Marine Pharmacognosy: An Overview

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Abstract - Life began in primordial seas around 3.6 billion years ago and arthropods evolved during the Cambrian. In the early period and still today, they comprise the most diverse group of animals and also constitute the most species amongst animal groups. Marine monographs are very few when compare to herbal monographs. By considering this situation an attempt has been made to explore knowledge on marine pharmacognosy. This review includes marine sources, their morphological characters, catching techniques, extraction process, isolation techniques and their recent development in drug research.

Keywords: Marine Pharmacognosy, Secondary metabolites, Drug development, Natural products.

I. INTRODUCTION

Oceans cover nearly 70% of earth's surface and possess nearly three lakh deserted species of plants and animals from marine sources, representing 34-36 phyla and some of them are exclusively of the marine ecosystem. [1] It is reported that the first living organisms were appeared in the sea more than 3500 million years ago [2] and evolutionary development has equipped many marine organisms with the appropriate mechanisms to survive in a hostile milieu in terms of extreme temperatures, changes in salinity and pressure as well as overcome the effects of mutation, bacterial and viral pathogens. [3] Many marine drugs also been mentioned in Ayurvedic texts like Sankha (Conch), Pravala (Coral), Sukti (Pearl Oyester), Mukta (Pearl), Agnijara (Amber) etc.,[4] for various ailments.

Humans have been attempting to understand and use oceanic resources since ancient times. Ancient maritime people, notably the Chinese and Japanese, ate a variety of iodine rich seaweeds that undoubtedly accounted for their low incidence of goitre. Chinese Pharmacopoeia recommends recipes for a number of disorders such as pain, menstrual difficulties, abscesses and cancer. [5]

II. CLASSIFICATION OF MARINE SOURCES

Marine Pharmacognosy can be defined as the study of chemicals derived from marine organisms. [6] The classifications can be studied from the following fig. 2.1

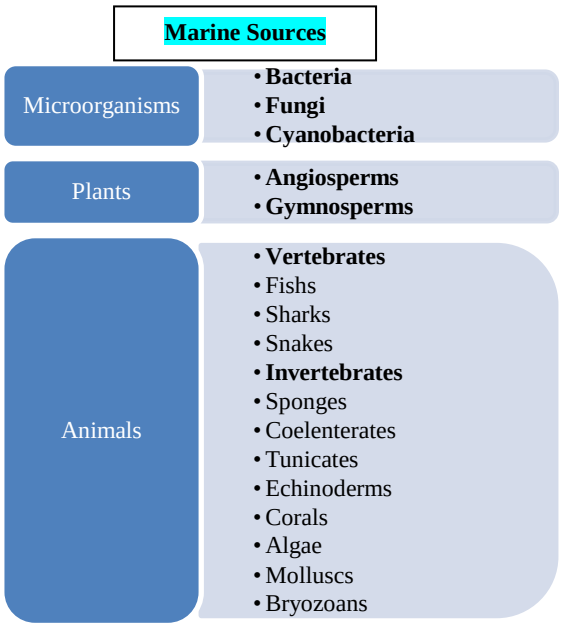


Fig 2.1 Classification of Marine Sources

III. SIGNIFICANCE OF MARINE SOURCES

Marine flora and fauna play significant role as a source of new molecular entity. The oceans of the world contain over 5 millions species in about 30 phyla. Because of the diversities of marine organisms and habitats. Marine natural products enclose a wide variety of chemical classes including

- Terpenes
- Shikimates
- Polyketides
- Acetogenins
- Peptides
- Alkaloids

of varying structure and a magnitude of compound of mixed bio-synthesis. Many of the marine compounds have shown promising biological properties that have complicated chemical structure of which could be hard to recognize it. [7]

IV. SCIENTIFIC DEVELOPMENT OF MARINE DRUGS IN MODERN TIMES

It has been known for centuries that sponges contain bioactive compounds that are of potential medical importance. Richter in 1907 outlined that the active component of the roasted bath sponge, used already by Roger against struma, is iodine. In the 19th and early 20th centuries, cod liver oil was in use as supplementary nourishment. However, only in middle of 20th century scientists began to systematically probe oceans for medicines.

By the early 1950's, Ross Nigrelli of the asborn laboratories of the New York aquarium, extracted a toxin from auvierian organs of the Bahamian Sea Cucumber, Actynopyga *agassizi*. He named this toxin as 'Holothurin' which showed some antitumor activity in mice. [8]

During the last 30-40 years numerous novel compounds have been isolated from marine organism having biological activities.

Researchers found that marine organisms have defensive chemical weapons (secondary metabolites) for their protection. These compounds help them to deter predators, keep competitors at bay or paralyze their prey. Investigations in their chemical ecology have revealed that the secondary metabolites not only play various roles in the metabolites of the producer but also in their strategies in the given environment. [9]

V. COLLECTION TECHNIQUES FOR MARINE DRUGS

- Beach Combing
- Wading
- Snorkeling
- Dredging
- Corers
- Scuba Diving
- Submersibles [6]

VI. DRYING TECHNIQUES

Drying should be done before extraction by lyophilisation or can be dried at certain temperatures to remove any excess water and debris. [6]

VII. ISOLATION TECHNIQUES AND BIOLOGICAL ASSAYS

- Extraction (Methanol, Chloroform, Ethanol, Acetonitrile, etc.,)
- Chromatographic Purification
- De replication (LC-MS, NMR)
- Structure elucidation (HR-MS, TMS, NMR, IR, UV-Vis, etc.,)
- Bio-assay testing (anticancer, antimicrobial, antiviral, anti-inflammatory, antiparasitic, anticholesterolemic, etc.,). [6]

VIII. CLASSICAL REVIEW

8.1. AGNIJARA (AMBERGRIS)

The jarayu (uterus) of an aquatic animal called agninakra, which lives in oceans, pushed out of the sea due to waves. This, when dried up in the sun is called agnijara, *Physeter catodon* the scientific name of sperm whale.

Agnijara is first mentioned in Rasarnava (5-6 AD) under the context of Abhraka druti (melting mica). Later works on rasa sastra quoted Agnijara especially for parada jarana. It is rasa Vagbhata (7-8 AD) who provided excellent information towards the identity of agnijara. He considered it as one of the sadharana rasa. It alleviates all the three doshas and relieves the diseases like dhanurvata(Tetanic convulsion) and vataroga(Neurological disease). [10]

8.2. VARATIKA (KAPARDIKA/COWRI)

It is an outer covering of an animal, who belongs to mollusca., which has yellow tinge, has nodules on the back and which is oval in shape. Kapardika can cure parinamasula (Duodenal ulcer), grahani (Malabsorption syndrome) and kshaya (Pthisis) [12] and enhances the digestive power. It is aphrodisiac and beneficial to eyes. [11]

8.3. MUKTA (PEARL)

Mukta enhances the complexion of the body and nourishes the vision as well as the digestive power. It has hridya (beneficial to heart) and medhya (Nootropic) [12] properties. It increases the virya (the strength of semen). [11]

8.4. PRAVALA (CORAL)

Pravala is the skeleton of an animal *Anthozoa polyps*. It eradicates kshaya, rakta pitta (bleeding disorder) and kasa (cough) [12] and it is good appetizer as well as digestive. It is easily digestable and wards off the effects of evil spirits. It is useful in eye diseases. [11]

IX. MORPHOLOGICAL REVIEW

9.1. SPONGES:

Sponges occur as a light lump of porous nature and they are yellowish brown, soft, elastic and irregularly shaped. When fresh, they are covered with a gelatinous substance that must be removed to prevent putrefaction. [13]

9.2. CORALS:

Corals are of varied types and are exclusively marine. Two types are commonly in medicine. One is a porous lumpy variety and the other is a slender precious variety. Both are red in colour due to a pigment. [13]

9.3. CRUSTACEANS:

Crustaceans like mud crabs can be identified by their colour of upper surface of body dark greenish brown to black. Their sexual identity can be identified as males have slender and triangular shaped abdominal flap,while female have semicircular shaped flap. Adults may weigh 700gm. Peak breeding season varies place to place September-February, June-July and November-February. [14]

9.4. EDIBLE OYSTER:

Ostrea gryphoides (*Saccostrea gryphoides* Schl.) is a shell fish found in the Atlantic and Indian Ocean coasts. It has a small, hollow, ovate excavation in which the animal with a soft, fleshy suborbicular body is enclosed. The shell has a hinge at one end and opens into two valves; one shallow and the other deep, which is found adhering to the rock. The shell is hard, externally grey or dark-brown, rough and marked with lateral undulated streaks; internally it is white, smooth and shining. [13]

X. MICROSCOPICAL REVIEW

Sponge tissues are extremely rich in bacteria that can comprise up to 40% of their biomass. Photomicrographs of a thin section of sponge tissue were observed with O-boluidine showed composition of cells types of cyanobacteria. Likewise the trichore structure of the filamentous marine cyanobacterium Lynbya majuscule-3lL was observed and orange colour filament tip of cyanobacterial phycoerythrin and filament sheath associated bacterial DNA (blue) was observed. [14]

XI. PHARMACOLOGICAL REVIEW

11.1. Algae (Cavlerpa genus) [15]

C. mexicana and *C. sertularioides* (fresh)

↓

Collection (Coastal region of Bessa, Brazil)

↓

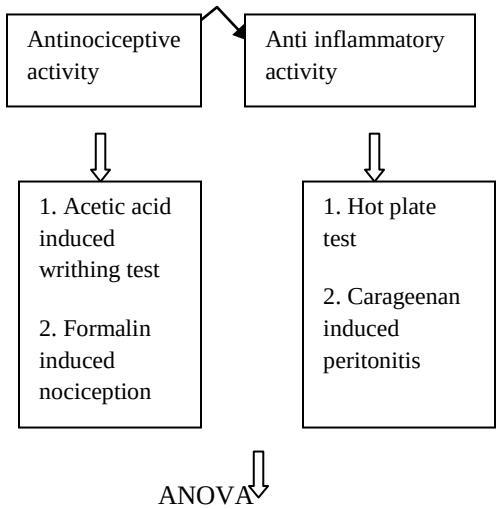
Authentication (Federal University of Paraiba, Brazil)

Lyophilized ↓

Extraction (hexane, chloroform, ethyl acetate, methanol and water) → given orally.

↓

Animals (male and female swiss mice) 20-28 g.



Mechanism of action?

11.2. Marine invertebrate [16]

Polyclinum madrasensis sebestian

↓

Collection (Gulf of Mannar) by SCUBA divers (2-5 m depth)

↓

Narcotized (menthol crystals)

↓

Storage in 5% formalin solution

↓

Authentication (Tuticorin)

Dried at 50^0C ↓

Pulverized into 40 mesh size

↓

Extraction (Pet ether → hexane → methanol) each 200 ml for 24 h

↓

Evaporated to dryness

↓

Strains (*E. coli*, *K. pneumonia*, *S. aureus*, *S. pneumonia*, *P. vulgaris*, *P. aeriginosa*, *S. typhi*, *S. dysentrica*)

↓

Antimicrobial activity (MIC/MBC)

11.3. Fish [17]

Bioactive peptides isolated from various fish protein hydrolytes have shown a numerous bioactivities such as antihypertensive, antithrombic, immunomodulatory and antioxidative activities. And also possess anticoagulant and antiplatelet properties.

11.4. Sea Anemone (Cnidarians) [18]

Stichodactyla mertensii & *S. gigantean*

↓

Collection (Mandapam, Southeast Coast of India)

↓

Male albino mice (20±2g)

↓

Methanolic extract | Aqueous extract

⇩

Haemolytic and Analgesic activity; CNS depression and Anti inflammatory activity

XII. TOXICOLOGICAL REVIEW [18]

12.1. *S. mertensii* & *S. gigantea*

↓

Methanolic extract & Aqueous extract

↓

Ocypode macrocera (Sea Shore Crabs) (20±30 g weight)

↓

Third walking leg

↓

LD 50 (at 1 mg/ml)

12.2. *S. mertensii* & *S. gigantea*

↓

Methanolic extract & Aqueous extract

↓

Male albino mice (20±2g)

↓

LD50 (at 0.75 ml in 2 min & 10 sec)

XIII. DEFINED AND UNDEFINED MECHANISM OF ACTION [19]

Alejandro et. al. Reviewed compounds of the antitumour and cytotoxic properties of 136 marine natural products. The defined and undefined mechanisms of action of novel compounds are depicted in the following table 13.1.

Defined mechanism of action	
Aaptamine	Clavulone II
Agosterol A	Cryptophycin 52
Aplyronine A	Dictyostatin 1
Bastadin 6	Dideoxypetrasynol A
Bistramide A	Dolastatin
Bryostatin 1	Geoditin A
Cephalostatin 1	Jaspamide
Undefined mechanism of action	
Actinomycete dihydroquinone	Demethylinusterol A4
Amphidinolide B4	Dysidea Sesquiterpene quinone
Amphimedoside D	Dysidea sesquiterpene hydroquinone
Belamide A	Fuscocinenoside C
Biselide A	Globostelletin
Blumblide C	Gymnastatin F
Clavularia diterpene	Haliclona sterol
Clavularia diterpene	Haterumaimide Q

XIV. SELECTED EXAMPLE OF MARINE NATURAL PRODUCTS [20]

S. No.	Source	Product	Application Area	Status
1.	Marine Sponge	Ara-A	Anti viral	Market
2.	Marine Sponge	Ara-C	Anticancer	Market
3.	Marine Fungi	Cephalo sporins	Antibiotic	Market
4.	Cone Snail	Conotox ins	Chronic Pain	Phase I/II/III
5.	Nemertine Worm	GTS 21	Alzeimer's disease	Phase I/II
6.	Sponge	LAF 389	Cancer	Phase I
7.	Bryozoan	Bryostat in 1	Cancer	Phase II
8.	Sea Squirt	Yondeli s^{Tm}	Cancer	Phase II/III
9.	Sea Slug	Dolastat in 10	Cancer	Phase II
10.	Sea Slug	IIX 651	Cancer	Phase I
11.	Sea Slug	Cemado tin	Cancer	Phase II
12.	Sponge	Dixoder molide	Cancer	Phase I

13.	Sponge	HT 1286	Cancer	Phase I
14.	Sea Squirt	Aplidi Tm	Cancer	Phase II
15.	Shark	Squala mine lactate	Cancer	Phase II
16.	Sponge	IPL 512602 (Steroid)	Inflammati on, Asthma	Phase II

XV. CONCLUSION

Although many research has been done on marine organisms, still not yet familiar among the herbal drugs or herbal mineral drugs. So this review may help the researchers to find a path in drug development. More focus is needed to improve the utilization of marine organisms in pharmaceutical field.

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