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Biotechnological applications of marine red algae

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ABSTRACT

The current trend in research area is exploring the marine organism and plants for finding out new therapeutic compound and the research is now moved towards the marine red algae. They are diverse in some extent and they belong to ancient group of marine organism. They are important ecological primary producers because they play an important role in maintaining the coral reefs by secreting calcium carbonate on their cells that provides the structural habitat for many other micro organisms. It has many biotechnological applications that make the red algae as effective anti viral agent, anti diabetic agent, anti inflammatory agent, anti microbial agent and good anti cancerous agent. We can able to create a 100% good nutritive and pure food by combining this red marine algae and spirulina an alga with good nutritive content. Thus unique and unpredictable features of the marine red algae can be studied only if its genetic nature is fully revealed.

Keywords: Marine red algae; Biotechnological application; Therapeutic agent; nutritious food.

INTRODUCTION

The current trend in research area is exploring the marine organism and plants for finding out new therapeutic compound. It's obviously algae is the one that comes to mind of every explorer because of its unique properties. The advantage of using algae is they no need any good fertile land for their growth and they can grow in drought hard soil, salinated soil. Most of them grow in sewage area or waste water effluents and thus gives the application of algae in using for the waste water treatment. Algae have many biotechnological applications that have been explored and have to be explored more by our researchers. Of three classifications of algae red algae is concerned to have many unique and therapeutic properties that has to be brought out for the benefit of the world. This is because Red marine algae is the good source of natural bioactive compounds, most of those exhibit chemical and structural features are unique and different form of those not found in terrestrial compounds. They are diverse in some extent and they belong to ancient group of marine organism. The red algae are usually referred as Rhodophyta which is characterized based on the photosynthetic pigments called phycoerythrin, phycocyanin and allophycocyanins. They differ from other classes of algae by lacking centrioles, flagella and chloroplast endoplasmic reticulum. They have unstacked thylakoids in plastids. They are mostly occupied in the tropical, coastal, continental, temperate and cold water regions. They are about 6000 species lying under 670 marine genera. Most of them belong to Corallinaceae or Gigartinaceae that occurs in the intertidal and sub tidal region up to 250meters. They are important ecological primary producers because they play an important role in maintaining the coral reefs by secreting calcium carbonate on their cells that provides the structural habitat for many other micro organisms. Their storage material is floridean starch, floridoside and their cell wall is made up of cellulose sugars and carrageenans. It has good calcium content which is just enough for human body's daily nutrition content. The 55% of the human body requirement to magnesium can be satisfied by these red algae. The 180% of human iron content is present in these red algae and it is suitable for those people who do not consume animal nutrients. These red algae have many useful components that act as various therapeutic purposes which are listed below.

MARINE RED AGLAE AS FOOD AND NUTRIENTS

In 600 Bc itself the records of Chinese had mentioned about the algae and it can be able to be used as food source**.** Japanese has well learned the nutrient content of the red algae because they are using these red algae as commercially food. Nori is the red algae which is aqua cultured commercially by Japanese for providing complete nutrient supplement to their people. The other commercially available red algae food is Dulse sp. (Palmaria palmate), carrageen moss (Mastocarpus stellatus and Chondrus cripus) [1]. Most of the food industry like chocolate, milk, yoghurts and puddings are filled in nutrient with the red algae Kappaphycus and Betaphycus. These have high mineral, vitamin and nutritive elements. The sea vegetables are now emerging as a new edible vegetable in current days because these algae contains twenty times more mineral and vitamins that could satisfy need of good metabolism than other plants in the land. The vast red algae found in ocean are Gigartina is found to be the good sea food with good new therapeutic value. It has capacity to prolong life by preventing disease and helps in enhancing life. Many dairy industry uses carrageenan in making jellys and puddings and this carrageenan is most abundantly in Gigartina. Thus we can able to create a 100% good nutritive and pure food by combining this red marine algae and spirulina an alga with good nutritive content. Hence there is need for extensive farming and natural harvest of red algae that can be used as commercial food in various natural environment of the world.

ANTIVIRAL AND IMMUNOSTIMULANT PROPERTY OF MARINE RED ALGAE

From the ancient times onwards the use of marine algae as food and therapy were well known. Its role as immune booster that is its property against virus has been found out and used in several antiviral preparations by Asian people. Traditionally the red algae are used as food but later its applications in medicine have been found out later when the different species of this alga have explored. Especially the marine red alga has the property of provoking the immune response towards various viruses and continues use of these algae provides the good stable immunity against several viruses. In olden days these red algae extracts have been used in the treatment of urinary infections, asthma, goiter, ulcers, stomach problems and tumour. The cell wall of red algae is mostly made up of polysaccharides which can able to induce the interferon production thus acting as good antiviral compound as well as improve the B cell and T cell activity. Sulphated polysaccharides family usually called carrageenans which is found in increasing amount in red marine algae is used in the treatment against Genital herpes and sexually transmitted disease like HIV in 2006. It is used in coating of the condom because to prevent the causative agent that causes genetic warts called human papillovirus. The first step in virus infection is adhesion of virus particles to cell surface thus this activity of virus is inhibited by the carregeenans that is present in the red algae [2].

The good potential of marine red algae has reviewed when it is used in the treatment of chronic herpes simplex infections. In olden days there is no medicine for this virus infection but later they found a drug called Acyclovir which has stopped the infections by inhibiting the synthesis of viral DNA [3]. This drug served well for the treatment of herpes but later it developed the toxicity and its cost of synthesising was high. Moreover the use of this drug for long term may lead to the development of drug resistance strains and in later period Genital herpes (HSV-II) has emerged in which acyclovir has no effect on it. During this situation the researchers has found out the antiherpetic action of the red marine algae called Dumontiaceae. This alga has helped the people in recovering from Epstein Barr (another herpes virus) and other fungi infection called Candida in a less period of time which is more effective than previously described old drug when it is administrated orally which was proved and tested by Dieg et al [4]. Thus it is considered ad natural immunomodulatory and antiviral agent with no toxicity or side effects. Its anti tumour ,immune stimulant property, and immune- enhancing activity (improving activity of T- and B-cells) are due to the presence of long chained sugars called polysaccharide present in the cell wall . Genus of red marine algae called Gigartina is also found to provoke the immune response because of its rich content of sulphated polysaccharides, and sulphur-containing complex sugars [5]. Serkedjieva [6] has used the Ceramium rubrum which is marine red algae obtained from Bulgarian Black Sea seacoast against the virus called influenza viruses. This extract of red marine algae had inhibited the both the types A,B reproduction of influenza virus both invivo and invitro followed by the reduction of its cytopathogenic effect (CPE) at its desired concentration. It has dosage related and strain specific effects . Thus proves the antiviral property of the marine red algae which gives the idea of developing the antiviral products from the marine red algae.

MARINE RED ALGAE AS THERAPEUTIC AGENT

The therapeutic value of marine red algae is found to be numerous of which only ten percent is revelled yet ninety percent has to be found out. The red marine algae have given the research a pool of opportunities to discover new compound and its therapeutics value. These red algae may cure for many deadly diseases which we need to give concentration and have to explore it. Generally the red marine algae has the property of reducing the blood cholesterol and fat thus act as the anti obesity agent. it also has the property of rejuvenating the gastrointestinal tract and lungs because of its carregeenan content. We can also call these red marine algae as purifiers of our body because it can able to bind to heavy metals, carcinogens and pesticides and can remove from our body though its cell wall. Especially the Dumontiaceae has tough cell wall which can able to bind to toxic substances [7]. Thus

Dumontiaceae is the most valuable seeweed with many useful properties that has to be explored. Skin ailments such as eczema, psoriasis, and herpes can be treated efficiently with the red marine algae called Gigartina. Phenols, terpenes, polysaccharides and steroids are mostly found in the red algae Dichotomaria obtusata have anti-edematous effects [8].

ANTI INFLAMMATORY PROPERTY

The red algae also have anti inflammatory property which was investigated by Luiz Henrique Agra Cavalcante-Silva who used Bryothamnion triquetrum red algae's methanolic extract in animal models like murine. The anti inflammatory activity of these red algae was compared with the activity of indomethacin using the induction of Zymoson A. His experiment has thus revealed the anti inflammatory property of the red algae Bryothamnion triquetrum which is found in the coastal region of Cabo Branco beach in Brazil [9]. Not just one or two algae has this property but our researchers like Khadija Oumaskour and Nabila Boukaber had exposed the anti inflammatory property of twenty three marine red algae found in the Atlantic coast of Morocco. The Methanolic extracts of Asparagopsis armata, Gigartina acicularis ,Chondrus crispus and Gelidium sesquipedale, Corallina elongata, Laurencia pinnatifida Chondria dasyphylla, Palmaria palmata and Pterosiphonia complanata has showed the greatest anti inflammatory property with the percentage of 70%. percentage higher to 70%. While the medium property was observed in the range of 50% is observed in species like Chondria dasyphylla, Hypnea musciformis, Gigartina pistillata, Palmaria palmata and Acrosorium venulosum, complanata. The anti-inflammatory activity of marine red algae called Dichotomaria obtusata which is found in the Jaimanitas Beach. The aqueous extract of these marine red algae components like phenols or tannins , lactonic compounds, reduced carbohydrates and other sugars was tested in the TPA-induced ear edema in mice and the results has shown that it possess the dose dependent anti inflammatory effect by inhibiting the synthesis and action of inflammatory inducing proteins [11]. This research shows that compounds present in the red algae have some therapeutic value which has to be exposed to the scientific world for the benefit of world. Thus there is lot of marine red algae species that possess the anti inflammatory effect but there is very less research works in concerns about the isolation of compound or making the crude red algae as potential therapeutic pharma compound.

ANTINOCICEPTIVE PROPERTY

The Dichotomaria obtusata was found to have very good analgesic activity because of his compound like carbohydrates, tannis, phenols and lactonics which was estimated by Ana Iris Frías Vázquez. The aqueous extract of this algae can to inhibit the endogenous mediators release when tested with the acetic acid Another marine red algae Bryothamnion triquetrum coastal region of Cabo Branco beach in Brazil has antinociceptive which was tested aganist in murine models which was induced with acetic acid writhing. Its nonciceptive activity (analgestic activity) was compared with the activity of dipyrone and it has 55.9% response in murine models with the 80.9% of dipyrone [12]. Hence this property of marine red algae is not been investigated properly in many species of red algae but above research study proves that they have such property. Thus good analysis of red algae will give the good therapeutics drugs with no side effects or toxic effects.

COSMETIC APPLICATION OF MARINE RED ALGAE

The speciality of the marine red algae is that they are not only have compounds that can help in disease but also the compounds that enhances out outer skin texture that is it does also has cosmetic application. Our skin requires nutrients like poly phenols, amino acids, sulphated polysaccharide, galactan and anti oxidants in order to maintain its texture, tone and good healthy skin. Hence marine red algae are the source of all those compounds which can be used for making the good natural cosmetic products. Laurencia undulate is red algae with high polyphenolic content and Corallina pilulifera (CMP) have ability to prevent oxidative stress induced by UV and also reduce the expression of MMP-2 and MMP- 9 in human dermal fibroblast (HDF) cells [13]. Elastin of the skin tissues can be improved by Asparagopsis armata which is abundant in Atlantic Ocean. It also has ability to reduce wrinkles, fine lines and act as antioxidants. High mineral content of the Lithothamnium calcareum has ability to restore skin tone and act as cleansing and detoxifying agent. Strength of elastin can be improved with the help of red seaweed called Corallina officinalis. Most of the pharmaceutical and cosmetic formulations used the Porphyridium cruentum as one of its active ingredients because it has compound that helps in maintaining the good appearance of skin.. Marine red algae are the reservoir of natural antioxidants. Most of the species of red algae has antioxidant activity especially Ahnfeltiopsis, Gracilaria, Halymenia, Laurencia, Padina and Polysiphonia species. Some special compounds found in red algae that can able to act as antioxidant property for example A. devoniensis has amino acid called mycosporine that has antioxidant activity. Most of the cosmetic industry especially deodorant products have extracts of Ceramium rubrum for its unique compounds [13]. Thus research has opportunity to develop pure red algae cosmetic products.

ANTIMICROBIAL PROPERTY

Everyone will be aware that the red algae are capable of antimicrobial activity and researchers also have proved that activity of some of the red algae. Hence the red algae are considered as best antimicrobial agent but there is no commercial use of these algae in the products of antimicrobial products. The antimicrobial activity of methanolic and (50:50) of methanol, dichloromethane extracts of the twenty three marine red algae of above species has been revealed against Bacillus cereus, Bacillus thuringensis and Bacillus subtillus (gram positive bacteria). The activity is also against the most disease causing bacteria like Clostridium sporogenes, Staphylococcus aureus, Mycobacterium smegmatis, Streptococcus feacalis and Bacillus sp, Escherichia Coli and Pseudomonas sp (gram negative bacteria) and against Candida tropicalis, Candida albicans and Cryptococcus neoformans (fungai) Acanthaphora spicifera a red algae found in the Tamilnadu, South East Coast of India whose methanolic extracts has good anti bacterial activity against Escherichia coli, Bacillus subtilis, Pseudomonas aeruginosa and Bacillus palmitus. It also has anti fungal activity against Candida albicans, , Aspergillus niger and Microsporum gypseum which was found by Pitchaimuthu Pandian et al [14]. It was mentioned that the antibacterial and anti fungal activity of Laminariadigitata and Ascophyllumnodosum that is found in Icelandic aganist Pseudomonas aeruginosa and Candidaalbicans Staphylococcus aureus, Listeria onocytogenes and Escherichia coli [reference 13]. Aseer Manilal [15] has estimated the anti bacterial activity of thirteen red algae found in the Indian coast against pathogenic bacteria that affects both humans and marine organisms like shrimps. The red algae specie like Asparagopsis taxiformis, Hypnea valentiae Laurencia ceylanica and Laurencia brandenii has found to have high antimicrobial effects but they do not have efficient inhibitory activity against plant pathogens. Off these four algae he revealed the good antibiotic activity of taxiformis aganist shrimp pathogenic virus and its components like pyrrole-2-carboxylic acid, pentadecanoic acid and octadecanoic acid have good role in this microbial destruction Thus a good antibiotic product is available in nature as marine red algae.

ANTI CANCER ACTIVITY OF MARINE RED ALGAE

Red algae are the best remedy for cancer because it has many compounds buried in it with anti cancerous activity and many of which has to be revealed. For the first time antitumor especially antimetastatic of Marginisporum crassissimum which is found in the Japan costal sea was shown by Hiroishi in mouse melanoma cell line B16-BL6, JYG-B (a mouse mammary carcinoma cell line) and finally in the a human mammary carcinoma cell line KPL-1 and they had seen the effective inhibition of tumour in invitro. The compound of less than 100Da responsible for that was also isolated by them which prove that red algae possess the good anti tumor activity In the review paper made by Ghislain Moussavou, the anti cancer activity of marine red algae is clearly exposed. Dactylone compound present in the red algae Laurencia sp called Ishige okamurae and Lithothamnion sp can be used for the treatment of colorectal cancer with the dosage of 45 µmol/l. This compound has potential to arrest the cell cycle, Mitochondrial Membrane, Caspases or Cyclins and P53. In the treatment of breast cancer the red algae Porphyra dentate and Lophocladia sp was used, especially the steroid fraction and Lophocladines of these algae is used with the drug dosage of 48.3 µg/mL and 3.1 µM or 64.6 µM respectively . The steroid fraction has ability to induce apoptosis in 4T1 cancer cells and able to decrease arginase activity and reactive oxygen species in MDSCs of tumor bearing mice. Alkaloid named 2,7-naphthyridine is usually referred as Lophocladines A and B of Lophocladia sp acts as a δ-opioid receptor antagonist and had affinity for NMDA receptor with cytotoxic effect on MDAMB-435 breast cancer and NCI-H460 human lung tumor cells. The ethanol extracts and methanol of Phoma herbarum and Gracilaria termistipitata respectively has good therapeutic value in treating various types of cancer The red marine algae have high soluble and insoluble fibre content which not only makes it as edible but also makes it as anti cancerous agent. The dietary fibres of Kappaphycus alvarezii (κ-carrageenan) was tested as anti cancer agent against human colon cancer in colon cancer cells HCT116. Sulphated fractions (F1 and F2) of that algae contains D-galactose and 3,6-anhydro-D-galactose was found to up regulate the mRNA expression levels of Bcl-2, Bcl-xL and caspase3 and the down regulate the XIAP and PARP-1 and also causes apoptotic cell death, nuclear fragmentation, apoptosome formation. Hence the soluble dietary fibre from K. alvarezii can be used as anti cancerous agent with low toxic effects which was proved by researchers Thus the best cure for cancer is lies inside the ocean in the form of red algae which researchers have to explore and make the good use of it.

ANTI DIABETIC ACTIVITY OF MARINE RED ALGAE

There is a rumour among researchers that the best complete cure for diabetics is lying in the marine sea weed. Thus it creates a hunger to explore this compound from the marine seaweed. It is found that components found in marine red algae have capacity to act as anti diabetic compound. Bromophenols are phenolic compounds that have capacity to inhibit Protein Tyrosine Phosphatase (PTP) which is responsible for inhibiting insulin. Hence these compounds are found in some marine red algae like Symphyocladia latiuscula Rhodomela confervoides, Polysiphonia urceolata which has been experimented to show the efficient hypoglycemic activity. It has ability to inhibit PTP, α-glucosidase, and AR. The hyperglycemic effect of ethanol extract of Rhodomela confervoides was identified in male wistar rats which are induced by streptozotocin. It has a efficient IC50 values that indicates its hypoglycemic activity Researchers have also used the red algae to make nanoparticle that can cure diabetics. Silver nanoparticles

that were synthesise zed using red marine alga Halymenia poryphyroides which was used as a capping agent and reducing agent. It has shown the good α-glucosidase inhibitor and α–amylase inhibitor . Thus red algae have good anti diabetic activity.

GENETIC STUDIES OF MARINE RED AGLAE

Red algae are the source of compound called bromophenol and this compound has various therapeutic effects like anti diabetic and anti microbial. But only few species were exposed by researcher. The Genetic study or genomic study of these red algae is still a question because only few important algae species have been analysed at its genomic level. Yoji Nakamura has made the genomic model of mariculture crop called Nori Pyropia yezoensis using next generation sequencing. He especially investigated the pigmentation property of the algae and found the homolog of phycobilisome-degradation gene that is responsible for the fading of the colour of the nori in aquaculture Researchers mostly concerned about sequencing the organelles of marine algae especially chloroplast and in marine red algae only Glockner et al had sequenced the chloroplast genome of Cyanidium caldarium Thus unique and unpredictable features of the marine red algae can be studied only if its genetic nature is fully revealed. Hence there is the lot of studies in genetic content of the marine algae species has to be done to understand and find out new genes and their function. There is lot of molecular biology tools available and these have to be used to sequence full genome of the algae and alga biologist has to move deeper to DNA level.

CONCLUSION

Even though there is a prolonged used of this marine red algae in many research there is no clinically sustained medicine or products based on red algae has been released. Researchers have to explore his all biotechnological applications that once again will give the medicine for all viral disease in the form of consumable food.

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