International Journal of Engineering Science Invention (IJESI)
ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726
www.ijesi.org ||Volume 7 Issue 2 Ver IV || February 2018 || PP. 01-09

Therapeutic Role of Bioactive Compounds from Non-Conventional Marine Sources: A Review

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ABSTRACT: *The marine ecosystem acts as a reservoir of bioactive compounds with immense use in treatment of many diseases hence acting as potent biopharmaceuticals. The natural as well as the synthetic modified form of these compounds serve as a reservoir of numerous therapeutic agents. Recent progress in drug discovery from marine sources has resulted in development of drugs capable of treating cancer along with various other disorders and diseases. Advancement in available technology has led to higher exploration of marine resource like sponges, corals, etc. and leading to their implication in biopharmaceutical markets. Starting from vital primary metabolites like vitamins, amino acids, etc., to secondary metabolites, these bioactive compounds play an immense role in life saving compounds development. Hence this review is focused on the bioactive compounds collection from sponges and other marine organisms finally leading to their role in cancer treatment as well as in many life threatening bacterial and viral infections.*

KEYWORDS: *Bioactive compounds, Biopharmaceuticals, Marine, Marine natural products, Sponges*

Date of Submission: 09-02-2018 Date of acceptance: 24-02-2018

I. Introduction

Marine ecosystem represents 95% of the biosphere and this vast marine ecosystem has been divided into coastal and open ocean habitats which provide humans with unparalleled potentially beneficial bioactive compounds used in medicine development. The first discovery in this field was by Bergman and Feeney in the year 1951. A Caribbean marine sponge named *Cryptotethya crypta* was the first marine organism from which bioactive compound was isolated and it was done by Bergman. This sparkled the interest in marine natural products [MNP]. Unusual arabino or ribo-pentosyl nucleoside obtained from this sponge was the first official report that MNP's are useful for human health and is a field for looking forward by the pharmaceutical companies as well as for the health research community.[1,2] A brilliant comparative data was published by Garson based on statistical data from the US National Cancer Institute (NCI) screening program provided by Dr. Peter Murphy. According to this report higher incidence of cytotoxic activity by marine invertebrates was observed and hence making them a preferred source.[3] Biopharmaceutical drugs structurally mimics compounds like enzymes, hormones, cytokines etc which are found within the body and are produced using biotechnological advancements. The MNP's have much fewer side effects because of high specificity. New therapeutic techniques and agents are improvised to make pharmaceutical products more effective against diseases. Nowadays many new biotechnological tools were used to improve biopharmaceutical products by upgrading vaccine developing processes and designing new chemically defined cells etc.[4] Even though the pharmaceutical market has evolved a lot due to advancement in high throughput instrumentations availability, still the demand for new upcoming drugs of marine origin is demanded. Many drug resistant infectious diseases are growing day by day and emergence of various upcoming disorders is giving motivation to the pharmaceutical industries to explore many bioactive compounds.

Biologically active chemical compounds like secondary metabolites are obtained from marine microorganisms as well as from marine flora and fauna. Marine ecosystem is very diverse but the limitation factor that the marine researchers/industry face is, the troublesome and laborious collection procedure of the marine organisms as well as their maintenance and preservation procedure. If the collection procedure is not done properly it can lead to damage of surrounding organisms and can affect the marine population as well as it can hinder the bioactive compound collection procedures also. Intensive ecological pressure and strong predators increase the potency of bioactive compounds from marine life. The collection of various marine

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bioactive chemical compounds from marine organism depends on metabolism of the predators and these compounds are used for human benefit.[5]

II. Objectives

90% of oceanic biomass consists of various kinds of marine flora and fauna such as different bacterial species, fungi, algae, various flowering plants, mangroves and many invertebrates like sponge, corals etc. Several new microbes and invertebrates situated in largely unexplored marine environment are also potent producer of bioactive secondary metabolites. They are taxonomically diverse, largely reproductive, biologically active and chemically unique. These vast marine sources will offer a great scope for discovery of new drugs.[6] A large number of biopharmaceutical compounds obtained from marine origin are under clinical trials and are pending approval. Lots of marine origin biopharmaceutical compounds have already reached the market. The compounds that are either already approved or under clinical trials pending approval are listed in the Table 1.

2.1 Benefits of using Marine natural compounds

Marine ecosystem supplies various kinds of compounds with potential biopharmaceutical uses. 70% of the planet is covered by ocean making this ecosystem a very dominant one. The main benefits of using marine natural compounds are that they are eco-friendly and have potentially less side effects than the non-natural drugs used. Since the marine ecosystem contains a huge variety of organisms hence the compounds these organisms produce have a huge diversity. MNP's have much higher chemical diversity as well as propensity regarding interaction with biological specimens in comparison with non-natural compounds. Marine derived bioactive compounds have properties like anti-proliferative, anti- tumor, anti-microbial, anti- fouling, anti-microtubule, etc. For example a compound named cytarabine which is obtained from *Cryptotethya crypta* is an approved compound used for cancer treatment. These qualities make them potentially useful in the field of pharmaceutics. Alongside the above reasons a prime factor is that the MNP's are less toxic to the human health and much cheaper than existing non-natural drugs hence making them a sustainable alternative with respect to human health and country's economy.

In the field of cosmetics the use of marine extracts is a much safer and healthier option. Replacement of non-natural compounds with marine natural compounds is on a rise due to the benefits of MNP's. Marine sources provide compounds with anti-aging properties along with anti-oxidant nature and ultraviolet protection. Vitamins and amino acids obtained from marine sources are also used for cosmetic purposes.[7,8]

III. Literature Review

In the ocean most beautiful creation is coral reefs. They not only provide shelter for a wide variety of marine life but also provide humans with creation. They are potential resource for various valuable medicines (http://marinebio.org/oceans/coral-reefs.asp). Coral ecosystems are referred as the medicine cabinet because of the creatures found there contains a huge resource of medicines and many useful compounds. The concept of marine bio prospecting is very new along with the fact that it is rapidly growing with the passage of years. According to recent reports the majority of marine compounds obtained have anti-cancer properties followed by anti-microbial properties hence emphasizing their utility in the current pharmaceutical industry. Recent advances in available technology like LC-NMR and the availability of suitable databases has led to an enhancement of novel drug hunt.[9]

For example from Japanese reef a chemical named Kainic acid was discovered which has the ability to diagnose fatal neuronal disease Huntington's chorea. Another example includes coral origin natural sun block "factor 50" sun cream which was developed by the Australian researchers. (http://coralreef.noaa.gov/aboutcorals/values/medicine/). A lot of drugs are under clinical trials as well as some are approved for human use and are available in market. Many other bioactive compounds collected from various marine organisms are listed on Table 2. Certain marine organisms are highlighted below to emphasize the importance of marine sources

.

3.1 Sponges

Classified under the phylum porifera they are relatively simple animals that originated with the first animal life in Precambrian times. There are between 9,000 and 15,000 species of sponges. Sponges generally reside in polar shelves as they have a unique ability to filter small food particles from passing water. (http://www.uaeinteract.com/uaeint_misc/teanh/017minv.pdf).

Sponges are well-studied group in terms of MNP source. They provide a high amount of bioactive compounds. Sponges are categorized under filter feeding animals because of their ability to filter bacteria from inhalant water current. The living tissues in combination with some antibiotic agents provide an enhanced microbial defense. The microbial growth control ability of sponge extracts has been demonstrated by use of simple laboratory experiments using bacterial cultures.[10] Bioactive compounds collected from sponges are listed on Table 3.[11]

3.1.1 Biopharmaceutical applications

Marine sponges belong to *Ircinia* genus are rich in terpenoids which has a potent pharmaceutical activity. Tetronic acid moiety obtained from terpenoids shows antibiotic activity as well as some terpenoids show analgesic activity along with antibiotic effects as seen in case of variabilins. Since marine sponges rich in various secondary metabolites, halogenated alkaloids are also primitively found in them. Bromoalkaloids are widely distributed halogenated alkaloids which has both antitumor and antimicrobial activity predominantly found in marine sponges. Marine sponges have potential therapeutic effects. The compounds of marine sponges have anti-inflammatory, anti fungal and anti cancer effect. The sponge *D.nigra* had antibacterial activity. A sponge named *Ircinia ramosa* showed properties like antiviral and CNS stimulatory. Carribean sponge named *Tethya crypta* provides marine drugs like spongothymidine and spongouridine. Deep-sea sponges play ecological roles similar to deep-sea corals. Marine sponges are well known sources of various chemical compounds and these compounds not only have significant biological activity but also have several therapeutic effects on human (http://www.britannica.com/EBchecked/topic/560783/sponges). For example *Petrosia* species produces poly acetylenenic alcholos along with petrocortyre A which are biologically active lipids. It has cytotoxic activity against human solid tumor cell liner. Aeroplysinin and aerthionin are bioactive compounds with antibiotic activity against B. subtilis. These above mentioned compounds are obtained from sponge named *Aplisina cavernicola*. Various marine sponges, especially those are containing organic fibre are used in daily household purposes of mankind for thousands of years.[5]

3.2 Crustaceans

Crustaceans have bilaterally symmetrical body and the exoskeleton is made up of hard chitin which is strengthened by calcification. For the growth of crustaceans the exoskeleton need to be molted repeatedly (http://www.uaeinteract.com/uaeint_misc/teanh/017minv.pdf).

Byproducts from marine bioprocessing plants include crustacean shells and shell-fish wastes. Shell wastes contain chitin which is a major structural compound and can be identified as a biologically active polysaccharide and thus valuable for many applications. Chitin containing shell wastes are available commercially and also utilized for the production of chitosan which is obtained by removing acetyl group from chitin. Chitosan and its oligomers acts as fat scavengers in the digestive tract and remove fat and cholesterol via excretion. They also help in reducing LDL-cholesterol level in liver and blood.

- Chitosan oligomers have both antitumor and ant metastatic effect against cancer likes carcinoma.
- Chitin and chitosan helps in wound healing by higher production of macrophages that release cytokines necessary for the healing process along with the ability to stimulate fibroblast production by affecting the fibroblast growth factor.
- Chitosan also used to treat Alzheimer's disease as it works as an inhibitor of β-secretase.
- Chitosan and chitosan oligomers behave as antioxidants by scavenging oxygen radicals.

IV. Technical Approach

4.1 Collection of sample

Intertidal species can be collected at low tides. Sub tidal shallow water species can be collected by scuba diving. In some cases like of sponges collection of specimen along with substratum is preferred in order to avoid destruction

of important features (http://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?article=1018&context=honors). Collection of species should be done very carefully so that specimens neighboring the sample of interest do not get harmed. Conservation of ecosystem should be always kept in mind. Intertidal species can be collected at low tides. Sub tidal shallow water species can be collected by scuba diving. In some cases like sponges, collection of specimen along with substratum is preferred in order to avoid destruction of important features. Mobile species are to be collected by nets. In case of species that grow slowly a part of the colony should be taken and the photograph of the entire colony can be taken for cross reference. In this way the entire colony does not get damaged. Individual bags should be used for collecting individual specimens. If the specimen collected is alive then it should be immediately transferred to an aquarium for live observation and photography. Specially in case of sponges knifes are to be used in order to collect the sponges from the substratum and it should be labelled on spot to avoid confusion as well as *in situ* photography should be taken.
(http://www.patagoniamarina.info/eng/Documents/Sampling%20and%20preservation.pdf)

4.2 Maintenance and preservation

After collection the marine samples should be maintained and preserved properly for further study. Preservation technique is different in case of sample kept for morphological study from sample kept for genetic analysis. Every technique has its own disadvantages and advantages. Like in case of corals they can be preserved as dry samples. Ethanol preservation is very effective for preserving samples supposed to undergo anatomical as well as genetic studies. 90-95% concentrated alcohols are used to preserved samples that are supposed to undergo genetic analysis but lesser concentration like 70% are used for anatomical study samples. For the sake of histological studies buffered formalin is also a valid option though this technique doesn't work for samples which are supposed to undergo genetic analysis. But as observed gluteraldehyde does fixation better than formalin hence a preferred fixative. Hydantoin is also used in place of formalin during certain cases. Other supportive techniques include freezing at -80°C for DNA preservation as well as techniques like using of liquid nitrogen for preservation as well as freeze drying are suitable options (http://clade.ansp.org/malacology/people/rosenberg/archiving/method/methods.html). Before preservation relaxants are used to reduce unnecessary suffering of higher developed organisms (http://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?article=1018&context=honors).

Table 4: List of preservatives and relaxants used for maintenance of marine sources

Phylum/Taxon	***Preservatives***	***Relaxant***	***Note***
Porifera/calcarea & Demospongiae	96% ETOH	NO	Preserve shortly after collection to avoid decomposition.
Arthropoda/ decapoda (crabs, shrimps, lobsters)	4%formalin; then transfer to 70%ETOH.	Clove oil better than menthol crystals.	Careful legs can fall off.
Cnidaria/ octocorallia (soft corals)	70%ETOH	Menthol crystals.	Only a piece of larger colony is enough when entire colony has been photographed.

4.3 Extraction

Bioactive compounds from sponge were extracted via use of Bakus and Green method. Extraction was done by use of methanol and distilled water as solvents. For extraction by using methanol the sponges need to be lyophilized first and then powdered form of sponges soaked in methanol for few hours. The amount of methanol was twenty times of weight of sponge. The solution was filtered using a Whatman Filter Paper No. 3. Filtered solution was dried using a vacuum oven and then refrigeration (4°C) was done (http://www.searchmesh.net/pdf/SWDorschel.pdf).

4.4 *Isolation*

A sponge sample was transported to Cal Poly where it was thawed and partitioned following the Kupchan Isolation Scheme. Sponge extracts can also be isolated via a combination of liquid-liquid extractions, adsorption silica-gel column chromatography and high-pressure liquid chromatography (HPLC). Isolation of bioactive compound containing bacteria from marine sponge was done by using the sponge sample after it was homogenated and serially diluted up to 10-6 dilutions and plated on the surface of Zobell marine agar.

4.5 Biochemical measurement of secondary metabolites (bioactive compounds)

The extracts were tested for the presence of bioactive compounds by using following standard methods.

4.5.1 Test for proteins

For protein isolation Millon's test and Ninhydrin test are performed by several researchers.

Millon's test: To test the presence of protein, crude extracts are used along with 2ml of Millon's reagent followed by gentle heating as long as white precipitate turns red.

Ninhydrin test: Another test was performed to identify the presence of amino acids and proteins. The crude extract was boiled with 2ml of 0.2% solution of Ninhydrin which will result in violet colour and mark the presence of protein.

4.5.2 Test for carbohydrates

Carbohydrate tests were performed to mark the presence of carbohydrates in bioactive compounds.

Fehling's test: 2ml mixture of Fehling A and B reagents are added to crude extract and slowly boiled. It was observed that a precipitate obtained towards the end of the tube had a colour resembling to brick red hence showing reducing sugars existence.

Benedict's test: Crude extract was mixed with 2ml of Benedict's reagent and boiled; a reddish brown precipitate formed which indicated the presence of the carbohydrates.

Molisch's test: 2ml of Molisch's reagent is added to the crude extract. After shaking properly 2ml of concentrated H_2SO_4 are added to the side of the test tube and a violet ring will appear between two reagents.

4.5.3 Test for phenols and tannins

A bluish-green or black colour will appear in response to the mixing of crude extracts with 2ml of 2% $FeCl_3$ solution and finally showing/indicating the presence of phenols and tannins.

4.5.4 Test for terpenoids

Crude extract are dissolved in 2ml of chloroform and waited to dry. To this, 2ml of concentrated H_2SO_4 are added and heated for about 2 minutes until a grayish colour appeared this indicates the presence of terpenoids.

4.5.5 Test for alkaloids

Crude extract are mixed with 2ml of 1% HCl and heated gently. Before adding Mayer's And Wagner's reagents crude extracts are first mixed with 2ml of 1% HCl are then a turbid precipitation will appear that indicates the presence of alkaloids.[12]

4.6 Instrument used for bioactive screening

- Ammonium sulphate precipitation and dialysis. Protein profile of partially purified compound via SDS-PAGE can be done with respect to method by Laemmli (1970).[13] In order to determine every fraction of the crude extract molecular weights have to be obtained by low-resolution mass spectrometry. Molecular weight results obtained are to be compared with the literature values of the compounds previously isolated, i.e. a comparison with previous data is done.
- Proton and carbon NMR spectra can also be done and the values obtained are again compared with the previously obtained values to obtain identification about the presence of known compounds. To confirm the presence or absence of previously discovered marine natural products mass spectra result of compounds are compared with corresponding ^{1}H and ^{13}C NMR.[14]
- The upcoming of improved techniques and instrumentations have made it much easier to characterize and identify compounds even with low molecular weights that are obtained from marine sources. Techniques like LC-MS/MS, LC-NMR and certain suitable databases for data mining have been a boon to this procedure (http://www.ncbi.nlm.nih.gov/pubmed/22910370).
- The Thin layer chromatography (TLC) analysis of the extract shows different glycolipid contents and patterns.
- High-Performance Liquid Affinity Chromatography (HPLC) / Reverse phase HPLC is based on bio specific interaction between the carbohydrate recognizing ligand and the complementary glycoconjugate. The result can be used for structure based purification strategies for the desired glycolipids. (http://www.hzg.de/imperia/md/content/gkss/institut_fuer_kuestenforschung/koc/poster/gkss_awi_0302_mbba_22.pdf).
- Identification of Bioactive Compound Present in Sponge by GC-MS Analysis: - WILEY and NIST databases are used to identify individual constituents of the extract by comparing with mass spectra and RRts (Relative Retention times) of published data MALDI- TOF / TOF-MS are also available for amino acid sequence analysis.[15]

V. Looking Forward

Successful drug supply and delivery are needed to be paid attention for the development of a proper pharmaceutical. Locating and characterizing priority areas which are suspected to contain deep-sea corals and sponges is important using appropriate survey technologies, including low-resolution, broad-scale surveys to identify potential targets and high-resolution surveys for creating detailed maps. Some recommendations include scientific understanding of marine biotechnology along with Commercialization and R&D funding (http://www.britannica.com/EBchecked/topic/560783/sponge).

The sea offers a rich source of biodiversity from which a series of potential drugs are obtainable. The lives saving drugs are mainly found abundantly in marine sponge. Nowadays several new metabolites with high commercial value produced by sponges and their symbionts are available in the market. Crustaceans also play important role in bioactive compound production. The isolation techniques shown above are hence helpful in developing potential purified bioactive compounds in the pharmaceutical industry for the development of drugs.

Acknowledgements

We sincerely thank all the authors of the reference materials used for this review purpose for their intensive work in the field of marine sciences. Finally we would like to thank our families for their encouragement and support.

Financial support and sponsorship: Nil.

References

[1]. Harshad Malve, Exploring the ocean for new drug developments: Marine pharmacology, *Journal of Pharmacy and Bioallide Sciences*,2016,Vol 8,Issue 2

[2]. Werner Bergmann, Robert j. Feeney. Contributions to the study of marine products. Xxxii. The nucleosides of sponges. I. *J. Org. Chem.*, 1951, *16* (6), pp 981–987

[3]. M.H.G. Munro et al., The discovery and development of marine compounds with pharmaceutical potential, *Journal of Biotechnology*, 1999, Vol.70,15-25

[4]. Sekhon B.S., Biopharmaceuticals: an overview, *Thai J. Pharm.* Sci. 2010,34, 1-19

[5]. Jirge S.S; Chaudhari Yogesh S., Marine: The Ultimate Source Of Bioactives And Drug Metabolites, *IJRAP*, 2010, 1 (1) 55-62

[6]. Boopathy N.S; K. Kathiseran., Anticancer Drugs from Marine Flora: An Overview, *journal of oncology*, 2010, vol 2010 ,article ID 214 186

[7]. Rushikesh Sable *et al*., Peptides, Peptidomimetics, and Polypeptides from Marine Sources: A Wealth of Natural Sources for Pharmaceutical Applications, *Marine Drugs*, 2017, 15, 124.

[8]. Ana Martins *et al*., Marketed Marine Natural Products in the Pharmaceutical and Cosmeceutical Industries: Tips for Success, *Marine Drugs*, 2014, 12, 1066-1101.

[9]. Ulrike Lindequist, Marine-Derived Pharmaceuticals – Challenges and Opportunities *Biomolecules & Therapeutics*, 2016, 24(6), 561-571.

[10]. Selvin J; Lipton AP., Biopotentials of secondary metabolites isolated from marine sponges, *Hydrobiologia*, 2004, *513*, 231-238

[11]. A.M.S. Mayer; Rodriguez A.D.;Berlinck, R.G.S; Hamann, M.T., Marine pharmacology in 2003–4, *Comparative Biochemistry and Physiology*, Part C 145, 2007, 553–581

[12]. Yadav RNS; Munin Agarwal, Phytochemical analysis of some medicinal plants, *Journal of Phytology*, 2011, 3(12),10-14

[13]. Brammavidhya. S.;Usharani. G., Bioactive Potential Of Sponge Associated *Bacillus Cereus* Sbs02 Isolated From *Hyattela cribriformis*, *International Journal of Research in Environmental Science and Technology*, 2013,,**3(2),** 61-64

[14]. Hutagalung R.A et al., Extraction and Characterization of Bioactive Compounds from Cultured and Natural Sponge, Haliclona molitba and Stylotella aurantium Origin of Indonesia, *International Journal of Bioscience, Biochemistry and Bioinformatics*, 2014, Vol. 4, No. 1

[15]. Johnson J.A. et al., Antimicrobial screening and identification of Bioactive compounds present in marine sponge Zygomycale sp. collected from Kanyakumari coast, *Journal of Chemical, Biological and Physical Sciences*, 2012, Vol. 2, No. 4, 1842-1848.

[16]. Long B.H. et al., *Cancer Research*, 1998, 58, 1111-1115

[17]. Jung J.H; Sim CJ., Bioactive compounds from the marine sponges Pachastrella sp and Jaspis sp. *J Toxicol Toxin Rev*; 1995, 14:138

[18]. Boobathy S. et al., Isolation of symbiotic bacteria and bioactive proteins from the marine sponge- *Callyspongia diffusa*, *Indian Journal of Biotechnology*, 2009, vol 8, 272-275

[19]. Rudi, A. et al., *Prod.* 2001, 64, 1451-1453.

[20]. Florence G.J. et al., *Nat Prod Rev*., 2007, 25, 342-375

INTERNET REFERENCES

- http://www.britannica.com/EBchecked/topic/560783/sponge
- http://marinebio.org/oceans/coral-reefs.asp
- http://coralreef.noaa.gov/aboutcorals/values/medicine/
- http://www.uaeinteract.com/uaeint_misc/teanh/017minv.pdf
- http://www.berr.gov.uk/files/file10469.pdf
- http://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?article=1018&context=honors
- http://www.searchmesh.net/pdf/SWDorschel.pdf
- http://www.ncbi.nlm.nih.gov/pubmed/22910370
- http://www.hzg.de/imperia/md/content/gkss/institut_fuer_kuestenforschung/koc/poster/gkss_awi_0302_mbba_22.pdf
- http://clade.ansp.org/malacology/people/rosenberg/archiving/method/methods.html
- http://www.patagoniamarina.info/eng/Documents/Sampling%20and%20preservation.pdf

Table 1: Marine derived therapeutic compounds

Name of organism	***Biopharmaceutical product obtained***	***Medicinal use***	***Clinical status***
Paranemertes peregrine	DMXBA	Alzhemier's disease, cognition	Phase II
Dolabella auricularia	Tasidotin	Cancer	Discontinued
Sponge	Dysidine	Diabetes	Preclinical
C. marmoreus	XEN-2174	Nervous system	Phase II
Cryptotethya crypta	Vidarabine	Antiviral	FDA approved
Bacteria	Arenamides A&B	Inflammation	Preclinical
Dolabella auricularia	ASG-5ME	Cancer	Phase I
Conus catus	Leconotide	Cancer	Phase I
Sponge	Callyspongidiol	Immunity	Preclinical
Petrosia contignata	IPL576092	Anti-asthmatic	Discontinued
E. turbinate	ET743	Antitumor agent	PhaseII/III
Conus geographus	Conotoxin G	Pain	Discontinued
Soft coral	Capnellene	Inflammation	Preclinical
Conus magus	Ziconotide	Neuropathic pain	Approved
Jornua funebris and Netropsia	PM-10450	Cancer(CC)	Phase II/I
Dolabella auricularia	SGN-75	Cancer	Phase I
Bacteria	Pulicatin A	Nervous system	Preclinical
Jaruna funebris	PM00104	Cancer	Phase II
Sponge	Calycullin A	Nervous system	Preclinical
Dolabella auricularia	Synthadotin	Cancer	Discontinued
Symploca sp	Brentuximab vedotin	Hodgekin's lymphoma	Phase 0
Elysia rufescens	Elisidepsin	Cancer	Discontinued
Sponge	Plakortin	Malaria	Preclinical
Dolabella auricularia	Soblidotin	Cancer	Discontinued
Aplidium albicans	Aplidine	Cancer	Phase III
Soft coral	G gyrosanols	Viral infection	Preclinical
Aspergillus sp.	Plinabulin	Cancer	Discontinued
Microbes	Tetrodotoxin	Cancer	Phase III
Agelas mauritianus	KRN-7000	Cancer	Discontinued
Alga	Floridosides	Inflammation	Preclinical
Pseudoptergorgia elisabethae	PseudopterosinS	Wound healing	Discontinued
Bryopsis pennata	Kahalalide F	Cancer (PC, MM, MSCLC)	Phase II
Eucheuma /Cnondus	Iota carrageenan	Antiviral	OTC(over the counter)
Ecteinascidia turbinata	Trabectedin	Cancer	EMEA approved
Aplysinella rhax	NVP-LAQ824	Cancer	Discontinued
Sponge	Homogentisic acid	Malaria	Preclinical
Dolabella auricularia	CDX-011	Cancer	Phase II
Aplidium albicans	Plilditepsin	cancer	Phase II/III
Bacterium lyngbyoic acid	Phenethylamine	Bacterial infection	Preclinical
Salinispora tropica	Marizomib	Multiple myeloma	Phase I
Streptomyces griseus	Cytarabine	Cancer (ML, NHL, ML)	Approved
Squalus acanthias	Squalamine	Cancer	Discontinued

Sponge	Hymenidin	Tuberculosis	Preclinical
Lithoplocamia lithistoides	PM-060184	Cancer(antimitotic)	Phase I
Bugula neritina	Bryostatin I	Cancer	Phase III
Hemiastrella minor	Hemiasterlin	Cancer	Discontinued
Halichodria okadai	Eribulin mesylate	Cancer	FDA/EMEA approved
Bacteria	Grassystatins A-C	Immunity	Preclinical
Spisula polynyma	Spisulosin	Cancer	Discontinued
Alga	Bromophycolides	Malaria	Preclinical
Discodermia dissouta	Discodermolide	Cancer	Discontinued
Ecteinascidia turbinata	Lurbenectidin	Cancer	Phase II
Sponge	Dysideamine	Nervous system	Preclinical
Halichodria okadai	E7389	Cancer	Discontinued

Table 2: Biopharmaceutical compounds from marine species

Organism	***Bioactive compound***	***Application***	***Reference***
Eleutherobia sp.	Eleutherobin	Cancer cell inhibitor.	16
Plakinastrella sp.	Peroxides	Brine shrimp cytotoxicity.	17
Clathria sp.	Clathsterol	Against HIV-1	16
Tetchya lincurum	Heolysin	Hemagglutination.	18
Suberites douncula	Suberitin	Hemolytic	18
Discodermia dissoluta	Discodermolide	Tumor cell growth inhibitor.	19
Ircinia fasciculote	Cephalostatin 1	Anticancer	20
Haliclona sp.	Manzamine A	Antimalarial	http://www.berr.gov.uk/files/file10469.pdf
Digenia simplex	α-Kainic acid	Antiparasitic	http://www.berr.gov.uk/files/file10469.pdf
Coral (Family Isididae)	Orthopedic implants	Bone grafting	http://www.berr.gov.uk/files/file10469.pdf

Table 3: Marine biopharmaceutical compounds from sponges

Compound	***Chemistry***	***Drug class***
Thiocyanatins	Polyketide	Anthelmintic
Dysinosin C	Peptide	Anticoagulant
Renieramycin A	Alkaloid	Antiprotozoal
Ingenamine G	Alkaloid	Antituberculosis
Dehydrofurodendin	Furanoterpene	Antiviral
Neamphamide A	Depsipeptide	Antiviral

International Journal of Engineering Science Invention (IJESI) is UGC approved Journal with Sl. No. 3822, Journal no. 43302.

Akash Bararia* ." Therapeutic Role of Bioactive Compounds from Non-Conventional Marine Sources: A Review" International Journal of Engineering Science Invention (IJESI), vol. 07, no. 02, 2018, pp. 01–09.