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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 especially 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].

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A relatively small number of marine organisms have already yielded thousands of novel chemical compounds [4]. 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 several disorders such as pain, abscesses, menstrual difficulties, and cancer [6].

The marine sponges and other microorganisms have been a vast source of natural compounds covering a wide range of bioactivity such as photoprotective, antihelmintic, antibacterial, anti-coagulant, antifungal, anti-inflammatory, anti-malarial, anti-protozoal, anti-tuberculosis, 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 colors, shapes, and consistencies. Sponges have strategies to

defend themselves against foreign prokaryotic and eukaryotic organisms, by the production of secondary metabolites that repel them [11, 12]. 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 methicillin-resistant *S. aureus* (MRSA), recently has been rendered ineffective [13]. Thus, the discovery and development of new antibiotics have become a high priority in biomedical research. Marine sponge crude extracts present a high incidence of antibacterial activity against terrestrial pathogenic bacteria [14, 15].

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

TABLE 1: ANTIBACTERIAL PROPERTY OF FEW MARINE SPONGES

Compound	Compound class	Species/order	Reference
Discovering 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)

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)

Anti-malarial Compounds: Several sponge-derived anti-malarial 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 chloroquine, 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 the discovery of numerous compounds, but the mechanism of inhibition is still poorly characterized.

Immunosuppressive Compounds: In addition to their potential for the 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.

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

TABLE 4: ANTIVIRAL 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	Sulfamate steroid	Xestospongia	(34)
Hamigeran B	Phenolic macrolide	*Hamigera tarangaensis*/ Poecilosclerida	(35)

TABLE 5: IMMUNOSUPPRESSIVE PROPERTY OF FEW MARINE SPONGES

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

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 the associated microbe under controlled conditions. But, the ability of the symbiont to produce the mixture consistently for several generations in culture media has to be tested and standardized. Understanding the optimum ecological conditions which drive the sustainable production of bioactive compounds from sponges and their microbial associates would help in formulatin 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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REFERENCES:

1. Winston JE: The systematist' perspective. In: Biomedical importance of marine organisms. D.G. Fautin, editor, California Academy of Sciences, San Francisco 1988; 1-6.
2. Macdougall JD: A short history of Planet Earth; John Wiley Eds.: New York, 1996: 5.
3. Argulis L and Schwartz K: Five Kingdoms, an illustrated guide to the phyla of life on Earth; W.H. Freeman & Company: New York, 1982: 16-17.
4. Ireland CM, Copp BR, Foster MP, McDonald LA, Radisky DC and Swersey JC: Biomedical potential of marine natural products. In: Marine Biotechnology, Pharmaceutical and Bioactive Natural Products. Plenum Press, New York, Vol. 1, 1993: 1-43.
5. Malakoff D: Extinction on the high seas. Sciel~'ce 1997; 277: 486-488.
6. Ruggieri GD: Drugs from the sea. Science 1976; 194: 491-496.
7. Pallela R, Yoon NY and Kim SK: Anti-photoaging and photoprotective compounds derived from marine organisms. Mar Drugs 2010; 8: 1189-1202.
8. Mayer AM, Rodríguez AD, Berlinck RG and Hamann MT: Marine pharmacology in 2005–6: Marine compounds with anthelmintic, antibacterial, anticoagulant, antifungal, anti-inflammatory, antimalarial, antiprotozoal, anti-tuberculosis, and antiviral activities; affecting the cardiovascular, immune and nervous systems, and other miscellaneous mechanisms of action. Biochim Biophys Acta 2009; 1790: 283-308.
9. Bergquist PR: In Sponges. Hutchinson and Co. Ltd., London, UK, 1978: 268.
10. Simpson TL: In The cell biology of sponges. Springer-Verlag, New York, 1972: 662.
11. Sarma AS, Daum T and Müller WEG: Secondary metabolites from marine sponges-akademie gemeinnu¨tziger Wissenschaften zu Erfurt. Ullstein-Mosby Verlag, Berlin 1993: 168.
12. Proksch P: Toxicon 1994; 32: 639-655.

13. Rice LB: Am J Infect Control 2006; 34(5): S11-19.
14. Amade PH, Pesando D and Chevolot L: Oceanography and marine biology. An annual review. Mar Biol 1986; 70: 223-228.
15. Amade PG, Chariou G, Baby C and Vacelet J: Antibiotic-resistant bacteria inhibited by extracts and fractions from Brazilian marine sponges. Mar Biol 1987; 94: 271-275.
16. Matsunaga S, Fusetani N and Konosu S: Bioactive marine metabolites, VII: structures of discodermins B, C, and D, antimicrobial peptides from the marine sponge *Discodermia kiiensis*. Tetrahedron Letter 1985; 26: 855-856.
17. Fusetani N, Matsunaga S, Matsumoto H and Takebayashi Y: Cyclotheonamides, potent thrombin inhibitors, from a marine sponge *Theonella sp*. J Am Chem Soc 1990; 112: 7053-7054.
18. Torres YR, Berlinck RGS, Nascimento GGF, Fortier SC, Pessoa C and De Moraes MO: Antibacterial activity against resistant bacteria and cytotoxicity of four alkaloid toxins isolated from the marine sponge *Arenosclera brasiliensis*. Toxicon 2002; 40: 885-891.
19. Urban S, De Almeida Leone P, Carroll AR, Fechner GA, Smith J, Hooper JNA and Quinn RJ: Axinellamines A–D, novel imidazo-azole-imidazole alkaloids from the Australian marine sponge *Axinella sp*. J Org Chem 1999; 64: 731-735.
20. Tan P, Luscinskas FW and Homer-Vanniasinkam S: Cellular and molecular mechanisms of inflammation and thrombosis. Eur J Endovasc Surg 1997; 17: 373-389.
21. De Rosa S: 'Mediterranean marine organisms as a source of new potential drugs'. In: Natural Products in the New Millennium: Prospects and Industrial Applications, Rauter A, Palma FB, Justino J, Araujo ME, Santos SP, eds. (The Netherlands: Kluwer Academic Publishers) 2002; 441461.
22. Bennet CF, Mong S, Clark MA, Kruse LJ and Crooke ST: Differential effects of manoalide on secreted intracellular phospholipases. Biochem Pharmacol 1987; 36: 2079-2086.
23. Giannini C, Debitus C, Posadas I, Paya M and DAuria MV: Dysidotronic acid, a new and selective human phospholipase A2 inhibitor from the sponge *Dysidea sp*. Tetrahedron Lett 2000; 41: 3257-3260.
24. Cimino G, De Stefano S, Minale L and Fattorusso E: Ircinin 1 and 2, linear sesterterpenes from the marine sponge Ircinia oros. Tetrahedron 1972; 28: 333-341.
25. Randazzo A, Debitus C, Minale L, Pastor PG, Alcaraz MJ, Paya M, Gomez-Paloma L and Petrosaspongiolides MR: New potent and selective phospholipase A2 inhibitors from the New Caledonian marine sponge Petrosaspongia nigra. J Nat Prod 1988a; 61: 571-575.
26. Jacobs RS, Koehn FE and Gunasekera SP: Topsentin, a unique phospholipase A2 inhibitor [abstract]. Presented at the Japan-US Seminar on Bioorganic Marine Chemistry 1994.
27. De Carvalho, MS and Jacobs RS: Two-step inactivation of bee venom phospholipase A2 by scalaradial. Biochem Pharmacol 1991; 42: 1621-1626.
28. Angerhofer CK, Pezzuto JM, Konig GM, Wright AD and Stichter O: Antimalarial activity of sesquiterpenes from the marine sponge *Acanthella klethra*. J Nat Prod 1992; 55: 1787-1789.
29. Konig GM, Wright AD and Angerhofer CK: Novel potent antimalarial diterpene isocyanates, isothiocyanates, and isonitriles from the tropical marine sponge *Cymbastela hooperi*. J Org Chem. 1996; 61: 3259-3267.
30. Miyaoka H, Shimomura M, Kimura H, Yamada Y, Kim HS and Wataya Y: Antimalarial activity of kalahinol A and new relative diterpenoids from the *Okinawan sponge*, *Acanthella sp*. Tetrahedron 1998; 54: 13467-13474.
31. Cutignano A, Bifulco G, Bruno I, Casapullo A, Gomez-Paloma L, Riccio R and Dragmacidin F: A new antiviral bromoindole alkaloid from the Mediterranean sponge *Halicortex sp*. Tetrahedron 2000; 56: 3743-3748.
32. Ford PW, Gustafson KR, McKee TC, Shigematsu N, Maurizi LK, Pannell LK, Williams DE, De Silva ED, Lassota P, Alien TM, Van Soest R, Andersen RJ, Boyd MR and Papuamides AD: HIV-inhibitory and cytotoxic depsipeptides from the sponges *Theonella mirabilis* and *Theonella swinhoei* collected in Papua New Guinea. J Am Chem Soc 1999; 121: 5899-5909.
33. Ross SA, Weete JD, Schinazi RF, Wirtz SS, Tharnish P, Scheuer PJ and Hamann MT: Mololipids, a new series of anti-HIV bromotyramine-derived compounds from a sponge of the order Verongida. J Nat Prod. 2000; 63: 501-503.
34. Qureshi A and Faulkner DJ: Haplosamates A and B: new steroidal sulfamate esters from two haplosclerid sponges. Tetrahedron 1999; 55: 8323-8330.
35. Wellington KD, Cambie RC, Rutledge PS and Bergquist PR: Chemistry of sponges 19: Novel bioactive metabolites from Hamigera tarangaensis. J Nat Prod. 2000; 63: 79-85.
36. Costantino V, Fattorusso E, Mangoni A, Di Rosa M and Ianaro A: Glycolipids from sponges, VII: simplexides, novel immunosuppressive glycolipids from the Caribbean sponge *Plakortis simplex*. Bioorg Med Chem 1999; 9: 271-276.
37. de Leone PA, Redburn J, Hooper JNA and Quinn RJ: Polyoxygenated Dysidea sterols that inhibit the binding of [I125] IL-8 to the human recombinant IL-8 receptor type A. J Nat Prod 2000; 63: 694–697.
38. Takei M, Burgoyne DL and Andersen RJ. Effect of contignasterol on histamine release induced by anti-immunoglobulin E from rat peritoneal mast cells. J Pharm Sci. 1994; 83, 1234–1235
39. Quinn RJ, Gregson RP, Cook AF and Bartlett AF: Isolation and synthesis of 1-methylisoguanisine, a potent pharmacologically active constituent from the marine sponge Tedania digitata. Tetrahedron Lett 1980; 21: 567-568.
40. De Smet P, Parys JB, Callewaert G, Weidema AF, Hill E, De Smedt H, Erneux C, Sorrentino V, Missiaen L and Xestospongin C: It is an equally potent inhibitor of the inositol 1,4,5-triphosphate receptor and the endoplasmic-reticulum Ca^{2+} pumps. Cell Calcium 1999; 26: 9-13.

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