H., Fattah,A.,Khaleafa, M., Zaky, S.H.,(**2004).**Factors affecting antimicrobial activity of *Synechococcus leopoliensis*.*Microbiol. Res*., **159**: 395-402.

Oranday, M A., Verde, M. J., Martinez, J. and Waksman, N. H., **(2004).**Active fractions from four species of marine algae.*Int. J. Exp. Botany.*,165-170.

Ozdemir, G., Karabay, N.U., Dalay, M. C. and Pazarbasi, B., **(2004).** Antibacterial activity of volatile extracts of *Spirulina platensis. Phytother.Res*. **18(9):**754-757

Papke, U.U., Gross, E.M. and Francke, W.,**(1997)**. Isolation, identification and determination of the absolute configuration of Fischerellin B.A new algicide from the freshwater cyanobacteria *Fischerella muscicota* (Thuret).*Tetrahedron Lett*.,**38**: 379-382.

Parisi, A.S., Younes, S., Reinehr, C.O. and Colla, L.M., (**2009).** Evaluation of antibacterial activity of *S. platensis* **.** *J. Basic and Appl. Pharmaceut. Sci*., **30(9):** 297-301.

Patterson, G.M.L., Parker, D.L. and Bolis, C.M., (**1994)**. Fungal cell wall polysaccharide elicit an antifungal 2 metabolite (phytoalexin) in the Cyanobacterium *Scytonema ocellatona. J. Phycol.***33**: 54-60

Pradhan, J., Das, B.K., Sahu, S., Marhual, N M., Swain, A.K., Mishra, B.K. and Eknath, A.E., **(2012)**. Traditional antibacterial activity of freshwater microalga *Spirulina platensis* to aquatic pathogens.*Aqua. Res.,* **43(9):**1287-1295

Premlatha, M., Dhasarathan, P. and Theriappan, P.,**(2011).** Phytochemical characterization and antimicrobial efficiency of sea weed samples, *Ulva fasciata* and *Chaetophora antennina*. *Int. J. Pharma and Biosci.,***2 (1):** 288-293.

Priyadharshini, S., Bragadeeswaran, S., Prabhu, K., Sophia, R. S., **(2011)**. Antimicrobial and hemolytic activity of seaweed extracts *Ulva fasciata* (Delile 1813) from Mandapam, Southeast coast of India. *Asian Pac. Trop. Med*., S38-S39.

Rabadiya, B. and Patel, P., **(2010).***Spirulina:*Potential clinical therapeutic application. *J. Pharm. Res.***3(8):** 1726-1732.

Ramadan, M.F., Selim, M., Asker, M. and Zeinab, K.L., (2008).Functional bioactive compounds and biological activities of *Spirulina platensis* lipids.*Czech. J. Food. Sci.*,26 (3): 211-2226

Ramamurthy, V and Raveendran, S., **(2009)**. Antibacterial and antifungal activity of *Spirulina platensis* and *Lyngbya majuscule. J. Ecobiol.,* **24 (1):** 47 – 52

Ramamurthy, V and Raveendran, S., **(2009)**. Antibacterial and antifungal activity of *Spirulina platensis* and *Lyngbya majuscule. J. Ecobiol.,* **24 (1):** 47 – 52.

Rania, M.A.A. and Taha, H.M., **(2008).**Antibacterial and Antifungal Activity of Cyanobacteria and Green Microalgae.Evaluation of Medium Components by Placket-Burman Design for Antimicrobial Activity of *Spirulina platensis*.*Global J. Biotechnol.Biochem*.,**3(1):** 22-31.

Ravel, A. and Carmel, S., **(2010).** Aeruginazole A, a novel thiazole – containing cyclopeptides from the *Nostoc* cyanobacteria *Microcystis* sp. *Org. Letter*. **6(12):** 3536-3539.

Renukadevi, K.P., Saravana , J. and Angayarkanni., **(2011)**.Antimicrobial and antioxidant activity of *chlamydomonas reinhardtii* **.** *Int. J. Pharma.and Res*., **2(6):** 1467-1472.

Rodriquez, M., Jaime, L., Santoyo, S., Cifuentes, G., Garcia, R., Senorans, F. and Ibanez, E.,**(2008).** Pressurized liquid extraction of bioactive Compounds from *Phormidium* sp. *J. Agri. Food Chem*., **56(10):** 3517-3523.

Rosa Martha Perez-Gutierrez.,**(2006)**. Isolation and identification of antibacterial compounds from *Oedogonium capillare* leaves.BLACPMA.,**5(1):** 15-19.

Saeidnia, S., Gohari, A.R., Shahverdi, A.R., Permech P., Nasiri, M., Mollazadeh, K. and Farahani, F.,**(2009)**.Biologically activity of two red algae, *Gracilaria salicornia* and *Hypnea flagelliformis* from Persian gulf. *Pharma. Res*., **1(6):** 428-430

Salvador, N., Gomez-Garreta, A., Lavelli, L. and Ribera, M.A.,**(2007)**. Antimicrobial activity of Iberian *macroalgae*.*Sci. Mar*., **71**: 101-113.

Santoyo, S., Herrero, M., Javier, F., Cifuentes, A., Ibanez ,E. and Jaime, L., **(2006).** Functional characterization of pressurized liquid extracts of *Spirulina platensis. Eur. Food Res. Technol*., **224:** 75-81

Sarada, D.V.L., Kumar, C.H. and Rengasamy, R., **(2011)**. Purified C-phycocyanin from *Spirulina platensis* (Nordstedt) Geitler: a novel and potent agent against drug resistant bacteria.*World J. Microbiol.Biotech*.,**27**: 779-783

Sasidharan, S., Darah, I. and Jain K., **(2008).***In Vivo* and *In Vitro* toxicity study of *Gracilaria changii*. *Pharma. Biol.,* **46**: 413–417.

Sastry, V.M.V.S and Rao, G.R.K.,**(1994).** Antibacterial substances from marine algae: successive extraction using benzene, chloroform and methanol. *Bot. Mar*.**37**:357–360.

Shaikh, W., Shameel, M., Hayee-Memon, A., Usmanghani, K., Bano, S. and Ahmed, V.U., 1990. Isolation and characterization of chemical constituents of Stoechospermum marginatum (Dictyotales, Phaeophyta) and their antimicrobial activity. Pak. J. Pharm. Sci. 3(2):1-9

Shaikh, W., Shameel, M., Hayee-Memon, A., Usmanghani, K., Bano, S. and Ahmed, V.U., 1990. Isolation and characterization of chemical constituents of Stoechospermum marginatum (Dictyotales, Phaeophyta) and their antimicrobial activity. Pak. J. Pharm. Sci. 3(2):1-9

Shanab,S.M.M.,**(2007)**. Bioactive Allelo-chemicals compounds from *Oscillatoria* species (Egyptian isolates). *Int. J. Agri. and Biol*., **9(4)**: 617-621.

Shanab,S.M.M.,**(2007)**. Bioactive Allelo-chemicals compounds from *Oscillatoria* species (Egyptian isolates). *Int. J. Agri. and Biol*., **9(4)**: 617-621.

Shanmugapriya, R. and Ramanathan, T., **(2011).** Screening for antimicrobial activity of crude extracts of *Skeletonema costatum. J. Appl. Pharma. Sci.,***1(7):** 154-157.

Sims, J.J., Donell, V., John, L. and George, H., **(1975).** Antimicrobial agents from marine algae.*Chemotherapy*.,**7(3)**: 320-321.

Singh, A.P. and Chaudhary., B.R., **(2010).**Preliminary phycochemical analysis and *In Vitro* Antibacterial Screening of *Pithophora oedogonia* (Mont.) Wittrock- A Freshwater green alga Forming Mats in the Water Bodies. *J. Algal Biomass Utln*.,**1 (2):** 33-41

Singh, I.P., Millian, K.E.,Gerwick, W.H., **(1999).**Tanikolide, a toxic and antifungal lactons from the marine cyanobacteria.*Lyngbya majuscuta. J.Nat. prod*. **62(9):** 1333-1335

Sivakumar, J. and Santhanan.P., **(2011).**Antipathogenic activity of *Spirulina platensis*.*Recent Res. in Sci. and Technol.*, **3(4):** 158-161.

Solomon, R.D. J., and Santhi, V. S., (**2008).** Purification of bioactive natural product against human microbial pathogen from marine sea weed*Dictyota acutiloba. World J.MicrobialandBiotech.***24(9):** 1747-1752.

Souza, M.M., Prietto, L., Souza, A.C., Ribeiro, A.C. and Badiale-Furlong, E., **(2011).**Assessment of the antifungal activity of *Spirulina platensis* phenolic extract against *Aspergillus flavus.Ciênc.Agrotec.*,**35 (6):**1050-1058.

Srivastava, N., Saurav, K., Mohanasrivasan,V., Kannabiran, K. and Singh, M., **(2010).** Antibacterial potential of macroalgae collected

from the Madappan coast, India. *British J.Pharmacol.and Toxicol*.,**1(2):** 72-76.

Sudha, S.S., Karthic, R., Rengaramunjan, J. and Athulya.,**(2011) .**Antimiicrobial activity of *Spirulina platensis* and *Aphanothece* sp. on selected clinical bacterial isolates and its antioxidant activity. *South As. J. Biol. Sci.*,**1:** 87-98.

Tan, L.T., Marquiz, B.L. and Gerwich, W.H., **(2002)**. Lyngbouilloside,a novel glycosidic macrolide from the marine cyanobacteria *Lyngbya bouillanii. J.Nat. Prod*. 65(6): 925-928.

Taskin E, Ozturk M and Kurt O*.,* **2007.**Antibacterial activity of some marine algae from the Aegean sea (Turkey). *Afr. J Biotech*.**6:** 2746-2751

Teruya, T., Sasak, H.,Kitamura, K., Nakayama, T., Suenaga, K., (**2009)**. Biselyngbyasida a macrolide glycoside from the marine cyanobacteria *Lyngbya* sp. *Org. Letter*.,**11(11):** 2421-2424

Thillairajeshkar, K., Duraipandiyan, V., Perumal, P. and Ignacimuthu, S**., (2009)**.Antimicrobial activity of *T.erythraeum* (Ehr) microalga from south east coast of Tamil nadu, India.*Int. J. Integra. Biol*., **5(3):** 167- 171.

Thomas, D., Marcel, J. and Juiji, T.,**(2003).** Clinosterol: A Terpenoid from the Kenyan marine green microalga *Halmida macroloba. Western Ind. Ocean J. Mar. Sci.,***2(2):** 157-161.

Trabelsi, L., Msakni, N., BEN, Q. H., Bacha, H. and Roudelsi, S., **(2009)**. Partial characterization of extracllular polysaccharides produced by Cyanobacterium *Arthospira platensis*.*Biotech.and Bioprocess Engg*., **14:** 27-31.

Uma, R., Sivasubramanian, V. and Niranjali, D.S.,**(2011).**Preliminary phycochemical analysis and *in vitro* antibacterial screening of green micro algae, *Desmococcus Olivaceous, Chlorococcum humicola* and *Chlorella vulgaris. J. Algal Biomass Utln*.,**2 (3):** 74– 81.

Uyisenga, J.P., Nzayino,P.,Seneza,R., Hishamunda,L., Uwantege, K., Gasana,N. and Bajyana. E.S., **(2010)**.In Vitro Study of Antibacterial and Antifungal Activity of *Spirulina Platensis.Int. J. Ecol. and Develop*.,**16(10):** 315-719

Vairappan, S.C., **(2003).**Potent antibacterial activity of halogenated metabolites from Malaysian red algae, *Laurencia majuscula* (*Rhodomelaceae*, *Ceramiales*).*J. Biomolecular Engg.,* **20 (4-6):**255-259.

Vijayabhaskar.and Shiymala, V.,**(2011).** Antibacterial activity of Brown algae (*S. wightii* and *Turbinaria ornata*) from the gulf of Mannar biosphere reserve. *Advances in Biol. Res*., 5(2): 99-102.

Vincenzini, M., Sili, C., Philippis, R.D., Ena, A. and Materassi, R., **(1990)**.Occurance of Poly-hydroxybutyrate in *Spirulina* sp. *J.Bacteriol*., 2791-2792.

Williams, P.G., Yoshida, W.E., Moore, R.E. and Paul**,** V.J. **(2003)**. Tasipeptins A and B: New cytotoxic desipeptides from the marine cyanobacterium *Symploca* sp. *J. Nat. Prod*., **66:** 620-624.

Xue, C.H., Hu, Y.O., Saito, H., Zhang, Z.H., Li, Z.J., Cai, Y.P., Ou, C.R., Lin, H. and Imbs, A.B., **(2002)**. Molecular species composition of glycolipids from *Spirulina platensis*.*Food Chem*., **77**: 9-13.

Zhang, H., Hu, C., Jia, X., Xu, Y., Wu, C., Chen, L. and Wang, F., **(2012)**.Characteristics of γ-hexachlorocyclohexane biodegradation by a nitrogen fixing Cyanobacterium, *Anabaena azotica*.*J. Appl. Phyco*., **24:** 221-225.

Zheng, Yi., Chen, S., Lu.and Sheng, H.,(**2001)**. Screening for antimicrobial and antifungal activities in some marine algae from the Fujjan coast of China with three different solvents.*Chinese J. Oceanology and Limnol.,***19(4)** :327-331.

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