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MARINE DRUGS FROM SPONGES AND THEIR USES – A REVIEW

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ABSTRACT: The marine world is largely unexplored that harbors most of the biodiversity. In recent years, marine natural products have yielded a considerable number of drug candidates. Marine microorganisms, whose genetic and biochemical diversity became a rich source of novel chemical entities for the discovery of more effective drugs. Marine microbes specially marine sponges are playing a unique contribution for human health and well- being. In addition to the primary metabolites (amino acids, nucleotides and vitamins), they also contribute many secondary metabolites which constitute 50% of the pharmaceuticals. Drugs derived from the marine natural products are being developed for treating cancers, immune suppressive disorders and resistant microbial species. The need to augment production of these marine compounds to prepare various drugs through tissue culture and mariculture and their uses in human population has been stressed on this article.

Keywords: Marine Sponges, Pharmaceuticals, Microbes, Metabolites.

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INTRODUCTION: Man has taken advantage of nature's ability to produce remedies to treat infection, inflammation, pain, and many other diseases. The oceans are a rich source of both biological and chemical diversity. They cover more than 70% of the earth's surface and contain more than 200,000 described species [1]. The first living organisms appeared in the sea more than 3500 million years ago and evolutionary development has equipped many marine organisms with the appropriate mechanisms to survive in hostile and extreme conditions in terms of temperatures, salinity and pressure, as well as overcoming the effects of mutation, and pathogens [2, 3]. A relatively small number of marine organisms have already yielded thousands of novel chemical compounds [4].

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It is estimated that several species of marine microorganisms are yet to be discovered and described [5]. The history of using marine products for therapeutics began from the Chinese seaweed-based recipes for a number of disorders such as pain, abscesses, menstrual difficulties and cancer [6]. The marine sponges and other microorganisms has been a vast source of natural compounds covering a wide range of bioactivity such as photoprotective, antihelmintic, antibacterial, anticoagulant, antifungal, anti-inflammatory, antimalarial, antiprotozoal, antituberculosis, antiviral and other miscellaneous mechanisms of action [7, 8]. Sponges, belongs to the phylum Porifera and are among the oldest multicellular organisms and show relatively little differentiation and tissue coordination [9, 10].

Marine sponges are sessile invertebrates with a wide variety of colours, shapes, and consistencies. Sponges have strategies to defend themselves against foreign prokaryotic and eukaryotic organisms, by production of secondary metabolites that repel them [11, 12]. In fact, marine sponges are

among the richest sources of interesting chemicals produced by marine organisms.

Antibacterial Activity:

This resistance has rapidly spread, and the infections caused by *Staphylococcus aureus* and other resistant strains of pathogenic bacteria are currently a considerable problem. Even vancomycin, which was the last resource for the treatment of infections by methillicin-resistant *S. aureus* (MRSA), recently has been rendered ineffective [13]. Thus, the discovery and development of new antibiotics has become a high priority in biomedical research. Marine sponge crude extracts present a high incidence of antibacterial activity against terrestrial pathogenic bacteria [14, 15].

TABLE 1: ANTIBACTERIAL PROPERTY OF FEW MARINE SPONGES

Compound	Compound class	Species/order	Reference
Discodermins B, C, and D	Cyclic peptide	Discodermia kiiensis/ Lithistida	(16)
Topsentiasterol sulfates A–E	Sulfated sterol	Topsentia sp./Halichondrida	(17)
Arenosclerins A, B, and C	Alkylpiperidine Alkaloid	Arenosclera brasiliensis/ Haplosclerida	(18)
Axinellamines B–D	Imidazo-azoloimidazole Alkaloid	Axinella sp./Halichondrida	(19)

Antiinflammatory Compounds:

Acute inflammations in the human body can result from microbial infection, physical damage, or chemical agents [20]. The antiinflammatory sponge products are selective inhibitors of specific enzymes of a range of diseases, like psoriasis or rheumatic arthritis. The currently used nonsteroidal antiinflammatory drugs often fail to control the disease and present important side effects such as risk of gastrointestinal bleeding and renal complications [21].

TABLE 2: ANTI INFLAMMATORY PROPERTY OF FEW MARINE SPONGES

Compound	Compound class	Species/order	Reference
Manoalide	Cyclohexane sesterterpenoid	Luffariella variabilis/ Dictyoceratida	(22)
Dysidotronic acid	Drimane sesquiterpenoid	Dysidea sp./ Dendroceratida	(23)
Ircinin-1 and -2	Acyclic sesterterpenoid	Ircinia oros/ Dictyoceratida	(24)
Petrosaspongiolides M-R	Cheilantane sesterterpenoid	Petrosaspongia nigra/ Dictyoceratida	(25)
Spongidines A-D	Pyridinium alkaloid	Spongia sp./ Dictyoceratida	(26)
Topsentin	Bis-indole alkaloid	Topsentia genitrix/ Halichondrida	(27)

Antimalarial Compounds: Several sponge-derived antimalarial compounds have been discovered during the last decade. New antimalarial drugs are needed to cope with the increasing number of multidrug-resistant Plasmodium strains that cause malaria. Plasmodium falciparum has become resistant against chloroquinone, pyrimethamine, and sulfadoxine [28].

TABLE 3: ANTI MALARIAL PROPERTY OF FEW MARINE SPONGES

Compound	Compound class	Species/order	Reference
Axisonitrile-3	Sesquiterpenoid isocyanide	Acanthella klethra/ Halichondrida	(28)
Manzamine A	Manzamine alkaloid, diterpene isocyanates	Haplosclerida Cymbastela hooperi/ Halichondrida	(29)
Kalihinol A	Isonitril-containing kalihinane diterpenoid	Acanthella sp./ Halichondrida	(30)

Antiviral Compounds:

Sponges are also a rich source of compounds with antiviral properties. The high number of HIV-inhibiting compounds discovered does not reflect greater potential of sponges to fight AIDS

compared with other viral diseases, but rather the interest of many researchers. The strong focus on screening for anti-HIV activity has led to discovery of numerous compounds, but the mechanism of inhibition is still poorly characterized.

TABLE 4: ANTI VIRAL PROPERTY OF FEW MARINE SPONGES

Compound	Compound Class	Species/Order	Reference
Dragmacidin F	Indole alkaloid	Halicortex	(31)
Papuamides C and D	Cyclic peptide	Theonella mirabilis, T. swinhoei/Lithistida	(32)
Mololipids	Tyramine lipid	Verongida	(33)
Haplosamates A and B	Sulfamated steroid	Xestospongia	(34)
Hamigeran B	Phenolic macrolide	Hamigera tarangaensis/ Poecilosclerida	(35)

Immunosuppressive Compounds: In addition to their potential for treatment of cancer, nitric oxide synthetase inhibitors down regulate T-cells are, suppressing the immune system, and they diminish the fierceness of migraine attacks. Immune system suppression is desired in cases of hypersensitivity to certain antigens (e.g., allergies) or organ transplantations.

TABLE 5: IMMUNOSUPPRESSIVE PROPERTY OF FEW MARINE SPONGES

Compound	Compound Class	Species/Order	Reference
Simplexides	Glycolipid	Plakortis simplex/ Homosclerophorida	(36)
Polyoxygenated Sterols	Sterol	Dysidea sp./ Dendroceratida	(37)
Contignasterol	Oxygenated Sterol	Petrosia contignata/ Haplosclerida	(38)

Muscle Relaxants: Disturbances in neuromuscular communication resulting from stress cause permanent muscle activation.

TABLE 6: MUSCLE RELAXANT PROPERTY OF FEW MARINE SPONGES

Compound	Compound Class	Species/Order	Reference
1-Methylisoguanosine	Nucleoside analogue	Tedania digitata / Poecilosclerida	(39)
Xestospongin C	Macrocyclic bis-oxaquinolizidine	Haplosclerida	(40)

CONCLUSION: Sponge-microbial associations are found to be very specific in the production of particular bioactive compounds. However, the mutual mechanism between host and the microbial associate, in compound production is not well understood. The easiest and best way for commercial production of these compounds are either by culturing the host and/or the associated microbe under controlled conditions. But, the ability of the symbiont to produce the compound consistently for several generations in culture media has to be tested and standardized. Understanding the optimum ecological conditions which drives the sustainable production of bioactive compounds from sponges and their microbial associates would help in formulating various production strategies. Adopting different cultivation strategies and metagenomic approaches would be the need of the hour in discovering new genes, enzymes and natural products and in enhancing the commercial production of marine drugs.

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