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Study of Marine Organisms in Pharmaceuticals

Rutuja S. Rokade
Suchita S. Gadekar
[1]Student , Pratibhatai Pawar College Of Pharmacy, Shrirampur, Maharashtra, India
[2]Assistant Professor, Pratibhatai Pawar College Of Pharmacy, Shrirampur, Maharashtra, India

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ABSTRACTS
For the development of novel medications to combat serious illnesses, the marine environment offers countless and diverse resources. The diverse aquatic plants and animals that make up this exceptional ecological resource include some that have been documented and others that are still unidentified. Organisms are still in the trial stage and are known to have hidden therapeutic potential. Their antimicrobial, antiviral, anti-inflammatory, anticancer, antifungal, anti-obesity, and immunoprotective properties are well recognized. It is also known that some non-commercial marine organisms have therapeutic qualities,that are employed in the pharmaceutical sector. According to reports on their nutrient profile, fish are excellent providers of nutrients and offer a plethora of health advantages.

Key Words: Marine Organisms, Seafood, Anti-inflammatory, Anticancer, Antimicrobial, Drugs.

I. INTRODUCTION

A subfield of pharmacognosy called "marine pharmacognosy" is primarily focused on naturally occurring compounds with therapeutic value found in marine environments. Typically, marine species of bacteria, viruses, algae, fungi, and sponges are the source of pharmaceuticals.

Marine organisms are extremely varied and include a wide range of species from the tree of life. The following list of marine organisms includes broad categories of these organisms:

- Plankton
- Plants and Algae
- Invertebrates
- Fish
- Mammals
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1.1 Marine Source

- Bioactive compounds come from marine organisms like sea slugs, sponges, tunicates, fish, soft corals, nudibranchs, sea hares, and opisthobranch Molluscs—as well as from marine microorganisms.

1.1.1. Antibacterial

- Isolated from a diatom of marine origin, Phaeodactylum tricornutum, eicosapentaenoic acid is a polyunsaturated fatty acid that has demonstrated activity against a variety of Gram-positive and Gram-negative bacteria, including a multidrug-resistant strain of the aureus staphylococcus.

1.1.2. Anti-inflammatory

- In an in vivo study using a rat model of carrageenan-induced paw edema, the anti-inflammatory properties of extracts and other parts of the Mediterranean sponge species Spongia officinalis were investigated.

1.1.3. Neuroprotective

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- By blocking acetyl-and butyryl-cholinesterase, extracts from the South Indian green seaweed Ulva reticulata have demonstrated neuroprotection with an efficacy on par with drugs that are currently licensed to treat Alzheimer's disease.

1.1.4. Antiparasitic

- Tunisian sponge extracts (Sarcotragus sp.) prepared in dichloromethane have shown in-vitro anti-leishmanial activity by exhibiting the corresponding morphological changes in leishmania major promastigotes.

1.1.5. Antiviral Agents

- It has been reported that high molecular weight exopolysaccharides taken from the French marine sponge Celtodoryx girardae and the symbiotic bacteria that live there have anti-herpes simplex virus-1 (HSV) activity.

1.1.6. Anticancer

- Bryostatin is mainly derived from the bryozoan Bugula neritina, though it has also been extracted in certain forms from tunicates and sponges.
- The alkaloids sorbicillactone A and B, which are derived from sorbicillin, have demonstrated efficacy against leukemia cells devoid of any significant cytotoxicity.

1.1.7. Analgesic

- In 2004, the U.S. Food and Drug Administration (USFDA) approved ziconotate as the first medication derived from marine sources for the treatment of pain.
- It was initially isolated from the marine snail Conus magus and goes by the name Prialt.

1.1.8. Antimicrobial

- The antimicrobial agents known as cephalosporins have their origins in the marine environment.

Biological Availability of marine organism

Many different types of living things with diverse physiologies and environmental adaptation skill can be found in the ocean. Around 13,000 molecules have been reported from the marine environment, providing ample opportunity to discover new marine products. Three thousand molecules occupy the active areas. It is home to about 80% of the diverse plant and animal species. This genetic diversity manifests medicinal qualities, which leads to the development of a promising new drug from marine organisms that are biologically accessible.

1.1.9. Plankton: Any organisms that are carried by the flow of water throughout their surroundings are considered plankton. Since most plankton are so tiny, they are invisible to the human eye. Some are fairly big, like jellyfish.

Neuston: Dwells at the interface of air and water. Seabirds, insects, and Portuguese man-o'-war are a few examples.

Plankton: Anywhere between the surface and the group is home to plankton. Examples include salps, fish eggs, jellyfish, krill, and the larval stages of octopuses and crabs.

Nekton: Because of their strength and ability to swim freely, nematodes can elude currents. Squids, whales, and mature fish are a few examples.

Benthos: Benthos inhabit the riverbed or the ocean floor. The majority of plants, kelp, adult crustaceans, and adult echinoderms like starfish are a few examples.

1.1.10. Plankton Importance

The health of the planet and the preservation of ecosystems depend heavily on plankton. They sustain biodiversity, act as the cornerstone of aquatic food webs, and make major contributions to global biogeochemical cycles.

A. Role in the food chain

- Plankton, specifically phytoplankton, serves as the foundation for both freshwater and marine food chains.
- As primary producers, they provide vital nutrients to a variety of freshwater and marine species while also converting sunlight into energy through photosynthesis.

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B. Carbon Cycle

- Due to their ability to sequester carbon dioxide (CO2) from the atmosphere during photosynthesis, phytoplankton are essential to the global carbon cycle.
- Following their death, plankton sink to the ocean floor, where some of the carbon they contain is retained in sediments eliminating it from the air.

C. Oxygen Cycle

- Phytoplankton, being photosynthetic organisms, generate oxygen (O2) as a consequence of photosynthesis.
- The atmosphere and aquatic habitats both have their oxygen levels maintained by this process.

D. Nutrient Recycling

- In aquatic ecosystems, plankton play a major role in the cycling of nutrients.
- Plankton replenish the water with vital nutrients like iron, phosphorus, and nitrogen as they decay and die.

1.1.11. Medicinal Use

- Proteins, omega-3 fatty acids, B vitamins, trace minerals, antioxidants, and amino acids are abundant in phytoplankton.
- Benefits include mood enhancement and bodily detoxification.

1.2.3. Plants and Algae

In neritic and intertidal habitats, plants and algae are more prevalent in marine environments. Plants cannot survive in many parts of the ocean. This is due to the fact that sunlight cannot reach the majority of the region that makes up marine environments.

A. Plants

In the marine biome, plants can range in size from tiny single-celled creatures to massive, intricate forms. Naturally, marine plants grow close to the water's surface in order to capture sunlight for photosynthesis. Additionally, they gather nutrients from particles that currents carry up from the seafloor. A few plants flourish in the ocean's depths, where sunlight is absent.

B. Algae

Algae are photosynthetic organisms of the kingdom Protista that are primarily found in water. Algae come in a variety of sizes and forms, ranging from microscopic Micromonas species to enormous kelps that can grow up to 60 meters (200 feet) in length. Their cells have characteristics not seen in plants or animals, and their photosynthetic pigments are more diverse than those of plants.Algae have significant ecological functions as oxygen producers and the primary food source for nearly all aquatic life.

1.2.3. Invertebrates

- Organisms without backbones are known as invertebrates. Marine invertebrates come in a wide variety of forms.

As examples, consider: Crustaceans: lobsters, shrimp, and crabs
Mollusks: (octopi, oysters, scallops, squid, clams, and snails)
Cnidarians: jellyfish and sea squirts
Anemones and corals
Fish and Urchins and Starfish

1.2.3.1.Medicinal Benefits

- Marine invertebrates have yielded medicinal benefits and a substantial number of marine natural products (MNPs). Eating seafood made from edible marine invertebrates, like mollusks and crustaceans, has been connected to a number of health benefits that can enhance human wellness.
- The majority of species and applications of medicinal invertebrates were found in insects. Specifically, their diuretic, anaesthetic, antioxidant, anti-inflammatory, anti-rheumatic, immunomodulatory, analgesic, antiviral, antibacterial, anti-cancer, etc.

II. MARINE DRUGS

2.1 Cytarabine (cytosine arabinoside or arabinosyl cytosine, ara-C):

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The synthetic pyrimidine nucleoside cytarabine is derived from spongothymidine and was mainly isolated from Tethya crypta, a species of sponge found in the Caribbean. It is FDA-approved and primarily used for acute myelocytic leukemia, lymphocytic leukemia, and other types of leukemia.Meningeal leukemia and the chronic myelogenous leukemia blast crisis phase.

Route of Administration:A sterile solution of 100 mg of cytarabine injection per 5 mL is intended for subcutaneous, intrathecal, or intravenous administration.

Mechanism of Action

- Cytarabine directly damages and incorporates into DNA to produce its effects. Many different types of proliferating mammalian cells in culture are cytotoxic to cytarabine.
- It has cell phase selectivity, mostly destroying cells that are in the S-phase, or the process of synthesising DNA, and under specific circumstances preventing cells from entering the S-phase after entering the G1 phase.
- It seems that cytarabine functions by inhibiting DNA polymerase, albeit the exact mode of action is still unknown.
- A small but noteworthy addition of cytarabine to both has also been reported on DNA and RNA.

Uses: Meningeal Leukemia.

2.2 Tetrodotoxin

A well-known "marine toxin" and guanidine derivative with high substitution. Currently undergoing Phase III trials as an analgesic for cancer-related pain that is not well controlled, it is not an antitumor agent. To determine whether tetrodotoxin is effective in treating neuropathic pain associated with chemotherapy-induced peripheral neuropathy, a Phase II trial is currently being conducted.

Route Of Administration: Intravenous

Mechanism of Action

- At the extracellular pore opening, site 1 of the fast voltage-gated sodium channel is bound by trimetodotoxin.
- Any molecules that bind to this site will cause the ion channel to become temporarily inoperable.
- Along with several other conotoxins, Saxitoxin bind to the same location

Uses: Used In cancer treatment, Opiod.

2.3 Plitidepsin

Currently produced by total synthesis, it is a naturally occurring marine depsipeptide. It was mostly isolated from Aplidium albicans, a tunicate that lives in the Mediterranean Sea. Plitidepsin has a low nanomolar (nM) range of IC50 values and is a very powerful apoptosis inducer. The primary toxicity discovered with muscle toxicity, an increase in transaminases, general fatigue, diarrhea, and cutaneous rash were the most common schedules of plitidepsin.

Route Of Administration: Infusion

Mechanism of Action

- Because plitidepsin can both cause apoptosis and inhibit cell growth, it exhibits antineoplastic activity.
- The main target of plitidepsin within cells is eukaryotic elongation factor 1A2 (eEF1A2).
- Additionally, it stops MOLT-4 cells from growing and causes them to undergo apoptosis by stopping VEGF secretion, which prevents the autocrine loop between VEGF and VEGFR-1, which is necessary for MOLT-4 cell growth.

Uses

- Plitidepsin demonstrates immunosuppressive, antiviral, and antitumor properties.
- It has the potential to reduce tumors in cancers of the pancreas, stomach, bladder, and prostate.
- The human protein eEF1A is inhibited by plitidepsin and may interact with various coronaviruses proteins.

2.4 Trabectedin

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A marine natural product made from the tunicate Ecteinascidia turbinata species, which is primarily found in the Mediterranean and Caribbean Seas. The alkaloid molecule known as trametin. Tetrahydroisoquinoline class, and it was the first anticancer molecule of marine origin to receive EU approval for use in treating relapsed cases of platinum-sensitive ovarian cancer and soft-tissue sarcoma.

Route Of Administration: Peripheral Venous Line.

Mechanism of Action

- Guanine at the N2 position is alkylated by tramectedin through interaction with the minor groove of DNA, causing it to bend in the direction of the major groove.
- This is how it is believed that the medication influences different transcription factors connected to cell proliferation, especially through the transcription-coupled nucleotide removal and repair mechanism.

Uses

- Liposarcoma is a rare kind of cancer that develops in the body's fatty tissues and is treated with trasectedin.
- Leiomyosarcoma is an uncommon, quickly spreading cancer that affects the fat, muscle, bone, joints, and blood vessels in the body.
- Trabectedin is also used to treat cancer.

2.5 Ziconotide

Ziconotide is a synthetic molecule that is similar to v-conotoxin MVIIA, a naturally occurring 25-amino acid peptide. It was first isolated and refined from the venom of the fish-hunting marine snail species C. magus. As an analgesic, ziconotate has demonstrated promise with a unique mechanism of action. The FDA has given it approval as an analgesic.

Route Of Administration: intrathecal route

Mechansim Of Action

- Synthetic ziconomide is a peptide that is extracted from the venom of the marine snail Conus magus.
- It is a polybasic peptide with 25 amino acids, specifically.
- In the dorsal horn of the spinal cord, ziconotine inhibits N-type voltage-gated calcium channels present in the A-delta and C afferent pain fibers cord.

Uses

For patients with severe chronic pain who are unable to tolerate or who have not responded well to other treatments like intrathecal morphine and systemic analgesics, ziconide is an N-type calcium channel antagonist.

III. SOME MARINE ORGANISM USED IN MEDICINAL BENEFITS

3.1Finfish

- Fish plays a significant role in human nutrition. Fish is low in carbohydrates and high in proteins, lipids, minerals, and vitamins. It also contains other nitrogenous compounds. It is a great source of medication that aids in the treatment of many illnesses.
- The essential amino acids are present in fish proteins in the necessary ratio and enhance the mixed diet's total protein quality.

3.1.1. Mode of action of fatty acids found in finfish

- The function of the cell receptors in membranes is influenced by omega-3 fatty acids, which are an integral component of cell membranes.
- Nutritionists strongly advise it because it is one of the main factors lowering the risk of cardiovascular illnesses.
- They aid in controlling the hormone, coagulation of blood, arterial wall relaxation, etc.
- They attach themselves to cell receptors that control genetic function.

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3.2 Shellfish

- Shellfish plays a significant role in the aquatic food chain that feeds the world. The majority of its constituents are mollusks and crustaceans.
- It has also made a substantial contribution to the marine resources' ability to offer humans significant medical opportunities.
- They are high in protein and omega-3 fatty acids and low in calories. Together with magnesium, zinc, and iron, they are also rich in micronutrients along with vitamin B12.

3.2.1. Medicinal Use Of Shellfish

- Zinc is abundant in shellfish and can help strengthen the immune system. Eating shellfish on a regular basis can help boost immunity and zinc levels.
- Elevated blood levels have been associated with vitamin B12. Consequently, eating foods high in vitamin B12 contributes to heart disease prevention. It helps to improve brain development as well.
- Because of their high protein content, shellfish may be a good idea to supplement with high-qualitynutrition.
- Inadequate consumption of crustaceans can regulate disorders related to collagen and other proteins.

3.3. Seaweeds

- Seaweed is a well-known complex food that contains important food hydrocolloids such as carrageenan, agar, and alginates. The marine algae are referred to as seaweeds or marine macroalgae. They can grow in 180-meter-deep deep sea waters as well as shallow coastal waterbodies.
- The greenery is divided into three primary groups: green algae (Chlorophyceae), red algae (Rhodophyceae), and brown algae (Phaeophyceae).
- The marine algae has a large amount of sulfated polysaccharides in addition to a variety of biological and biomedical activities.

3.3.1 Medicinal use of seaweeds

A. Antioxidants

- Antioxidants can shield human health from ROS damage and reduce the amount of macromolecules that can lead to diseases like diabetes, cancer, and neurodegenerative illnesses, such as proteins, lipids, and DNA.
- Bioactive peptides derived from seaweed that have by using electron spin resonance to detect the radical scavenging activity, antioxidant properties have been regulated.

B. Anticoagulant Activity

- Blood coagulation stops blood flow in the damaged vessel wall during abnormal vascular conditions, exposing non-endothelial surfaces where vascular injury has occurred.
- Blood coagulation is controlled by coagulation factors.

C. Anticancer Activity

- Several chemicals that have been identified from seaweeds have been shown to slow the development of cancer.
- Seaweeds' bioactive substances have the ability to induce apoptosis in cancerous cells.

3.4 Coral Reef

- Known as the "jewels of the sea," coral reefs. In addition to being a haven for marine life, it also possesses excellent medicinal qualities.
- According to Poo (2018), corals are a valuable resource for treating a variety of illnesses, including cancer, bacterial infections, heart disease, arthritis, and
- Alzheimer's disease. different corals contains a variety of bioactive compounds that are extremely beneficial to health.

3.5 Cephalopods

3.5.1 Octopus

- The octopus, sometimes referred to as the "chameleon of the sea," is a good source of iron, omega-3, selenium, copper, vitamin B12, potassium, magnesium, and calcium.
- It also has multiple hearts and a brain.

3.5.2 Squids

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- Squids are common marine animals that belong to the phylum Mollusca and are classified as cephalopods.
- In addition to being a good source of calcium, iron, and vitamin C, it also has a high protein content that makes it a valuable export.

Medicinal Properties Of Cephalopods

- The Indian squid (L. duvauceli) is known for its antimicrobial properties. Other squid species that have antioxidant qualities include O. bartrami, which also has anti-cancer properties.
- Spendid squid (L. formosana) is another species that has antioxidant properties.
- Helpful is squid ink as a possible anti-hypertensive and aids in lowering blood pressure.

3.6. Jellyfish

- Belonging to the phylum Cinidaria, jellyfish are bioluminescent, transparent, or produce vivid colors like pink, blue, or yellow.
- Jellyfish lack most organs, including the brain, heart, eyes, and bones, and their body is primarily composed of water.
- Their physique is managed through the nervous system.

Medicinal Use Of Jellyfish

- The calcium-binding protein found in jellyfish is thought to be beneficial to human brain health and helps to maintain healthy cells.
- It is low in calories and high in carbohydrates, which aids in weight loss. It is beneficial for lowering high blood pressure.

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