ISSN–2278-5655

AMIERJ Aarhat Multidisciplinary International Education Research Journal

Volume–XIV, Issues– I(b) Jan – Feb, 2025

OPEN ACCESS Original Research Article

HEALTH BENEFITS OF SEA CUCUMBER

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Abstract:

Sea cucumbers are marine invertebrates, found in deep seas across the world. They have high commercial value as they are considered as a luxury food item and used in traditional medication due to their impressive nutritional profile and curative effects. Sea cucumber contain a wide range of bioactive compounds namely Triterpene glucosides, bioactive peptides, fatty acids, Chondroitin sulfates, lectins which exhibits therapeutic activities including antiangiogenic, anticancer, anticoagulant, antitumour, antiviral, antifatigue, antioxidant, wound healing have been ascribed to various species of sea cucumber. In this review we have presented a general view on major health benefits of sea cucumber.

Key words: *Sea cucumber, Chondroitin sulfates, Triterpene glucosides, antifatigue, antiangiogenic, anticancer.*

Introduction :

In recent decades, the concept of functional food and has offered a new and practical approach to achieving optimal hand by promoting the use of natural products with physiological benefits thus reducing the risk of various chronic diseases. (Shahidi F.2009)

Most of the currently available functional food and therapeutic agents are derived either directly or indirectly from naturally occurring sources especially the terrestrial food plants and marine species. (Venugopal V.2009)

See cucumbers are one of the Marine animals which are important to human food sources, particularly in some parts of Asia. Sea cucumbers belongs to the phylum Echinodermata, meaning that, they are spiny skinned, under class Holothuridea. (Taiyeb Ali et.al 2003)

They are usually soft bodied echinoderms comprising a diverse group of flexible elongated worm like organisms with a leathery skin and gelatinous body, looking like a cucumber. Habitually, they are tend to live on the sea floor in deep seas. (conand c.1990)

The name holothuroid was given by Greek philosopher Aristotle (holos – whole. ; thirious – rushing). The scientific name "Cucumis marimus" which means 'Sea cucumber' was coined by Pliny (an invertebrate taxonomist). (Rizwan B.H.2007)

It was further divided intro three sub classes namely – Dendrochirotacea, Aspidichiroracea and Apodacea. There are six orders under these subclasses, named as Aspidochirotida, Apodida, Dactylochirotida, Dendrochirotida, Elasipodida and Molpadida. Sea cucumbers of subclass Dendrochirotacea have 8-30 oral tentacles while those belonging to Aspidochirotacea may have 10-30 shield like or leaf-like oral tentacles. While, members of Apodacea may contain upto 25 pinnate or simple oral tentacles. (Conand.c 2004)

The length of sea cucumber is normally 10 to 30 Centimeter, however some small spieces of just 3 millimeter length and the largest reaching around 1 meter have also been recorded. They are soft and cylindrical bodied Echinodrms which preferably live as dense populations on the deep sea floor and use their tentacles for feeding purposes. (Guerard F. et al. 2011)

Sea cucumbers are an important component of the marine ecosystem. They are distributed in all ocean the

ISSN–2278-5655

AMIERJ Aarhat Multidisciplinary International Education Research Journal

Volume–XIV, Issues– I(b) Jan – Feb, 2025

OPEN ACCESS Original Research Article

world over, generally living near corals, rocks or sea weeds in warm shallow water. (Ridzwan B.H 2007)

Most of the harvestable species of sea cucumbers which are really targeted as *beche- de- mer*, belongs to two families and 7 genera of Aspidochierotids including Vohadschia, Holothuria, Actinopyga, Isostichopus, Stichopus, Parastichopus and Thelenota and one family and genus of Dendrochirotids: cucumaria (Cucumariidae). (Bruckner A.W. et.al. 2003)

The total number of presently existing sea cucumber species are about 1250, however recently, some new species have also been studied from the Indo- Pacific ocean, being popular as a center for rich biodiversity of Holothuroidea such as *Actinopyga echinites* (Brown fish), *Actinopyga lecanora* (Stone fish), *A. mauritiana* (Surf red fish), *A. miliaris* (Black fish), *Cucumaria frondosa* (Pumpkins). The main trade for the food purposes, there are perhaps hundreds of, thousands of sea cucumbers that are marketed for aquarium industry, however information on species, their exact quantities and source countries are rarely available. (Bruckner A. W. et.al.2003)

Bio-actives derived from Sea cucumber:

Among marine organisms sea cucumber is an interesting natural source of novel functional materials with biological activities that could be used in food as well as bio medicine industries sea cucumber is also known as 'teripang' or 'tripang' in Indonesia. 'beche-de-mer', a French term that means marine food product and 'balate' in Chamorro. Sea cucumbers are organisms that live in complex environment conditions to survive to extreme conditions, therefore they must adapt to new environmental conditions to survive and produce secondary biologically active metabolites which cannot be found in other organisms. Sea cucumber had some medicinal properties as the herb ginseng and it is also called as "haishen" which means "ocean ginseng". (Bahrami, et.al.2014) Sea cucumbers are a source of high value added compounds with health benefit effects to be used as functional ingredients. Bioactive peptides, vitamins, minerals, fatty acids, saponins, carotenoids, collagens, gelatins, Chondroitin sulfates, amino acids and other bioactive compounds are examples of such sea cucumber derived functional ingredients that can be added at different stages of the food and biomedicines production process. (kim s.k. et.al.2012)

From nutritional point of view see cucumber are ideal tonic and have an impressive profile of high value nutrients such as vitamin A, vitamin B, thiamine, riboflavin, niacin and minerals, especially calcium, magnesium, iron, and zinc. (Ridzwan B.H.2007)

Commercially processed sea cucumbers are rich sources of crude protein in comparison to most of seafood so far in use, that may contain protein content as high as 83% and is sold as nutraceutical in tabulated or capsulated forms. (Chen J. 2003)

Total amino acid content as against fatty acid profile is not so much varied among Species but both of these nutrients as well as polysaccharides and glycosides are higher in intestine and respiratory parts than the body walls. (Wen J. et.al.2016)

Sea cucumber protein especially produced from body wall is rich in glycine, glutamic acid and argenine. Glycine can stimulate production and release of IL-2 and B cell antibody and thus contribute to enhancing phagocytosis. Glycine and glutamic acid are essential components for cells to synthesize glutathione which can stimulate activation and proliferation of NK cells. Argenine can enhance cell immunity by promoting activation and proliferation of T cells. Due to these amino acid components, sea cucumbers have remarkable function in immune regulation. (Qin Z. et al.2008)

A major portion of sea cucumber body wall protein is comprised of collagen. Collagen is recognized as a valued component in the connective tissues, Due to its

ISSN–2278-5655

AMIERJ Aarhat Multidisciplinary International Education Research Journal

Volume–XIV, Issues– I(b) Jan – Feb, 2025

OPEN ACCESS Original Research Article

usefulness and specific distribution. (Rafiuddin. Et.al.2004) (Saito M. et.al.2002)

It can be further converted into gelatin by boiling to act as a functional bioactive substance. (Zhao Y. et.al.2007)

There are series of biotic and antiaging substances in sea cucumber, such as Triterpene glucosides, enzymes, amylases, fatty acids, cytotoxins, etc. with potential capabilities to increase immunity, resist tumor and coagulated blood, protect nerve tissue, ease pain as well as contribute to anti-cancer and anti-coagulation. (Yuan W.P. et. al. 2010)

Fatty acids of sea cucumber lipids fractions are the key components, liable for tissue repair and wound healing properties of this marine animal. (Fredalina B.D. et.al.1999)

Group of functional substances namely, mucopolysaccharides and chondroitins, have also been identified in sea cucumbers. It has been seen that people suffering from arthritis and connective tissue disorders are often devoid of these compounds. As such, sea cucumber derived chondroitin sulfates can be exploited as a nutraceutical to ease joint pain and arthritis like disorder. (Imanari T. et.al.1999)

The mechanism of action of chondroitin sulfates is considered to be similar to that of glucosamine sulfate; the latter compound is currently in use as therapeutic agent for easing osteoarthritis. (Yamada S. et.al.2008)

Sulfated polysaccharides are reported to exhibit antiviral activity and based on this fact; Japanese scientists have patented their scientific findings regarding potential use of sea cucumber Chondroitin sulfate to inhibit human immuno deficiency virus (HIV) infection. (Beutler J.A. et.al. 1993)

Sea cucumbers are rich in glucosides particularly Triterpene glucosides which are proven to have antifungal and antitumour activities. (Kalini V. et.al. 2005)

Sea cucumbers are also known to have impressive amount of lectins. (Gowda. N. M. et.al. 2009), cerebrosides (Ikeda Y et al. 2009), glycosaminoglycans(Kariy Y. et.al. 1997), sterols, omega-6-sterols and omega-6-fatty acids (EPA & DHA). (Goad L.J. et.al. 1985)

Medicinal and Health Benefits of Sea cucumber:

In addition, having a high nutritious value, sea cucumbers have long been recognised in folk medicine system of Asian countries. An impressive range of medicinal health functions like nourishing the body, tonifying kidney, moistening dryness of intestines, treatment of stomach ulcers, asthma, hypertension, rheumatism and wound healing have been associated with sea cucumber. (Chen J. 2003)

Most importantly, the potential medicinal benefits and multiple biological properties of sea cucumbers are now gaining recognition in modern biomedicinal research. Scientists believe that sea cucumber extracts are beneficial for human health in different ways and can help to reduce the growth of cancer cells. (Collin P.D. 1999)

In view of medicinal potential, modern food and pharmaceutical industry is keenly interested to develop some functional foods and nutraceuticals from different parts of sea cucumbers. Recently several pharmaceutical firms in Australia initiated the use of sea cucumber to prevent inflammation. (Mehnet A. et.al.2011)

A variety of sea cucumber derived food and pharmaceutical products are available in south Pacific and Asian markets including China, Japan, Malaysia, and Indonesia. In Asia and America, dry tablets prepared from the body wall of sea cucumbers are consumed as nutraceutical for physiological benefit. In Malaysia, boiled skin extracts are consumed as a tonic to treat asthma, hypertension, rheumatism and wound cuts and burns. (Fredalina B.D. 1999)

ISSN–2278-5655

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Volume–XIV, Issues– I(b) Jan – Feb, 2025

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Some medicinal benefits of sea cucumbers are described below:

1) **Anti-angiogenic:**

Antiangiogenic refers to the process of new blood vessel formation from a pre-existing vasculature that occurs under either physiological / pathological conditions. It is observed at tightly regulated conditions in normal physiology during embryogenesis, ovary cycling and wound healing. (Pangestuti R. 2011)

Sea cucumber has emerged as a potential source of antiangiogenic and antitumour agents of medical interest. Recent studies reveal the anticarcinogenic potential of sea cucumber-derived bioactive against certain cancers.

Tian et.al. (2005) examined in vivo and in vitro anti angiogenic and antitumour functionalities of newly identified compound philinopside E (PE) from sea cucumber. They assessed antiangiogenesis inhibition potential of compound using different assays like proliferation, adhesion, migration, apoptosis and tube formation in PE treated human umbilical vein endothelial cell (HUVECs) and human microvascular endothelial cells (HMECs). Philinopside E (PE) can be explored as an efficient anti-angiogenic agent for suppressing the active (phosphorylated) forms of vascular endothelial growth receptors involved in endothelial cell survival, adhesion, proliferation and migration.

The antiangiogenic activity of a newly isolated sulfated saponins namely philinopside A, from sea cucumber (*Pentaca quadrangulari*) was tested against angiogenesis and tumor growth by Tong et.al. (2005).

The researchers noted that sea cucumber derived philinopside A exhibits antiangiogenic effects in human microvascular endothelial cells (HMECs) suggesting its uses as a promissing anti-cancer agent.

Fucosylated chondroitin sulfate is another compound ifentified in the flower and body wall of sea cucumber. This compound offers good antiangiogenic activity, comparable with that of positive control hydrocortisone / heparin and even higher than shark cartilage chondroitin-6-sulfate. (Collin P.D. 1999)

2) **Anti-cancer:**

Sea cucumbers are reported to contain several compounds with Anticancer and Anti proliferative properties. The anticancer activity of 3-triterpene glucosides intercedesides A, B and C isolated from sea cucumber (*Mensamaria intercedens*) has exhibites cytotoxicity against human tumor cell lines and thus could serve as potential anticancer agent. (Zou Z. et.al. 2003)

The anticancer properties of 3 Malaysian sea cucumbers *Holothuria leucopsida, H.scabra* and *Stichopus Chloronotus* extracts rich in phenolics and inhibit growth of human cervical cancer cells. (Althunibat, et.al. 2009)

Aqueous and methanolic extracts of phenolics from *Holothuria tubulosa* rich in epicatechin and ellagic acid which inhibit the growth of cencer cell lines and induces apoptosis in human non small lung carcinoma and cervix adenocarcinoma cells. (Alper M., et.al. 2020)

Novel triterpenoid, frondoside A derived from an Atlantic sea based sea cucumber species namely, *Cucumaria frondosa* been reported to show an effective growth inhibitory function against human pancreas cancer cells. (Li X. et.al. 2008)

Antiproliferative and anticancer functionality of sea cucumber extracts might be ascribed to the presence of considerable amounts of total phenols and flavonides which are valued as effective antioxidants to protect from oxidative stress and degenerative disease including certain cancers. (Althunibat et.al. 2009)

ISSN–2278-5655

AMIERJ Aarhat Multidisciplinary International Education Research Journal

Volume–XIV, Issues– I(b) Jan – Feb, 2025

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3) Anti-coagulant:

Anticoagulant properties of the sea cucumber (*Ludwigothurea grisea*) are linked with the presence of Fucosylated chondroitin sulfates in the body wall of this marine animal. This compound has a chondroitin sulfate like core containing side chains made up of sulfated alfa-L-Fucose attached at carbon-3 position of the beta-D-glucaronic acid. During activated partial thromboplast in time assays the given compound showed excellent anticoagulant activity that could be ascribed to its capability to initiate thrombon inhibition by heparin cofactor II and antithrombin. (Mourao P.1996)

Mulloy et al. (2000) investigated that sea cucumber isolated fucosylated chondroitin sulfate (FCS), being a kind of sulfated polysaccharide, has potent anticoagulant activity.

In another study, the researchers investigated the anticoagulant / antithrombic action of sea cucumber body wall derived Fucosylated chondroitin sulfate (FCS) and the chemical derivatives of some polysaccharide, employing a stasis thrombosis model in rabbits. It has been found that both the particle defucosylation and desulfation of the polysaccharides suppressed their anticoagulant action. (Mourao et.al.1996)

4) Anti-tumour:

Sea cucumber contain a variety of antitumour ingredients, these antitumour active compounds play an important role in different stages of tumour development, progression and metastasis.

Triterpene glucosides, namly Holothurinosides A, B, C and D as well as desholothurine, A from sea cucumber a (*Holothuria firskali*), have considerable antitumour activity. Holothurinosides A and B are 1st non- sulfated pentasaccharide saponins isolated from marine echinoderms while C and D are di and tetrasaccharides. Sea cucumber derived holothurinosides; A-D and related saponin have shown antitumour and antiviral activities. (Rodriguez J. et.al.1991)

The effect of philinopside A, a novel sulfated saponin derived from sea cucumber (*Pentacta quadrangulari*) on the angiogenesis and tumor growth have been studied by Tong et.al. (2005) using different in vivo and in vitro trials, results revealed that philinopside A has high antitumour activity in both in vivo and in vitro trials.

Aminin et.al. (2010) identified a new immunomodulatoty lead compound, cumoside from sea cucumber (*Cucumaria japonica*) chemically, cumoside is a complex of monosulfated Triterpene glucosides and reveals antitumour activity against experimenal mouse in vivo.

5) Anti-viral:

There are evidences that sea cucumber bioactives also have anyiviral activity. The antiviral activity of Liouvillosides. A and B, which are trisulfate Triterpene glucosides isolated from Antarctic Sea cucumber. (*Staurocucumis liouvillei*) have been examined by Maier et. al. (2001).

Sea cucumber derived fucosylated chondroitin sulfates recognizedas a type of sulfated polysaccharides can inhibit human immunodeficiency virus (HIV) infection. Hence suggesting potential utilization of these valuable marine invertebrates as a natural therapy against HIV disorders and AIDS (aquired immine deficiency syndrom) (Beutler J.A. et.al. 1993).

6) Anti-fatigue:

Sea cucumber polypeptides have shown significant antifatigue and immune functions in mice, they exhibited no obvious effect on body weight in mice. Significantly prolonged the time of leaded-swimming and rolling stick, strongly degraded the content of blood urea nitrogen and increased the content of hepatic glycogen of post exercise micr. (Wang et.al.2007).

ISSN–2278-5655

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Volume–XIV, Issues– I(b) Jan – Feb, 2025

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The bioactive composition of cultured sea cucumber (*Stichopus japonicus*) and its anti fatigue effect in mice have been elucidated by Bing et.al. (2010)

The body wall of *S. japonicus* was found to be rich in acidic mucopolysaccharides, collagen, bioactive amino acids and lipids. (Bing et.al.2010)

7) Anti-oxidant:

Currently use of plants or marine based natural antioxidant compounds has gained much recognition due to their potential health functions and multiple biological properties. Thousands of plants Species have already been researched for potential antioxidants, however due to lack of exploration, much potential remains for screening marine organisms for their antioxidant principles. Sea cucumber is one of the potential source of valuable antioxidants. (Venugopal et.al. 2009).

Fresh and rehydrated sea cucumber with internal organs, possesed higher antioxidant activity. (Zhong et.al. 2007)

The antioxidant activity of sea cucumber derived peptides has been confirmed by chenghuil et.al. (2007). They separated sea cucumber hydrolysate into different molecular weight fractions by the methods of ultrafiltration. The results showed that peptides with molecular weight of 1000-3000 unit exhibited great antioxidants and scavenging effects on DPPH.

8) Wound healing:

Sea cucumber and sea cucumber-based products are now becoming available in shelves of health food stores due to their therapeutic effects, in perticular the wound healing functions.

It is believed that direct use of sea cucumber can reduce wound recovery time and help new tissue formation and recognition in human just as the sea cucumber's ability to quick regenerate its own body tissue when damaged. (Menton D.N. et.al.1973)

It is evident that sea cucumber (*Stichopus Chloronotus*) fatty acids including arachidonic acid, eicosapentaenoic acid and docosahexaenoic acid can play potential role in tissue repair and wound healing. (Rizwan B.H. et.al. 1999)

Appreciable amount of EPA in sea cucumber might be linked with the ability of echinodrms to initiate tissue repair. EPA is known to be the main active compound in fish oils and exerts its function by means of prostaglandin inhibition and anti-thrombic attribute l. (Mat et.al. 1994)

Conclusion:

Sea cucumbers showed high potential health benefits in foods as well as pharmaceutical industry. Hence these marine invertebrates have gained popularity among researchers in recent decades in area of new drug development

Extensive literature survey revealed that sea cucumber has a long history as a traditional food and folk medicine. Number of bioactives isolated from sea cucumber such as lectin, chondroitin sulfate, Triterpene glucosides (saponins), cerebrosides, bioactive peptides, fatty acid have shown multiple biological activities such as Anti-tumour, anti-viral, anti-angiogenic, anti-oxidant, anti-cancer, anti-fatigue, wound healing. Over all we concluded that sea cucumber can be explored as a potential drug. There is great potential to utilize sea cucumber to develop drug with physiological benefits for human being.

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Cite This Article:

Miss. Kadam G.R. (2025). *Health benefits of sea cucumber* **In Aarhat Multidisciplinary International Education Research Journal**: Vol. XIV (Number I, pp. 129–137)