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Health Promoting Effects of Marine Molluscs: An Overview

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Abstract: Marine molluscs are rich in vital nutrients and active secondary metabolites as well as have the ability to enhance immune response. Many species of mollusca were used in traditional medication in different parts of the world. Many marine molluscs exhibit antibacterial, antibiotic, anticancer, anti-Inflammatory, antimicrobial, anti-leukemic, and antioxidant activities and are rich source of bioactive compounds. Extract of shells, whole body or some specific organs have been used for treatment of many ailments such as dyspepsia, digestive impairment, malabsorption syndrome, enlargement of liver hepatomegaly, duodenal ulcer, jaundice, enlarged spleen and liver, asthma and cough, tuberculosis, urinary complaints, and inflammatory disorders. The aim of this review was to collect information from the available literature relating to marine molluscs with respect to health-promoting effects and bioactive compounds.

Keywords: Antibacterial, Anticancer, Anti-Inflammatory, Anti-leukemic, Antimicrobial, Antioxidant, Bioactive compounds, Health, Marine molluscs

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Introduction

Marine fauna is the sources of unique natural products used as food, fragrances, pigments, insecticides, medicines etc. Many pharmacologically bioactive compounds have been derived from marine invertebrates such as tunicates, sponges, soft corals, sea hares, nudibranchs, bryozoans, sea slugs and other marine organisms. The secondary metabolites derived from number of marine animals possess antibiotic, anti-parasitic, antiviral and anti-cancer activities (Simmons *et al.*, 2005; Giftson and

Patterson, 2014).

Molluscs (Latin word mollusc, meaning “soft”) (Anbalagan and Samuel, 2012) are one of the important groups of invertebrates and include soft bodied macro-benthic heterogeneous group of animals, found attached to the bottom of the intertidal region or free swimming (Das, 2017; Pawar and Al-Tawaha, 2017). Marine molluscs consist of around 31,643 species and comprise about 23% of all the named marine invertebrate organisms (Winckworth, 1940). Mussels, oysters,

clams, pearl-oysters, window-pane oysters, ark-shells, whelks, chanks, cowries, squids and cuttlefish have been exploited since time immemorial for food, pearls and shells (Mohamed and Venkatesan, 2017).

Marine molluscs contain a diverse array of active ingredients (carbohydrates, proteins, minerals, lipids, sterols, and nucleosides), which contributes in the medicinal value of these invertebrates. They are rich in vital nutrients and active secondary metabolites and possess health-promoting potential with antiviral, anti-inflammatory, and antimicrobial properties (Cheong *et al.*, 2017; Khan and Yang, 2019). Blunt *et al.* (2006) and Chandramathi and Thilaga (2018) reported that, marine molluscs contain more than thousands of bioactive compounds such as: peptides, sterols, terpenes, polypropionates, nitrogenous compounds, macrolides, prostaglandins, fatty acids derivatives, alkaloids etc.

Benkendorff (2010) stated that molluscs possess bioactive compounds with anti-tumour, anti-leukemic, and anti-bacterial properties. Further, medicines and bioactive compounds derived from shelled gastropods and bivalves play role as chemical defence against their predators. Marine molluscs are rich in biologically active natural products that provide new potential sources of anti-inflammatory agents (Tarek *et al.*, 2017).

Benkendorff (2010) and Chelladurai (2020) reported that, phylum mollusca is divided into 7 different classes of which four have been labelled as major and three as minor phyla. The four major classes include:

- Polyplacophora: Chiton, Katharina, Mopalia etc.
- Gastropoda: Conch, Cones, Snails, Cypraea etc.
- Bivalvia: Oysters, Clams, Mussels, Scallops etc.
- Cephalopoda: Squids, Octopuses, Cuttlefish etc.

The three minor classes include:

- Monoplacophora (Neopilina)

- Solenogastres (Neomenia)
- Caudofoveata (Chaetoderma, Limifossor).

Ecological roles of Molluscs (Das, 2017):

Due to their ubiquitous distribution and enormous species number, molluscs play important ecological roles in aquatic and terrestrial ecosystems of the world--

- Food for human and other animals (echinoderms, fish, birds and mammals).
- Biomonitoring and bioindication purposes (Oehlmann and Schulte-Oehlmann, 2002).
- Filtering phytoplanktons and source of food for fishes.
- Oxygenate the bottom by reworking sediments.
- Breaking down organic materials before bacterial re-mineralization.
- Many of them are commercially important.
- Source of drugs and bioactive compounds.

Literature Search Methods:

The review was carried out through extensive literature search, using electronic databases, and online search tools, such as EMBASE, Google Scholar, Medline, NCBI, PubMed, Science Direct, Scopus, and Web of Science databases. Data and information was collected from the thorough study of the journal articles, research papers, reports and various literatures. The keywords used for reviewing the literature were the ones that refer to the issues concerning the 'health promoting effects ' and 'marine molluscs'. For literature search, keyword "marine molluscs" is combined with: classification, ecological roles, drugs, and bioactive compounds.

Health Promoting Effects and Bioactive Compounds of Marine Molluscs:

The marine environment is a rich source of both biological and chemical diversity. This diversity has been the source of unique chemical compounds with the potential for industrial

Table 1: Bioactive compounds reported in marine molluscs

Mollusc fauna	Part of body	Therapeutic activity	Reference
• Pearl oyster (<i>Pinctada</i>)	Whole body tissue	• Treatment of tuberculosis, dyspepsia, jaundice, and urinary complaints.	Radhika <i>et al.</i> (2008)
• <i>Donax faba</i>	Shell extracts	• Antibacterial activity against pathogens	Giftson and Patterson (2014)
• <i>Hemifusus pugilinus</i>	Soft body tissue	• Antibacterial activity • Antioxidant activities	Arumugasamy and Cyril (2017)
• <i>Perna viridis</i> (Green Mussel) • <i>Meretrix meretrix</i> (Great Clam)	Whole body tissue extract	• Anticancer Activity	Praveena and Kaneez (2017)
• <i>Dicathais orbita</i>	Hypobranchial gland, Egg mass	• Anti-Inflammatory activity	Tarek <i>et al.</i> (2017)
• <i>Conus achatinus</i> (Gmelin, 1791)	Body tissue	• Bioactive compounds and Antibacterial activity	Chandramathi and Thilaga (2018)
• Sea slug (<i>Euselenops luniceps</i>) (Cuvier, 1817)	Whole body tissue extract	• Antimicrobial potential	Sivaprakasam <i>et al.</i> (2018)
• Marine heterobranch molluscs	Whole body tissue	• Anticancer activities • Antibiotic activity	Avila and Angulo-Preckler (2020)
• <i>Conus magus</i> • <i>Xancus pyrum</i> • <i>Harpa conoidalis</i> • <i>Cypraea errones</i> • <i>Hemifusus pugilinus</i>	Whole body tissue	• Control of the heart disease & pain control. • Treatment of dyspepsia, digestive impairment, melabsorption syndrome, enlargement of liver hepatomegaly and duodenal ulcer. • Antimicrobial activity • Treatment of dyspepsia, jaundice, enlarged spleen and liver, asthma and cough. • To kill the bacterial and fungal pathogens	Chelladurai (2020)
• <i>Brachidonta variabilis</i> • <i>Pinctada radiata</i>	Body tissue extract	• Antimicrobial activity	Sake <i>et al.</i> (2020)
• <i>Turbo brunneus</i> • <i>Cypraea annulus</i> • <i>Babylonia spirata</i>	Dried body tissue	• Anticancer Activity	Subavathy and Shibana (2021)
• <i>Perna canaliculus</i>	Whole body tissue	• Antibacterial activity	Aldairi <i>et al.</i> (2022)

development as pharmaceuticals, cosmetics, nutritional supplements, molecular probes, fine chemicals and agrochemicals (Kijjoa and Sawangwong, 2004).

Braitmaier (2020) documented that a “living pharmacy” crawls on the ocean floor off the coastline. A significant number of novel metabolites with potent pharmacological properties have been discovered from aquatic organisms (Sake *et al.*, 2020). Simmons *et al.* (2005) stated that the secondary metabolites extracted from many classes of molluscs exhibit

antitumor, antileukemic, antibacterial and antiviral properties, and antiparasitic activities.

Marine organisms such as sponges, tunicates, fishes, soft corals, nudibranchs, sea hares, opisthobranch Molluscs, echinoderms, bryozoans, prawns, shells, sea slugs, and marine microorganisms are sources of bioactive compounds. On the basis of their specific pharmacologic actions, marine drugs are antibacterial, anti-inflammatory, neuroprotective, antiparasitic, antiviral agent, anticancer, analgesic and antimicrobial (Navgire, 2021).

Dang *et al.* (2015) noted that, antiviral compounds are a crucial component of molluscan defences against viruses and have diverse mechanisms of action against a wide variety of viruses, including many human pathogens. Antiviral compounds found in abalone, oyster, mussels, and other cultured molluscs are available in large supply, providing good opportunities for future research and development.

Extensive biodiversity and availability of marine and estuarine molluscs, along with their wide-range of utilities as food and nutraceutical resources developed keen attention of the food technologists and dieticians. Among the phylum mollusca, Bivalvia, Gastropoda and Cephalopoda, were mostly reported for their nutraceutical applications and bioactive properties (Chakraborty and Joy, 2020).

Summer *et al.* (2020) referred the marine molluscs as the 'A Wealth of Potential Therapeutic Compounds'. The molluscs synthesize a wide variety of bioactive primary and secondary metabolites. More than 1145 compounds had been isolated from marine molluscs, including peptides, sterols, terpenes, polypropionates, macrolides, fatty acid derivatives, nitrogenous compounds, and alkaloids (Avila and Angulo-Preckler, 2020).

Bioactive Compounds Reported in Marine Molluscs:

Table 1 illustrates the bioactive compounds which have been reported from marine molluscs.

Health Promoting Effects of Marine Molluscs:

- Antibacterial activity against pathogens
- Antibiotic activity
- Anticancer activities
- Anti-Inflammatory activity
- Antimicrobial activity
- Antioxidant activities
- Source of Bioactive compounds
- Control of the heart disease & pain control.
- To kill the bacterial and fungal pathogens

- Treatment of dyspepsia, digestive impairment, malabsorption syndrome, enlargement of liver hepatomegaly and duodenal ulcer.
- Treatment of jaundice, enlarged spleen and liver, asthma and cough.
- Treatment of tuberculosis and urinary complaints.

Conclusion

Results of this study indicate that molluscs are the most noteworthy group of marine organisms with diverse health promoting effects and an excellent source of bioactive compounds. Various body parts of members of phylum mollusca such as shells, soft tissue, basal parts, mucilage, and even entire organisms also have been used for treatments of different ailments, and many diseases. Body of molluscs are an excellent source of active secondary metabolites and their use as food in daily diet is beneficial in avoiding many ailments and diseases.

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