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Bioprospecting of sea cucumber (*Holothuria* sp.) as industries and functional foods for human health

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Abstract

Sea cucumber inhabit scattered throughout the world's in tropical, subtropical and cool waters and known high protein of marine species and bioactive compounds as well as essential and non-essential amino acids that very important for the human health. Even sea cucumbers as a potential food source have become raw materials for the health pharmaceutical industries and as a source of food that is expensive. The bioactive compounds of sea cucumbers as amino acid namely steroids, saponins, aspartic acid, glutamic acid, serine, glycine, histidine, arginine, threonine, alanine, proline, thyrosine, valine, methioni, systein, isoleucine, leucine, phenylalanine, lysine, linoleic-, oleic, omega-3, O-6, O-9, EPA and DHA. These complex bioactive compounds is beneficial for heart and blood vessel health, anticoagulant, plays an active role in curing osteoarthritis, antioxidant, antiinflammatory, antitumor, antihypertensive, anticancer, antifungal, as well as cytotoxic activity. Some research to investigate the benefits of sea cucumber bioactive compounds has created business opportunities that are processed from raw materials of fresh, frozen and dried sea cucumbers. The market products are snack packaging such as sea cucumber crackers, sea cucumber tea, sea cucumber sardines, ready-to-eat frozen sea cucumber. Sea cucumber derivative products for health have produced as supplement, capsules and skincare products in a variety of serum products, creams, body lotions, shampoos and soaps. Bioprospection of sea cucumbers which are very rich in nutrients that are important for human health as a supplement to maintain health, sufferers and the healing stage, also really supports the growth stages of children and overcomes aging.

Keywords: Bioprospecting; Sea cucumber; Functional food; Marine industry

1. Introduction

Sea cucumbers inhabite spread throughout the world and the highest diversity in tropical waters, the species inhabited in sub-tropical and cold waters. Indonesia is one of the world's archipelagic and tropical country has great potential for fisheries resources and is known as a mega-biodiversity of marine species. The complex of marine species biodiversity has been widely researched and the results obtained have many potential benefits, namely as a source of functional food, pharmaceuticals and cosmetics. Functional foods are important foods to increase human immunity. The functional food is then produced with new technology that is more practical because it is a natural product with high benefits, especially in the field of pharmacology. The increase of public awareness of the importance of health has supported the increase in the need for functional food and the benefits of marine resources, one of which is sea cucumber, has caused these resources to increase their economic value [1, 2, 3, 4, 5].

Sea cucumbers (*Holothuria* spp.) are a group of Echinoderms, soft-bodied and thorn-skinned with an elongated body shape and can be found in shallow tropical waters around coral reefs, seagrass beds and dark bottoms, or at depths up to 10.000 m, waters clear, calm water and good water quality and free from pollution. The majority of sea cucumbers can be seen at low tide, usually they burrow under rocks, among coral reefs, seagrass and sand [6,7, 8, 9].

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The potential resources of Indonesian sea cucumbers are ranked the most in the world and Indonesia is the main supplier of sea cucumbers in the global market. Of the 38 sea cucumber exporting countries, Indonesia ranks first with a percentage of 12% in the international scale market, for sea cucumbers or beche-de-mer or trepan [11]. Currently, the status of sea cucumber resources in nature has experienced very high exploitation pressure which has caused a decrease in production. This condition becomes a problem because the management for its preservation is not optimal [7, 8, 10, 11, 12].

The high economic value of sea cucumbers is obtained based on research results, namely with complex nutritional and bioactive content. The results of research on the bioactive content of sea cucumbers that are beneficial to the human body began in 1920. Intensive research began in 1950 and the research is still ongoing today. The use of sea cucumbers began 400 years ago, which was published in a Chinese historical record book entitled "Miscallenies of Five Items in 1602" which stated that the consumption of haishen (sea ginseng) was a stamina-enhancing supplement [18]. However, its utilization in Indonesia is still relatively low when compared to other fishery products [2, 13].

The prospect of sea cucumbers as functional food ingredients is very potential to be developed.This condition is related to the increasing public awareness of its health benefits. Many studies have found that sea cucumbers can be used in the health sector namely repairing damage to the kidney system, indigestion or constipation, reproductive organ disorders, anticancer, antitumor, stamina enhancer, blood circulation, cholesterol, diabetes, hypertension, asthma, rheumatism, impotence, antiseptic, accelerate wound healing, antibacterial, antifungal, hemolytic or anemic. Other benefits in the cosmetic sector are antiaging, antioxidant, and antiinflammatory by utilizing collagen as an active ingredient for skin care [2, 5, 14, 15, 16, 17, 18].

The purpose of writing in detail is to explore in depth the potential of the sea cucumber to the industry and its potential development. This paper describes sea cucumbers in general, sea cucumber species, species distribution, commercial aspects, content of bioactive compounds, benefits of sea cucumbers and commercial derivative products. Research on the potential of sea cucumbers for health is still ongoing regarding the nutrition of sea cucumbers that tend to vary spatially and temporally, the composition of the bioactive compounds of sea cucumbers (*Holothuria* spp.) expected to be a reference for new research to combine or update previous research.

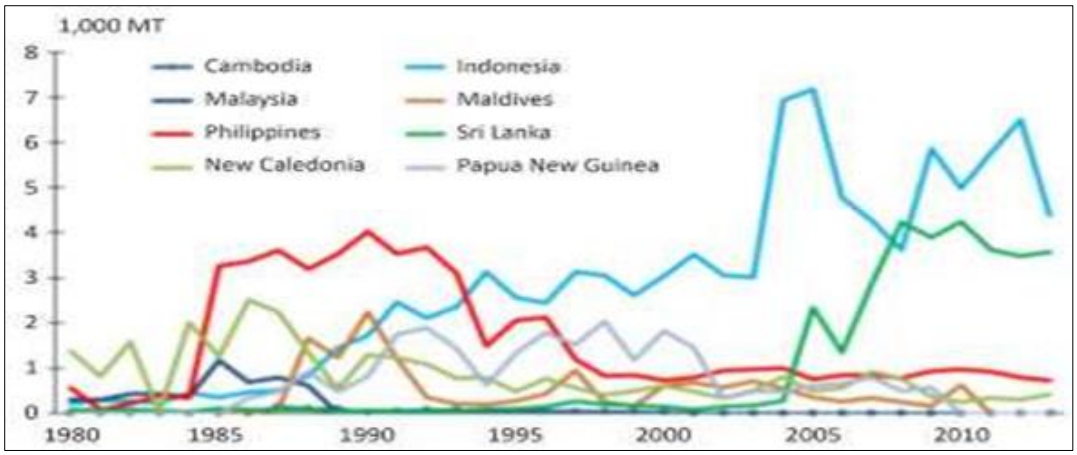
2. Material and methods

The material collection method discussed in this paper was collected and compiled based on searching scientific references in journals, national seminar papers as well as international seminars, books and searching for commercial sea cucumber products in the online market.

3. Result

3.1. Habitat ecology of sea cucumber

Sea cucumbers or sea cucumbers are echinoderms, which are trade product species that are widely cultivated to be caught, the body surface is like skin and can be elongated. Sea cucumbers in the world's marine waters but only 80 species are considered to have commercial value [18. 19]. This species has been traded for 1000 years in the Indo Pacific region to meet the Asian market as a ben-cheder-mer i.e. dry product [23]. The highest diversity of sea cucumbers lives in tropical waters, especially in the waters of Southeast Asia which is known as the center of world biodiversity, especially in the Indo-Malay-Philippine islands [26]. There are fifty-two species of sea cucumbers from the Genus Holothuria, Actinopyga, Bohadschia and Stichopus which are actively exploited in East Asia and Southeast Asia [27]. Sea cucumber production in Asian countries, Indonesia is the largest country that produces this species. Sea cucumber producing countries (Figure 1).



Source : FAO Fishstat J Database - Capture Production 1980-2013

Figure 1 Sea cucumber production in Asian countries [28]

Spatially, the distribution of sea cucumbers from tidal areas of mangrove areas that are very shallow and sandy or muddy at the bottom of seagrass beds and in deeper waters on coral reefs and then on the bottom of deep waters. Some sea cucumbers are filter feeders, but most of them are sea-bed feeding, ingesting, processing and excreting large amounts of benthic material which strongly supports the fertility aspect of the waters [29]. Sea cucumbers live on the bottom substrate with a ventral surface (trivium) by crawling using podia. The main anatomy of sea cucumbers (Figure 2).

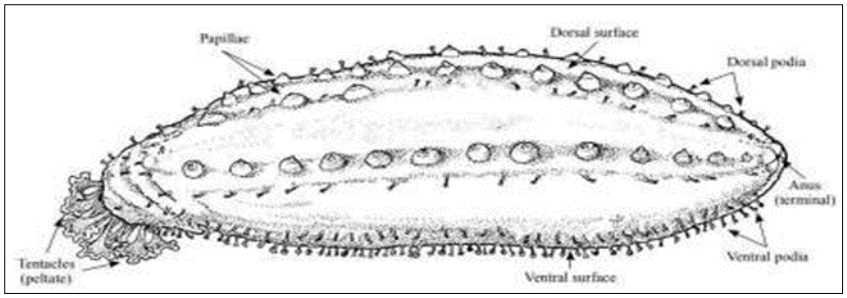


Figure 2 General body shape of sea cucumber [22]

Juvenile sea cucumbers measuring 0.3-2.1 cm tend to live leaving a protected area in the substrate where they grow into adults [30]. [31] found the genera Holothuria, Stichopus, Actinopyga, Bohadschia and Thelenota. The genus Holothuria is the most dominant genus of the genera Actinopyga and the genera Thelenota is the genus that is the least obtained from Maluku waters. Furthermore, it was stated that based on the minimum size of length and weight, *H. scabra* was the Stichopus variety that had the largest size. In the dominant species (*H. scabra*) as the most abundant species in Maluku, Indonesia, which is the largest species and the ratio of males to females is 1:0.51. While the growth pattern obtained negative allometric. The results of [32] research on sea cucumbers living in Algerian waters obtained that the sex ratio between males and females was 0.8: 1.2 and based on the region, there were no significant differences, also obtained no different for each season (spring , summer, autumn, winter). Reproduction of sea cucumbers in the same area was obtained in September based on the Gonad Somatic Index [GSI] obtained 0.33 and 0.22. Still in the same waters but in different locations, sea cucumbers were found to lay eggs in October. These conditions indicate that the breeding of sea cucumbers in an area is not the same and the value of the gonadal maturity index is also different, although oceanographic conditions have a positive correlation with the gonadal maturity index of sea cucumbers.

Sea cucumbers are a group of resources that live in coastal waters and have high economic value. In general, managers, especially in Indonesia, strongly encourage the production of sea cucumbers, by not limiting their exploitation when compared to other marine species, such as spiny lobster, napoleon fish, seahorses, sharks, crabs and small crabs, and turtles and the results of previous studies for sea cucumber species from Indonesian have not been carried out thoroughly.

3.2. Sea cucumber morphology

The morphology of external body of the sea cucumber is generally elongated cylindrical in shape, with the mouth and anus on opposite sides. The mouth parts have tentacles that are used to obtain food, especially particulate organic matter. The anus is at the posterior end, generally dorsal body part has a rough texture with papillae or small soft spines like warts, slimy and the body is generally hard.

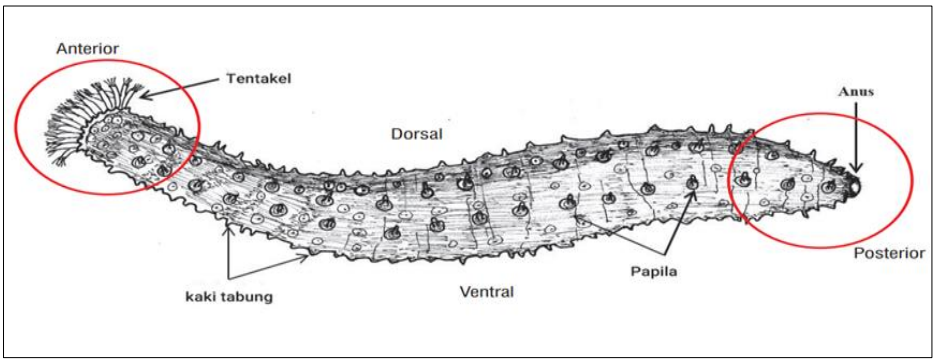
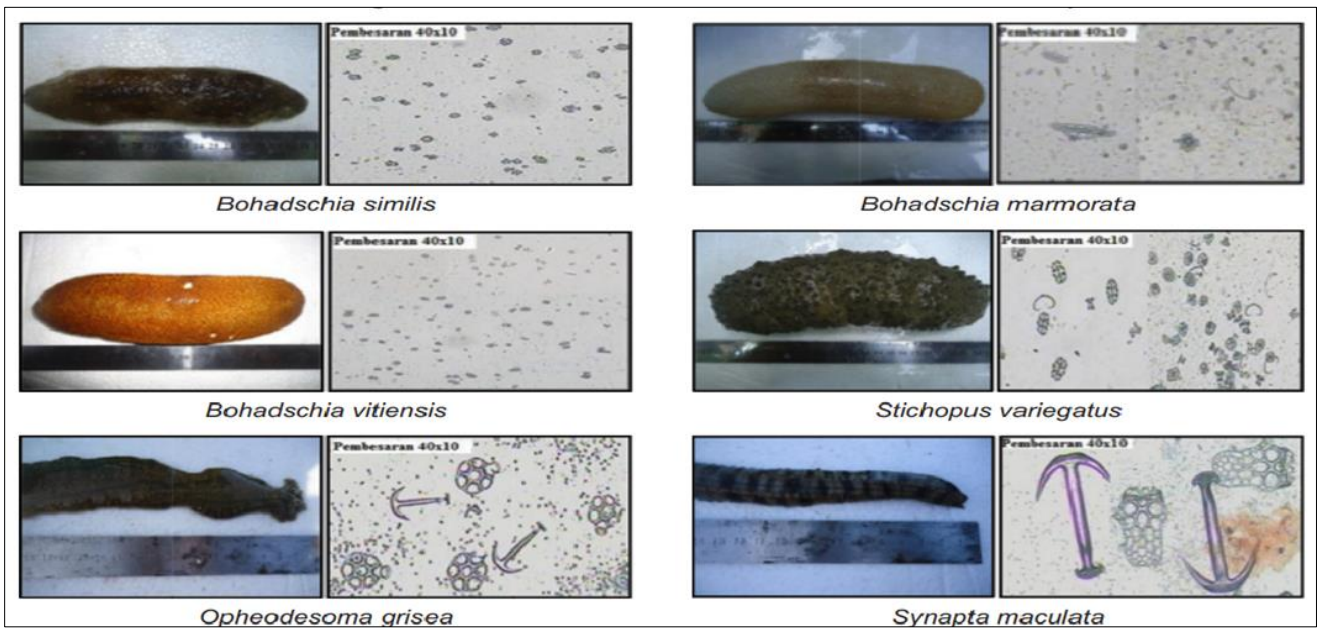


Figure 3 The general morphology of sea cucumbers [18]

While the ventral part has tube feet that are used to move creeping. The color of the ventral surface is lighter than the dorsal surface. More than 70% of the body weight of sea cucumbers is water, which will come out through the anus after a while after being in the air [17, 18, 33].

3.3. Species, Distribution and Economic Value of Sea Cucumbers

More than 1400 species of sea cucumbers that live in the world have been identified and have been described, and 400 of these species live in Indonesian waters. The results of the latest research show that there are 56 sea cucumber species in Indonesia which are included in the product traded for export purposes [18]. In various other waters of the world, each species of sea cucumbers with different local names and different economic values. The economic value of sea cucumbers is also determined based on their quality. Some pictures of the species of sea cucumbers that have been identified and are known in general [Figure 4].



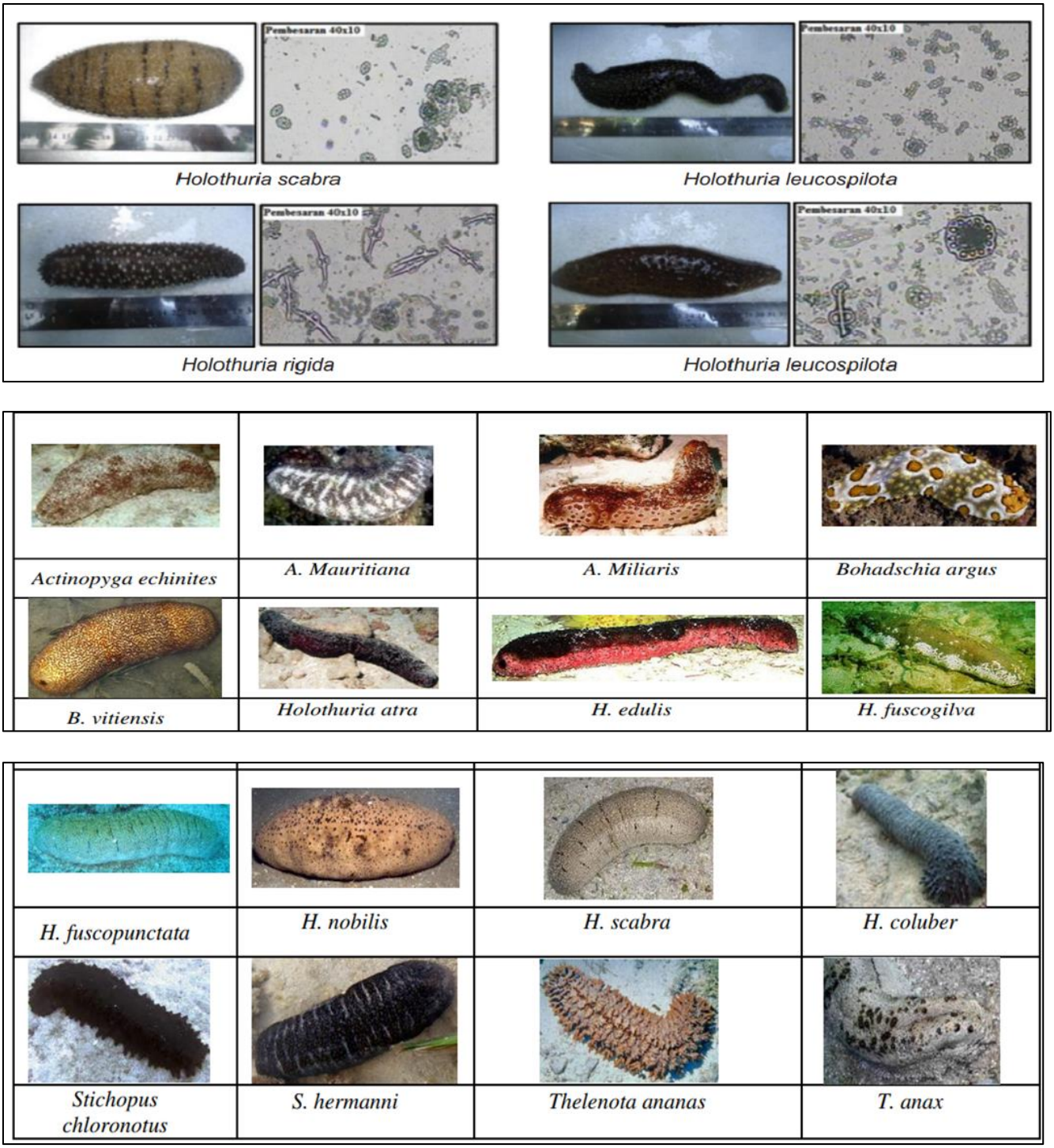


Figure 4 General external morphology of sea cucumber species

Most sea cucumber species as a high economic value live in Indonesian marine waters [Table 1], including *H. albiventer, H. atra, H. conusalba, H. edulis, H. exelens, H. hilla, H. impatiens, H. scraba, H. nobilis, H. lesson, Sticophus variegates, S. ananas, S. vatus, S. hermanni*. In Indonesia, the economic value of sea cucumbers in dry processed form is divided into 3 categories [18] namely low price product with a price range of 10.000-250.000 IDR/kg. Medium price (medium value species) with a price range of 251.000-500.000 IDR/kg, and expensive (Hight value species) with a price range greater than 500.000 IDR/kg. This is certainly a source of opportunity for fishermen to catch these sea cucumber species.

Several species of sea cucumbers are marketed online such as in Tokopedia, Shopee, Bukalapak and Lazada, the price of dried sea cucumbers is offered at a price between 2–4 million IDR/kg and the pricing is based on the species and quality. Republika.co.id (30/04/2014) released a news about the price of sea cucumbers in the Chinese market reaching

up to 34 million IDR/kg [34], while on the web. BursaBisnis.id published in the news of sea cucumbers price reached 44 million IDR/kg [35]. Kompas.com (06/04/2020) reported that the price of sea cucumbers reached up to 50 million IDR/kg [36], and Arsip Hukum bisnis (8/24/2017) the price of sea cucumbers in various countries was different, such as in China the price of sea cucumbers reached 34 million IDR/kg, in Japan the price of sea cucumbers starts from 500.000-24 million IDR/kg. While in Indonesia as a sea cucumber producer country, the price of the product is between 200.000 to 2 million IDR/kg. While in Singapore the price of sea cucumbers is between 500.000 to 12 million IDR/kg [37].

Table 1 Sea cucumber species, local, international names, distribution and economic value

No.	Scientific Name	Internasional Name	Local Name	Distribution	Price Low/L, Medium/M, Expensive/E	Refferences
1	*Actinopyga bannwarthi*	Blackfish	Teripang sepatu	Kupang, Pati, Karimunjawa Indo- West Pacific, Arabia, Australia,	M	18, 31, 38
2	*A. caerulea*	Blue see cucumber	Teripang kosong	Maluku, Karimunjawa	M	18, 31, 38
3	*A. echinites*	Deep water redfish, Brown fish	Teripang kunyit, Ladu-ladu, Kapok/Kapuk, Billala, Billado, Kassi, Sawala sepatu	Lampung, Karimunjawa,Alas Purwo (Jawa Timur), Papua South-Pacific, Ricaudy Reef, New Caledonia, Indian ocean, Reunion	M	3, 13, 18, 20, 22, 24, 27, 28, 31, 36, 38, 39
4	*A. lecanora*	Stonefish	Teripang batu, Hitam	Kepulauan Seribu, Karimunjawa, Alas Purwo (Jawa Timur), NTT, Papua, Indo-West Pacific and South China Sea	M	3, 13, 18, 20, 22, 28, 31, 36, 37, 38, 39, 40
5	*A. mauritiana*	Surf red fish	Teripang buntal, Ballang ulu, Sawala sepatu	Lampung, Karimunjawa Indo-Pacific, South China Sea, Africa and Hawaii, Unia Reef, New Caledonia	M	3, 13, 18, 20, 22, 24, 27, 28, 31, 38
6	*A. miliaris*	Black fish	Gamet, Lontong, Hitam	Karimunjawa , Papua, South-Pacific, New Caledonia, Cina	M	3, 18, 20, 22, 28, 31, 39, 40
7	*Babadscibia argus*	Leopard fish, Tiger fish, Spottedfish	Teripang ular mata, Gamat bati, Bintik, Cempedak, Patola,	Karimunjawa, NTT, Papua Indo-Pacific South-Pacific, South East, South China Sea, South	L	3, 13, 18, 20, 22, 28, 31, 37, 38, 39

			Teripang mata kucing	Asia, Indian ocean, New Celedonia, Australia		
8	*B. ocellata*	-	Teripang bintik	Lampung	M	18
9	*H. conusalba*	-	-	Karimunjawa	E	18, 38
10	*B. marmorata*	Chalkfish, Whitefish	Teripang kawasa, Olok-olok, Getah putih, Pulut, Benang, Krido, Pimam lawe-lawe	Maluku, Raja Ampat, Papua Indo-Pacific, South-Pacific, Red Sea, South China Sea, South- Asia, Africa, Indian ocean, Hong Kong	M	3, 7, 13, 18, 20, 22, 23, 28, 40
11	*B. subrubra*	Leopardfish	Teripang bintik, Kapok, falalyjaka	Karimunjawa, Madagascar, Hong Kong China SAR, Singapore, Taiwan Province of China	M	18, 22, 38
12	*B. vitiensis*	Brown sandfish	Teripang olok-olok, Gatta, Gama, Polos, Pimam maryantut	Maluku, Raja Ampat, Karimunjawa, Papua Madagscar, New Celodonia, Vietnam, Singapore South-Pacific, Indian Ocean	M	3, 7, 13, 18, 20, 22, 23, 38, 40
13	*H. albiventer*	-	Teripang coklat	Lombok Barat, Karimunjawa Philiphines	E	18, 38
14	*H. atra*	Lollyfish/ black trepang	Teripang takling hitam/coklat, Dara, Keling, Cera, Teripang dada merah	Lampung, Maluku, Karimunjawa, Mataram, Alas Purwo, NTT, Manado, Halmahera utara, Papua Indo-Pacific, South-Pacific, South China Sea, Persian Gulf, Africa, Red Sea to Hawaii, Malaysia	E	3, 7, 13, 18,20, 27, 28, 31, 34, 35, 36, 37, 38, 40, 41, 42
15	*H. coluber*	Snakefish	Teripang taikokong, Talengko, Teripang tali jangkar	Lampung, Karimunjawa, Papua, South Pacific, Micronesia,	M	18, 22, 27, 28, 38, 40

				Southeast Asia, including Viet Na, Malaysia and Timor Sea.		
16	*H. exellens*	-	Teripang hitam	Karimunjawa	E	18, 38
17	*H. fuscogilva*	White teatfish	Teripang susu putih, Bissawa	Karimunjawa, Kalimantan Pacific Ocean, South-Asian, Indian Ocean	E	13,18, 20, 28, 38, 39, 43, 56,
18	*fuscopuncatata*	Elephant trunkfish	Teripng susu putih, Kuning, Kunyit	Karimunjawa	E	18, 38
19	*H. cf. imitanss*	-	Teripang coklat	Karimunjawa	E	18, 38
20	*H. hilla*	-	Teripang batuna	Maluku, Alas Purwo, Karimunjawa, Halmahera utara	E	7, 18, 36, 38, 42
21	*H. edulis*	Pinkfish, Pink lollyfish, Trepang rose	Teripang dada cera, Perut, Lakling merah, Takling, Batu keeling, Teripang keling	Karimunjawa, NTT, Indo-Pacific, South-Pacific, South, China Sea, Red Sea to Hawaii, Srilangka, Africa, Madagascar, Red Sea, Southeast Arabi, Bengal Bay, East Indies, North Australia, Philippines, China and Southern Japan, South Sea Islands. Pacific and Southeast Asia, French Polynesia	E	3, 13, 18, 20, 22, 28, 31, 32, 37, 38
22	*H. fuscocinerea*	Labuyo (Philiphines)	Teripang coklat, Lakling coklat, Teripang karang	Seribu Islands, karimunjawa Indian Ocean, Red Sea, western central Pacific and Asia, Celebes and Amboina, Sri Lanka, Northern Australia, Philippines, China, Southern Japan, Guam and South Pacific Islands, Gulf of California.	E	13, 18, 22, 28, 31, 38

23	*H. impatiens*	Slender sea cucumber or Impatient sea cucumber	Teripang pulut, Teripang uler-uler, Teripang karang, Suwala hitam	Seribu Islands, Lampung, NTT, Karimunjawa Indo-Pacific, Persian Gulf, South China Sea, Southern California, Hawaii, Caribbean (Mexico) and other Tropical Waters	E	3, 13, 18, 20, 27, 28, 37, 38
24	*H. lesson*	Golden sandfish	Teripang ugai, Gosok	Karimunjawa	E	18, 38
25	*H. nobilis*	Black teatfish, Donkey dung	Teripang koro, cera hitam, Teripang susuan hitam	Karimunjawa, NTT Caribbean, Indo-Pacific, South Pacific, South China Sea, SE Asia, Red Sea to Hawaii, Africa, New Caledonia, Queensland, Australia	E	3, 13, 18, 20, 24, 28, 31, 37, 38, 39, 43
26	*H. scabra*	Sandfish, Black teatfish	Teriang gosok, Pasir, Pimam kateu, Teripang putih, kamboa	Pulau Bai (Bengkulu), Lampung, NTT, Belitung, Maluku, Raja Ampat, Jawa Timur, Karimunjawa, Makasar, Selayar, Pantai utara jawa, Sulawesi, Kalimantan, Papua Philiphines, Ambandjoa, Madagascar, Queensland, New Caledonia, Africa, Red Sea, South China Sea, South-Pacific, South East Asia, Indian Ocean, Malaysia	E	3, 5,7, 10, 13, 18, 20, 23, 24, 25, 28, 29, 30, 31, 33, 34, 37, 38, 39, 40, 44, 45, 46, 47, 48
27	*Holothuria* sp.	-	Teripang getah	Seribu Islands, Alas Purwo, NTT, Kalimantan	M	13, 20, 36, 37, 48
28	*H. whitemaei*	-	Teripang susu hitam	Karimunjawa	E	18, 38
29	*Stichopus chloronotus*	Greenfish,/Squar fish	Teripang jepung, Japon,	Karimunjawa	M	18, 28, 38

			Teripang belimbing			
30	*S. noctivagus*	-	Teripang gamat	Karimunjawa	E	18, 31, 38
31	*S. herrmanni*	Curryfish	Teripang gamet emas, Gamat kacang, Taikongkong	NTT, Karimunjawa Indo-West Pacific, South East Asia and South-Pacific, Indan ocean	E	3, 13, 18, 26, 38, 49
32	*S. horrens*	Dragonfish	Teripang kacang, Susu	Karimunjawa Malaysia, Halmahera utara	M	18, 28, 34, 38, 42
33	*S. monotuberculatus*	Giant red see cucumber	Teripang gamet pace	Karimunjawa East Pacific	E	18, 20, 38
34	*S. ocellatus*	-	Suwala kasur kuning	Seribu Islands, Lampung	E	13, 18, 27
35	*S. pseudoborrens*	-	Teripang duri	Karimunjawa	E	18, 38
36	*S. variegates*	-	Teripang gamat, Pimam mangkroukre	Karimunjawa , Sumatera Barat, Kepulauan seribu, Raja Ampat	E	14, 15, 23, 38
37	*S. quadrifasciatus*	-	Teripang gamat	Kepulauan seribu, Karimunjawa	E	13, 18, 31, 38
38	*S. vatus*	Curryfish	Teripang TKK, Suwala kasur	Karimunjawa , Kepulauan seribu, Lampung	E	13, 18, 27, 31, 38
39	*Thelenota ananas*	Prickly redfish/ Plum flower trepan	Teripang nanas	Karimunjawa, Kalimantan South-Pacific	E	3, 13, 18, 20, 28, 38, 48,
40	*T. rubralineata*		Teripang bati	Karimunjawa, Kalimantan, Philipines	E	18, 38, 48

3.4. Nutrient content

Analysis and synthesis technology in the pharmaceutical field to explore biological compounds related to the use of food sources continues to develop and identify new alternative biochemical compounds, with the aim of being used as materials that can be used for medicine and health as well as research results of high economic value. These progress is related to the development of awareness of healthy living and every human being wants to live a healthy life. The results of [50] proximate analysis on dried sea cucumbers obtained water content of 7.3%, ash 9.8% and protein 79.59%. While the proximate analysis of fresh sea cucumbers by [25] found the water content was 87.03% water, protein 76.64%, fat 4.16%, ash 14.34% and carbohydrates 4.93%, and the results of [64] research obtained the protein content of wet sea cucumbers was 44-55%. The protein in sea cucumbers is composed of a complex of amino acids, namely essential amino acids and non-essential amino acids. The high protein content of sea cucumbers shows good nutritional value and the protein content has complete amino acids. The proximate composition of different sea cucumber species obtained different compositions of bioactive compounds and even different compositions of compounds with different complexities. These conditions are related to species, seasonal variations, diet and habitat fertility.

Research on sea cucumbers has revealed a lot of very complex compounds that differ for each species such as collagen, mucopolysaccharide, glucosamine, chondroitin sulfate, triterpene glycosides, glycolipids, polysaccharides, minerals,

steroids, collagen, omega-3, DHA, EPA. Research results to analysis the bioactives compound in sea cucumbers have a number of unique biological and pharmacological activities or properties such namely antioxidant to reduce cells damage and tissues of the body, antibacterial, antifungal, antinociceptive or pain reliever and antiinflammatory or play an active role in inflammation and reduce swelling, radioprotective, antiinflammatory, antihypertensive. The bioactive content and benefits of sea cucumber species that have been identified by researchers (Table 2).

Table 2 Content of bioactive compounds and benefits of sea cucumbers

No.	Species	Bioactive Type	Functions	References
1	*T. ananas*	Triterpene glycoside (Saponin), Fucosylated (Chondroitin sulfates), Glycosaminoglycan, Polyunsaturated fatty acids (PUFA), EPA, DHA, Glucoronic acid, Fucose, Ester sulfate acid, mucopolysaccharide, glycolipids	Maintain heart and blood vessel health, anticoagulant, help treat osteoarthritis, antioxidant, antiinflammatory, anti-tumor, antiploriferative, antihypertensive, anti-cancer, modulate cholesterol metabolism	3, 51, 54
2	*Babadscibia marmorata*	Steroid, Saponin, Aspartat, Glutamat, Serin, Glisin, Histidin, Arginin, Treonin, Alanin, Prolin, Tirosin, Valin, Methioni, Sistein, Isoleusin, Leusin, Phenilalanin, Lisin	Anti-bacteria	56, 67
3	*Babadscibia* sp.	Steroid, Saponin	Anti-bacteria	57
4	*B. argus*	Cerberoside, Polyunsaturated fatty acids (PUFA), EPA, DHA, Arguside A-E	Anti cancer, anti-bacteria	3, 13, 56
5	*A. echinites*	Triterpene glycoside (Saponin), Steroidal sapogenins	Anti-bacteria	3
6	*A. miliaris*	Steroidal, Sapogenins,	Anti-bacteria	3
7	*A. mauritiana*	Essential amino acid (EAA), NEAA, Glisin. Prolin, PUFA, EPA, DHA	Anti cancer, anti-oxidant	53
8	*Actinopyga* sp.	Steroid, Fenol, Alkoloid, Saponin, triterpenoid	Anti cancer, sitotoxic, anti malaria	58
9	*S. chloronotus*	Phenols and flavonoids, Polyunsaturated fatty acids (PUFA), EPA, DHA	Anti cancer, anti-oxidant	3
10	*S. herrmanni*	Polyunsaturated fatty acids (PUFA), Asam lemak tak jenuh (linoleat, oleat, omega3, 6 dan 9, EPA, DHA), ukopolisakkarida,Glukosamin, Kondroitin sulfat, Mineral, Steroid, Trigliserida, Kolagen, Chondroitin, Gamapeptide, Glucosamine, Glikosida Keratin, Lektin, Glikoprotein, Glikosaminoglikan, Proteoglikan, Flafonoid, Saponin, Kalsium, Fosfor, Zat besi, Magnesium, Heparin, Heparin sulfat, Alkaloid, Zn, Ca, Fenol,	Anti-oxidant, anti-bacterial, anti-fungal, anti-oseptithesis, anti-inflammatory, anti-inflammatory, reduce swelling, anti-microbial, anti-thrombotic, improve blood circulation, launch kidney function, increase metabolism, diabetes, hypertension, anti-protozoa, inhibit tumor cell growth, arthritis. natural antiseptic.	3, 12, 26, 42, 46, 47, 53
11	*S. variegatus*	Methanol, Sphingoid, Aspartat, Glutamat, Serin, Glisin, Histidin, Arginin, Treonin, Alanin, Prolin, Tirosin, Valin, Methioni, Sistein, Isoleusin, Leusin, Phenilalanin, Lisin	Antibacterial, antioxidant, antimicrobial, antifungal, anticancer	13, 15, 21, 43, 57
12	*S. horrens*	Flafonoid, Saponin	antioxidant	52,

13	*H. lucospilota*	Triterpene glycoside (Saponin), Phenols and flavonoids, Organic solvent, Crude saponin, Triterpenoid	Cancer cells-A549, lung cancer, Cervical , anti-fungal	3, 13, 51
14	*H. scraba*	Lectin, Glycosaminoglycan, Phenols and flavonoids, Steroidal sapogenins, Metanol, n-hekasana, Etanol, Alkoloid, Saponin, Triterpenoid, Aspartat, Glutamat, Serin, Glisin, Histidin, Arginin, Treonin, Alanin, Prolin, Tirosin, Valin, Methioni, Sistein, Isoleusin, Leusin, Phenilalanin, Lisin	Antiacne, antibacterial, antiinflammatory, cancer C33A, antimold, antifungal, antimicrobial, antitumor, cytotoxic	2, 3, 13, 30, 38, 39, 45, 46, 48, 50, 52, 53, 57
15	*H. atra*	Lectin, Steroidal sapogenins, Triterpene glycoside (Saponin), Etanol, Alkoloid, Flafonoid, Steroid, Fenol,	Antibacterial, anticancer, antioxidant, anti-microbial, anti-fungal	3, 13, 35, 49, 51, 53,
16	*H. nobilis*	Triterpene glycoside (Saponin), Echinoside A	Anti cancer	3, 13
17	*H. hilla*	Triterpene glycoside (Saponin), Flafonoid,	Anti cancer, antioxidant	3, 51,
18	*H. impatiens*	Triterpene glycoside (Saponin)	Anti cancer	3
19	*H. leucospilota*	Triterpene glycoside (Saponin), carotenoids	Anti cancer, antioxidant	3, 53
20	*H. edulis*	Alkoloid, Saponin, Flafonoid, Triterpen, Steroid	Anticancer, antimicrobial, antibacterial	44, 60
21	*H. fuscogilva*	Triterpen glikosida, MUFA, PUFA, SFA	Cytotoxic activity, anti infective agents	54

3.5. Industrial and Derivative Sea Cucumber Products

The use of sea cucumbers as food ingredients if compared to other fishery products in Indonesia is low and less popular, as the cause of the low aesthetic value of sea cucumbers when served. The physical form of sea cucumbers is not attractive, but sea cucumbers are a potential source of biopharmaceuticals and as health food or high protein content [9]. Lifestyle changes, such as diet and low physical activity have led to an increased risk of developing metabolic diseases. The healing process of the disease requires medication, continuous use of chemical drugs have cause new strains of disease, even resistance to certain types of disease. In addition, medical expenses are also required. Thus, alternative efforts are needed to prevent all these risks, namely the use of various bioactive components sourced from living things in the form of functional food ingredients, especially the use of bioactive content from sea cucumbers.

Research to examine the bioactive benefits of sea cucumbers and their direct use as a source of high protein as well as an increase of population and increasing of public knowledge to the benefits of sea cucumbers have increased the demand for sea cucumbers in the international market. This condition has an impact on the stock of sea cucumbers exploitation due to the high economic value of the species. even some types of sea cucumbers reach a price of 3-4 million IDR in the local market in Indonesia. Sea cucumbers are marketed as dry processed products and nutraceuticals in capsule form. The potential health benefits have increased to sea cucumbers demand. The sea cucumber industry produces various derivative products and is distributed in the market at various high economic prices. Derivative products made from the main raw material of sea cucumbers are widely advertised and sold online system. Derived products of sea cucumbers and their commercial benefits and price ranges [Table 3) are marketed :

Table 3 Commercial derivatives of sea cucumbers

No.	Species	Product (Brand)	Function	Manufacture	Product	Price (1000 IDR)	Sources
1.	Gold cucumber (*S. variegates*)	Ron Faelen (Sea cucumber oil)	External wound healing	UD. Zaintisa		50	https://mareen.co.id
2.	Gold cucumber (*S. variegates*)	Dai Ron-sea cucumber capsules	Cell regeneration, coronary heart disease, gout, diabetes mellitus, cholesterol, hypertension, lupus, ulcers, acne, pneumonia, typhoid, tumors, stroke, epilepsy, asthma, osteoporosis, and fractures.	UD. Zaintisa		140	https://mareen.co.id
3.	Gold cucumber (*S. variegates*)	Gamat capsules (HPAI)	Bone health, healing of gout, kidney stones, high blood pressure, DB, diabetes mellitus, hepatitis, chronic ulcers, ovarian cysts, uterine myomas, breast cancer, leaky heart, acne	PT. HPAI (Halal Network International)		130	https://hni.net
4.	Gold cucumber (*S. variegates*)	MSI Gamat Gold Capsules	Treats gout, treats diabetes, lowers bad cholesterol, treats ulcers, pneumonia, anti-tumor, hemorrhoids, natural anti-septic, improves liver function, hepatitis, anti-aging, acne, cell regeneration	PT. MSI (Mahkota Sukses Indonesia)		200	https://mymsi.co.id

5.	Gold cucumber (*S. variegates*)	QNC Jelly Gamat	Cure for high blood pressure, gout, diabetes, relieve asthma, lower cholesterol and triglycerides, stop bleeding hemorrhoids, relieve joint pain (arthritis), relieve stomach pain, chronic ulcers, and acute ulcers, heal burns, cuts and post-operative wounds, a cure for sinusitis, asthma, and tonsillitis, arthritis, bone loss, and calcification of the bones	CV. Jogja Natural Herbal		180	www.bukalapak.com www.tokopedia.com www.shopee.co.id
6.	Gold cucumber (*S. variegates*)	MNJ Jelly Gamat	Relieve inflammation, pain, smooth blood circulation, balance sugar levels, alternative treatment of tumors and cancer, treat hernia disease, increase metabolism	CV, Sami Mandjoer. Yogyakarta		145	www.bukalapak.com www.tokopedia.com www.shopee.co.id
7.	Cucumaria frondosa	Sea Cucumber capsules	Immune system booster, energy and blood circulation	Nammi.is		464	https://nammi.is/sea-cucumber-60-capsules.html
8.	Frondosa	Sea Cucumber Supplements	Anti-oxidant, anti-thrombotic, anti-angiogenic, anti-hypertensive, anti-inflammatory, anti-arthistic, immunity-boosting.	Deep Sea Diamond		1. 271	https://www.deepseadiamond.com/product/100-pure-sea-cucumber/
9.	*Holothuria* sp.	Sea Cucumber Capsules	Diet supplement, stamina enhancer, digestive tract tracker	SB Organic Wild		-	https://www.amazon.com/SB-Organics-Wild-Caught-Reproductive-Enhancement/dp/B07111W7LN

10.	*Holothuria* sp.	Marine Collagen	Healthy bones and joints, skin, hair and nails, supports healthy sleep patterns	Deep Blue Healt		394	https://www.deepbluehealth.co.nz/products/marine-collagen
11.	*Holothuria* sp.	Sea Cucumber Gele	Moisturizing and nourishing skin	The Body Deli Fresh Superfood Skincare		890	https://www.thebodydeli.com/products/sea-cucumber-gelee-and-cucumber-juice-elixir-set
12.	*Holothuria* sp.	Super Collagen Teripang Serum	Repair of skin tissue, skin lightening, removing spots, wrinkles, sagging or blackened eye bags	CMM Indonesia		125	https://www.tokopedia.com/herbalazeter/teripang-serum
13.	*Holothuria* sp.	Batris Serum Collagen	Brightening, firming, skin freshener, eye circles overcome reduced vision, moisturizer, pore-reducing and acne-free.	PT. Batris Herbal Indonesia		100	http://batrisyiaherbalindonesia.com/product/batris-serum-collagen-20ml/
14.	Gold cucumber (*S. variegates*)	MSI Gold Spray Serum	Source of skin nutrition, brightening, regenerating cells, shrinking pores, reducing wrinkles, removing spots, skin tightening	PT. MSI (Mahkota Sukses Indonesia)		85	https://mymsi.co.id https://www.tokopedia.com/nagroup/gold-beauty-glowing-serum-msi?whid=0
15.	Gold cucumber (*S. variegates*)	Sea Cume Sea The Beauty Serum	Anti aging, anti wrinkles, skin refresher and lightening (brighten), skin moisturizer (moisturizing), facial dark spot remover, skin elasticity, face tightening, younger-look	Elok.co.id		550	https://elok.co.id/seacume-serum-anti-aging

16.	*Holothuria* sp.	Orimaru Gamat Serum	Overcoming acne, black spots, pockmarks, reducing facial wrinkles, cell regeneration	CV. Cahaya Multi Mandiri		250	https://panduherba.com/product/serum-gamatteripang/
17.	Gold cucumber (*S. variegates*)	Naluskin Serum	Accelerate the process of wound healing, purulent acne, regeneration of dead skin cells, maintain skin moisture, body serum that protects the skin, accelerates the process	Co. Marine Of Beauty		74	https://shopee.co.id/NALUSKIN-SERUM-KOLAGEN-UNTUK-KULIT-AMAN-UNTUK-IBU-HAMIL-i.37592129.5144063874
18.	*Holothuria* sp.	Revitalizing Serum SR12	Brightening, skin tightening, pore shrinking, preventing new acne, skin health	SR12 Cosmetik. id		85	https://distributorsr12jakarta.com/product/revitalizing-serum-sr12/
19.	Gold cucumber (*S. variegates*)	Gamat Shampoo	Enhances hair softness and makes hair shinier, accelerates hair root growth, strengthens hair	PT. Indonesia Marine Cosmetech Indonesia (IMC)		20	https://teripangmarineskincare.wordpress.com/price/
20.	Gold cucumber (*S. variegates*)	Wahida's special herbal bath soap	Removes dead skin cells, regenerates skin cells, prevents premature aging, anti-septic and anti-aging	CV. Rajawai Emas		12	https://www.tokopedia.com/jadikinclong/sabun-herbal-ekstrak-gamat-wahida

21.	*Holothuria* sp.	Pibi pibo Gamat Soap With Kolagen	Cleansing the skin, removing dead skin so that the skin becomes bright and glowing, moisturizing the skin so it is not easy to dry and dull, reducing irritation to sensitive skin	Pibi pibo		50	https://www.pibipibo.co.id/ https://www.tokopedia.com/mywayshop/pibi-pibo-gamat-soap-with-collagen
22.	*Holothuria* sp.	Vallenza gamat soap	Regenerating dead skin cells, removing spots and acne on the face, smoothing and gentle and protecting radiation, helping to maintain skin moisture, covering cracked skin, skin elasticity, antiseptic agent, anti-aging agent	CV. An Naufa		9.5	https://shopee.co.id/Sabun-Kesehatan-Valleza-Soap-Gamat-90-Gram-i.63543798.1115165181
23.	Gold cucumber (*S. variegates*)	Gamat soap	Cleansing, softening and moisturizing skin, growing dead skin cells, removing acne scars, spots. Collagen keeps skin supple and prevents premature aging. Accelerates the recovery of purulent acne scars, anti-itching skin.	Diamond Green Wealth		50	https://www.bukalapak.com/p/perawatan-kecantikan/perawatan-tubuh-2311/perlengkapan-mandi-2314/7jrtpd-jual-sabun-gamat-gamat-soap
24	*Holothuria* sp.	Gamat Body Lotion Luxor	Dry skin care and chapped skin	PT. Indonesia Luxor		80	http://www.luxor.co.id/body-care https://www.gamatluxorstore.com/
25	*Holothuria* sp.	Gold-G Body Lotion	Moisturizing and softening skin, reduces skin damage caused by sun radiation,	Cospac Sdn. Bhd		50	https://www.lazada.co.id/products/hand-body-lotion-glowing-white-gold-g-gamat-ekstrak-lidah-buaya-handbody-garnier-viva-cream-pemutih-kulit-original-i1690042867.html

26.	Gold cucumber (*S. variegates*)	Sea Cucumber Gamat Cream IMC	Nourishing skin, protecting skin from UV rays	PT. Indonesia Marine Cosmetech Indonesia (IMC)		140	https://teripangmarineskincare.wordpress.com/price/ https://www.bukalapak.com/p/perawatan-kecantikan/produk-kecantikan-lainnya/cn10sz-jual-dijamin-teripang-gamat-cream
27.	*Holothuria* sp.	Mareen's sea cucumber crackers	Snacks rich in health benefits	UD. Zaintisa		15	https://mareen.co.id
28.	*Holothuria* sp.	Sea cucumber tea	Health Tea	Sangrime Tea Company. Korea		-	https://www.tradekorea.com/product/detail/P759540/Sea-cucumber-tea.html?RLGOODS=Frozen%20Boiled%20Sea%20cucumber%20Dice/Slice

4. Conclusion

Sea cucumbers are marine invertebrates with high economic value and have a long history as a traditional food and source of traditional medicinal ingredients. The important benefits of sea cucumbers have been validated through scientific and ethno-pharmacological research. The complexity of bioactive content have potential health benefits and therapeutic functions. Bioactive compounds have been identified, namely chondroitin sulfate, triterpene glycosides (saponins), lectins, heparins, serberosides, ganglosides, bio-active peptides, sterols, omega-6 and omega-3 fatty acids as well as essential and non-essential amino acids. These bioactive compounds are multi-biologically capable of metabolic processes in the body that are important for health problems, namely antiangiogenic, anticancer, anticoagulant, antihypertensive, antiinflammatory, antimicrobial, antifungal, antioxidant, antithrombotic and antitumor. Exploration of the important functions of sea cucumber bioactive compounds as a potential source of high value product is a source of functional food and the nutraceutical industry.

Compliance with ethical standards

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References

[1] Nurkholis, Nuryadin. D, Syaifudin. N, Handika. R, Setyobudi. R. H, and Udjianto. D.W. 2016. The Economic of Marine Sector Indonesia. Journal of Aquatic Procedia. Vol. 7:181-186.

[2] Kustiariyah. 2007. Sea Cucumbers as a Food and Bioactive Source. Bulletin Teknologi Hasil Perikanan. IPB. Vol X No. 1 .

[3] Bordbar, S., Farooq, A. and Saari, N. 2011. High-Value Components and Bioactives From Sea Cucumbers For Functional Foods—A Review. Mar Drugs. Vol. 9(10):1761–1805.

[4] Barber, P. H., Ablan-Lagman, C. A., Ambariyanto., Berlinck, R. G. S., Cahyani, D., E.D. Crandall, R. Ravago-Gotanco., M.A. Juinio-Meñez, I.G.N. Mahardika., K. Shanker., C.J. Starger., A.H.A. Toha., A.W. Anggoro, D.A. Willette. 2014. Advancing Biodiversity Research in Developing Countries: The Need For A New Paradigm. Bulletin Marine Science. Vol. 90:187-210.

[5] Siahaan. E. Amelia and Pangestuti, R. 2017. Review. Marine Fungtional And Neutraceutical: Prospects and Challenges. Journal Ilmu-Ilmu Perairan, Pesisir dan Perikanan. Vol. 6(3):273-281.

[6] Brown, E.O., M. L. Perez., L.R. Garces., R. J. Ragaza., R. A. Bassig and E.C. Sagaroza. 2010. Value Chain Analysis for Sea Cucumber in Philipines. Studies and Reviews 2010. The World Fish Centre. Penang. Malaysia. 44p.

[7] Ridhowati. S dan Asnani. 2015. Amino Acid and Fatty Acid Profile of Belitung Processed Sand Sea Cucumber (*Holothuria scabra*). Jurnal Metematika, Saint dan Teknologi. Vol. 16(2):71-78.

[8] Maureen, M., Pattinasarany dan Manuputty, G. D. 2018. Potential Types of Sea Cucumbers with Important Economic Value in the Seagrass Ecosystem in the Waters of Suli Village, Central Maluku. Jurnal Papalele. Vol. 2(1).

[9] Husain, G., Tamanampo, Jan, F. W.S., and Manu, G. D. 2017. Community Structure Of Sea Cucumber (Holothuroidea) In The Coastal Area Of The Island Of Jailolo Subdistrict Nyaregilaguramangofa South Halmahera Regency West Of North Maluku. Jurnal Ilmiah Platax.Vol. 5(2):177-188.

[10] Aydin. M and Erkan. S. 2015. Identification and Some Biological Characteristics of Commercial Sea Cucumber In The Turkey Coast Waters. International Journal of Fisheries and Aquatic Studies. Vol 3(1):260-265. ISSN: 2347-5129.

[11] Yenti. F., Apriandi. A., dan Suhandana. M. 2019. Utilization of Sand Sea Cucumber (*Holothuria scabra*) as a Functional Drink. Journal Marinade. Vol. 02(02):23-29. e-ISSN: 2654-4415.

[12] Herliany. N. E., Nofridiansyah. E and Sasongko. B. 2016. Dried Sea Cucumber Processing Study. Journal Enggano. Vol. 1(2):11-19.

[13] Wulandari. N., Krisanti. M dan Elfidasari. D. 2012. Diversity of Sea Cucumbers from Pramuka Island, Seribu Islands, Jakarta Bay. Unnes Journal of Live Science. Vol. 1(2).

[14] Meydia., Suwandy. R., dan Suptijah. P. 2016. Isolation of Steroid Compounds from Gama Sea Cucumbers (*Stichopus variegatus*) with Various Types of Solvents. JPHPI. Vol. 19(3):363-370.

[15] Fad'ha. G., Arma. U., and Busman. 2017. Antibacterial Activity Test of Gamat Sea Cucumber Extract (*Sticophus variegates*) from the Mentawai Islands Against *Streptococcus viridans* Bacteria. Journal B-Dent. Vol 4(1):52-60.

[16] Aziz. A. 1996. Food and How to Eat Various Types of Sea Cucumbers. Osenan. Vol. 21(4):43-59.

[17] Nurwidodo., Rahardjanto, A., Husamah., Mas'odi dan Hidayatullah, M. S. 2018. Easy Guidebook for Cultivating Sea Cucumbers. Malang. CV. Kota Tua Jalan Sunan 27b.

[18] Setyastuti, A., Wirawati. I., Permadi. S., Bayu. V. I. 2019. Indonesian Sea Cucumbers: Types, Distribution and Economic Value Status. Jakarta. PT. Media Sains Nasional.

[19] Suryaningrum, T. D. 2008. Sea Cucumbers: Their Potential as Nutraceutical Ingredients and Processing Technology. Jurnal Squalen. Vol. 3(2):63-69.

[20] Wulandari, D.A., Syahputra, G. and Putra, M. Y. 2020. The Bioactive Compound and Mechanism of Action of Sea Cucumber (Holothuridae) As Anticancer: A review. Journal Pure App. Chem. Res. Vol 9(3):153-170.

[21] Cahyati, M., Anindita, A. R. Priska., Kusuma, W. Nabilah., dan Adam, S. A. 2018. Utilization of Nanotechnology-Based Antioxidants (Glutathione) of Golden Sea Cucumber (Golden sea cucumber: *Sticophus variegates*) in Oral Cancer Squamous Cell Apoptosis. E-Prodent Journal of Dentristry. Vol. 2(2):149-154.

[22] Purcell, Steven, W., Samyn, Y and Conand, C. 2012. Commercially Important Sea Cucumber s Of The World. FAO Species Catalog For Fishery Purposes No. 6. ISSN.1020-8682.

[23] Handayani, T., Sabriah, V dan Hambuako, Ronald, R. 2017. Composition of Sea Cucumber Species (Holothuroidea) in the Waters of Kapisawar Village, Meos Mnaswar District, Raja Ampat Regency. Jurnal perikanan Universitas Gadjah Mada. Vol. 19(1):45-51.

[24] Shiell, Glenn. 2004. Field Observations of Juvenile Sea Cucumbers. SPC Beche-de-mer Information Bulletin. https://www.researchgate.net/publication/242696227.

[25] Karnila, R., stawan, M., Sukarno dan Wresdiyati, T. 2011. Characteristics of Sand Sea Cucumber (*Holothuria scabra* J.) Concentrate with Acetone Extracting Material. Jurnal Perikanan dan Kelautan. Vol. 16(1):90-102.

[26] Safithri, M., Setyaningsih, I., Tarman, K., Suptijah, P., Yuhendri, V. M. Y dan Meydia. 2018. Potential of Gold Cucumber Collagen as a Tyrosinase Inhibitor. JPHPI. Vol. 21(2):295-303.

[27] Setyastuti, A., Wirawati, I and Iswari, Marindah, Y. 2018. Identification and distribution of sea cucumber exploited in Lampung, Indonesia. Biodiversitas. Vol 19(2): 646-652. https://www.researchgate.net/publication/324526529.

[28] Altamirano, J. P. (2017). Issues and challenges in sustainable development of fisheries of the Southeast Asian Region: Marine species under international concern: Sea cucumbers. In The Southeast Asian State of Fisheries and Aquaculture 2017 (pp. 66-74).

[29] Elfidasari, D., Noriko, N., Wulandari, N dan Perdana, Analekta, T. 2012. Identification of Types of Sea Cucumbers in the Holothuria Genus from the Waters Around the Seribu Islands Based on Morphological Differences. Jurnal Al-Azhar Indonesia Seri Sains dan Teknologi. Vol. 1(3):140-146. https://www.researchgate.net/publication/296058840.

[30] Padang., A., Lukman, E., Sangadji, M dan Subyanto, R. 2016. Maintenance of Sand Sea Cucumbers (*Holothuria scabra*) in Confinement Pen. Jurnal Agribisnis dan Perikanan. Vol. 9(2).

[31] Asmiyenti, Djalil, D., Andika. Ivani, R and Genatrika, E. 2019. Anti-acne Cream Formulation of Sand Sea Cucumber (*Holothuria scabra* Jaeger) . Jurnal Farmasi Galenika. Vol. 4(3): 84-92.

[32] Sulardiono, B. 2016. Potential Use of Sea Cucumbers (Holothurians) in Karimun Jawa Waters, Jepara Regency, Central Java Province. Buletin Oseonografi Marinia. Vol. 5(1): 64-72. http://ejournal.undip.ac.id/index.php/buloma.

[33] Dissanayake, D. C.T and G. Stefansson. 2012. Habitat preference of sea cucumbers: *Holothuria atra* and *Holothuria edulis* in the coastal waters of Sri Lanka. Journal of the Marine Biological Association of the United Kingdom. Vol. 92(3): 581-590. https://www.researchgate.net/publication/259419985.

[34] Tangko, A. Malik. 2009. Present Status of Sea Cucumber Production and Cultivation in South Sulawesi. Jurnal. Media Akuakultur Vol. 4 (1):32-39.

[35] https://www.republika.co.id/berita/internasional/abc-australia-network/14/04/30/n4suvx-wowharga-teripang-di-pasar-cina-34-juta-per-kilogram

[36] https://bursabisnis.id/harga-teripang-capai-harga-rp-44-juta-per-kilogram/

[37] https://travel.kompas.com/read/2020/04/06/120300427/mengapa-teripang-mahal-harganya-capai-rp-50-juta-

[38] https://arsiphukumbisnis.weebly.com/blog/ini-daftar-harga-teripang-terbaru-di-tahun-2017.

[39] Nursid, M., Maharani, A. Putri., Riyanti, and Maraskuranto, Endar . 2016. Cytotoxic Activity And Secondary Metabolite Characteristics Of Sea Cucumber *Actinopyga* sp. Methanolic Extract. Squalen Bulletin of Marine and Fish. Postharvest and Biotech. Vol. 11(1): 23-30.

[40] Yenti, Fitri., Apriandi, Azwin dan Suhandana, M. 2019. Utilization of Sand Sea Cucumber (*Holothuria scabra*) as a Functional Drink. Jurnal Marinande. Vol.02(02):23–29. http://ojs.umrah.ac.id/index.php/marinade.

[41] Mahmudah, R., Mu'nisa, A dan Ngitung, R. 2019. Identification of Bioactive Compounds in Black Sea Cucumber Extract (*Holothuria edulis*). Prosiding Seminar Nasional Biologi IV. 609:613.

[42] Ridzwan, B. H., Hanita, M.H., Nurzafirah, M.P., Norshuhadaa, S and Hanis, Z. Farah. 2014. Free Fatty Acids Composition in Lipid Extracts of Several Sea Cucumbers Species from Malaysia. International Journal of Bioscience, Biochemistry and Bioinformatics, Vol. 4, No. 3: 204-207.

[43] Ringo, Victor. S., Kadiwijati, L. R., Yuniantika, O dan Murniasih, T. 2017. Formulation of 96% Ethanol Condensed Extract Capsules of Keling Sea Cucumber (*Holothuria atra*) and Antibacterial Activity Test. Journal Indonesia Natural Research Pharmaceutical . Vol. 2(1): 45-55.

[44] Oedjoe, Marcelien Dj Ratoe and Eoh, Crisca B. 2015. Diversity of Sea Cucumbers (Echinodermata: Holothuroidea) in Sabu Raijua Waters, Sabu Island, East Nusa Tenggara. Jurnal Ilmu dan Teknologi Kelautan Tropis. Vol. 7(1): 309-320.

[45] Burhan, Asril ., Marwati., Hardianti, Besse dan Hasan, Waode .R. 2019. Anti-inflammatory Test of Combination Extract of Sand Sea Cucumber (*Holothuria scabra*) and Kersen Leaves (*Muntingia clabura* L.) on Rats (Rattus norvegicus). Jurnal Ilmiah Manuntung. Vol. 5(1):26-29.

[46] Damaiyanti, D. 2015. Characterization Of Water Extract Golden Sea Cucumber (*Stichopus hermanii*). Denta. Jurnal Kedokteran Gigi. Vol. 9(1):74-81.

[47] Shakouri, Arash., Shoushizadeh, M, Reza and Nematpour, Fatemeh. 2017. Antimicrobial Activity of Sea Cucumber (*Stichopus variegatus*) Body Wall Extract in Chabahar Bay, Oman Sea. Research Article Jundishapur J Nat Pharm Prod. 12(1).

[48] Wiadnyana, Ngurah Nyoman ., Puspasari, Reny dan Mahulette, R. Thomas. 2008. Status of Sea Cucumber Resources and Fisheries in Indonesia: Utilization and Trade. Jurnal Kebijakan Perikanan Indonesia. Vol. 1 (1): 45-60.

[49] Afrely, Riya, W., Rosyidi, M. Imron dan Fajariyah, Susantin. 2015. Diversity of Holothuroidea Types in the Intertidal Zone of Pancur Beach, Alas Purwo National Park. Jurnal Ilmu Basics, Vol. 16(1):23-28.

[50] Arifin, Haris N., Ningsih, Rachmawati., Fitrianingsih, Avin A and Hakim, Abdul. 2013. Antibacterial Activity Test Sea Cucumber Ectract (*Holothuria scabra*) Sidayu Coast Gresik Using Disk Diffusion Method. Journal Alchemy. Vol. 2(2):101 – 149.

[51] Setyastuti, A and Purwati, P. 2015. Species list of Indonesian Trepan. SPC Beche-de-mer Information Bulletin.p9-25. https://www.researchgate.net/publication/280495107.

[52] Noor, Siti .U and Gozali, Amelia. 2018. Eff ect of Gold Sea Cucumber (*Stichopus hermanni*) Extract Concentration on Antioxidant Activity of Grape Seed Oil (*Vitis vinifera*) Nanoemulsion. Jurnal Ilmu Kefarmasian Indonesia. Vol. 16(1):36-41.

[53] Yuliana., Ilyas, Asriani dan Sruriani. 2017. Isolation of Bioactive Compounds in Ethanol Extract of Sand Sea Cucumbers (*Holothuria scabra*) in the Selayar Islands. Jurnal Al-Kimia. Vol. 5(1):71-80.

[54] Mulawarmanti, D. (2019). Marine Biota as an Alternative Medicinal Ingredient (Use of Golden Sea Cucumbers as Adjuvant Therapy in Dentistry). Prosiding Seminakel. https://prosidingseminakel.hangtuah.ac.id/index.php/jurnal/article/view/24

[55] Rumlus, R., Semangun, H., Karnaradjasa, O dan Mangimbulude, J. C. 2015. Diversity of Sea Cucumber Types in Fafanlap and Gamta, Misool Islands, Raja Ampat Regency, West Papua and Activity Test for Chemical Compound Content. Jurnal Bonorowo Wetlands. Vol. 5(1) : 1-10. DOI: 10.13057/bonorowo/w050101

[56] Umboh, P.M.T., Wewengkang, Defny. S dan Yamlean, Paulina. V.Y. 2018. Antibacterial Activity of *Holothuria atra* Sea Cucumber Fraction Against Escherichia coli and *Staphylococcus aureus* Bacteria. Jurnal Ilmiah Farmasi Pharmacon. Vol . 7(4) : 88-97.

[57] Ervita, F., Sulstrianah dan Hafizah, I. 2015. Antibacterial Bioactivity of Ethanol Extract of Sand Sea Cucumber (*Holothuria scabra*) Against the Growth of *Klebsiella pneumonia* in Vitro. Jurnal Medula. Vol. 3 (1): 208-213.

[58] Pangestuti, Ratih dan Arifin, Zainal. 2018. Medicinal and Health Benefit Effects of Fungtional Sea Cucumbers. Journal Of Traditional and Complementary Medicine. Vol. 8 : 341-351. http://www.elsevier.com/locate/jtcme

[59] Han, Qi-an., Li, Kaifeng., Dong, Xiuping., Luo, Yongkang and Zhu, Beiwei. 2018. Fungtion of *Thelenota ananas* Saponin Desulfated *Holothuria atra* in Modulating Cholesterol Metabolism. Scientific Reports. www.nature.com/sciientificreports

[60] Darsono, Prapto. 2002. Sea Cucumber Resources on Derawan Islands, East Kalimantan. Jurnal Oseana. Vol. XXVII(1): 9-18.