Omni-Akuatika Special Issue The 4th KRIPIK-SciFiMaS 2022: 101-111
ISSN: 1858-3873 print / 2476-9347 online

Research Article

journal homepage: http://ojs.omniakuatika.net

Review: Nutritional Value and Health Benefit of Sea Urchin

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Received 9 November 2021; Accepted 24 February 2022; Available online 18 April 2022

ABSTRACT

Varieties of sea urchins can be found in the Indonesian`s ocean. Indonesian have been used it as food and medicine. Research about sea urchins had been conducted to give scientific evidence for further usage. This article will provide information about biological structure, nutritional value, and biological activities of sea urchins. The habitat and morphological structure will be described. Nutritional compound that had been identified from sea urchin are carbohydrate, essential amino acid, essential fatty acid, vitamin, carotenoid, mineral, and albumin. Sea urchin also contained some bioactive compound such as polysaccharides, sulphated polysaccharide, and fucoidan. Traditionally, sea urchins have been used as antiinflammation, antimicrobial, antioxidant, anticancer, anti-fatigue, antidiabetic, and anti-allergic agent. Several biological activities that have been proved scientifically are antioxidant, anticancer, antimicrobial, antiinflammation and anti-haemolytic activity either from the extract or bioactive compound. Therefore it can be concluded that sea urchin have numerous potential bioactive compounds that can be developed into pharmaceutical and/or nutraceutical product.

Keywords: Sea urchin, morphology, nutrition, bioactivities, bioactive compound

Abstrak

Beberapa jenis bulu babi dapat ditemukan di wilayah laut Indonesia. Masyarakat Indonesia telah memanfaatkan bulu babi sebagai makanan dan obat-obatan. Penelitian mengenai bulu babi telah dilakukan untuk memberikan bukti ilmiah terhadap pemanfaatan bulubabi lebih lanjut. Artikel ini akan memberikan informasi mengenai struktur biologis, nilai gizi, dan aktivitas biologis bulu babi. Habitat dan struktur morfologi bulu babi juga akan dijelaskan pada artikel ini. Gizi yang terkandung dari bulu babi antara lain karbohidrat, asam amino esensial, asam lemak esensial, vitamin, karotenoid, mineral, dan albumin. Bulu babi juga mengandung beberapa jenis senyawa bioaktif seperti polisakarida, polisakarida sulfat, dan fucoidan. Secara tradisional, bulu babi telah digunakan sebagai antiinflamasi, antimikroba, antioksidan, antikanker, anti-kelelahan, antidiabetes, dan anti-alergi. Beberapa aktivitas biologis yang telah dibuktikan secara ilmiah adalah aktivitas antioksidan, antikanker, antimikroba, antiinflamasi dan antihemolitik baik yang berasal dari ekstrak maupun senyawa bioaktifnya. Dengan demikian dapat disimpulkan bahwa bulu babi memiliki banyak potensi senyawa bioaktif yang dapat dikembangkan menjadi produk farmasi dan/atau nutraceutical.

Kata kunci: Bulu babi, morfologi, nutrisi, bioaktivitas, senyawa bioaktif.

Introduction

Sea urchin can be found in varied ocean niche, ranging from artic to tropical region. They belong to class echinoids that live in shallow water and abyssal depths. They have various color with size up to 14 inches (Agnello, 2017). Sea urchin is high value commodities and categorized as one of the pricey among seafood sold in the market; it reaches up to ~6.3 US$ per kilogram of urchin. In 2008, the production volume approximately exceeds 97,000 tons, with the highest production were *Strongylocentrotus* (40,000 tons) and *Loxxechinus albus* (more than 10,000 tons) (FAO, 2010).

Sea urchins have been used and developed as food and/or medicinal product as they proved to be highly nutritious and contained secondary metabolites with various biological activities. The gonads of this animal have been used as a regular staple food in Chili, Japan, California Alaska, and New Zealand. Additionally, people who live in South East Sulawesi, Indonesia believed that the gonads of sea urchin can be used as food supplement and increase their stamina (FAO, 2010). Studies by Braga-deeswaran et al. 2013 and Chen et al., 2010 showed that sea urchin contains amino acids, natural carotenoid, and fatty acid. The fresh and dried sea urchin contain 8.20% and 57.8% protein, 1.14% and 9.36% fat, 1.1-1.86% ash content, respectively. Additionally, gonad sea urchin and sea urchin embryos also have anticancer, antioxidant, antimicrobial, anti-inflammation, and antihaemolytic properties (Archana & Babu, 2016; Francis & Chakraborty, 2020a, 2020b; Kazemi et al., 2016; Qin et al., 2011; Sousa et al., 2009; Zhou et al., 2012). In some area, sea urchin has been used as functional food and immune system enhancer.

Comprehensive review articles about sea urchin are still limited, therefore this article will provide information about biological structure, nutritional value, and health benefit of sea urchin including e.g., anticancer activity, antimicrobial, antioxidant and antiinflammation, and its bioactive metabolites. Hopefully, this article can be used as a reference for the future research in the development of marine biota, especially sea urchin for nutraceutical and pharmaceutical product.

Biology of Sea urchin

Sea urchins are members of the echinoids class, part of Echinodermata phylum. They live in diverse niche in the ocean i.e., hard, rock pools, benthic surfaces, coral reefs, mud, and wave-exposed rocks, where there is algal abundance as their food. They can be found in mid to low intertidal zones of the ocean, with depths reach approximately 50 m below the sea surface. Sea urchins are nocturnal organisms, and they are sensitive to light, therefore they used their spines to move to reach shady area. They move into holes or crevasses as a shelter protect themselves from the strong sea tides and waves (Agnello, 2017). The tubular feet or podia of the sea urchin absorb oxygen, grasp algae for their diet, and clean their body surface. Podia placed in rows alternate with the spines, and they have well-developed suckers functionalized as attachment part. Podia receptive to chemical substances and touch. Meanwhile, the spines work as protector, grab and clasp food, and for the movement. They move slowly though crawling with tube feet and push the body using its spines (Agnello, 2017). The body form is radically proportioned, and the skin have diverse pigments such as pink, pale yellow, red, purple, green, or black. Gonads, which contain carotenoid pigments, also have varied pigments with yellow and orange as the most desirable color and white, tan, brown, black, or green to identify the undesirable gonads (Harris & Eddy, 2015).

The body of sea urchin has aboral (top) and oral (bottom) part. The surface of aboral consist of the anal section as excretory organ, gametes discharge organ, and as vascular system that control water distribution. Their body form is spherical and enveloped with mobile spines which covers 50% body weight of the sea urchins. The oral part consists of mouth, peristomal membrane, spines, and podia. The peristomal membrane make the mouth area to be able to make motion (Toha et al., 2017).

Gonad is sea urchin genital gland that stores nutrients. It also contains milt and roe during the spawning season. The reproduction process interlink with several factors such as nutrient accretion, nutrient transfer from nourish cells to gametogenic cells, gametes accumulation, and spawning (Harris & Eddy, 2015). The gonad development involve several stages such as mature, spent, regenerating, growing, and premature condition. Gonads are the most nutritive part of sea urchin which contain glycogen, protein, and lipid.

Nutritional Value

Sea urchins have high protein content (Verachia et al., 2012), lipid, carbohydrate, vitamin A, vitamin E, and trace element or minerals. Fresh sea urchin contains 7.04-8.20% of protein and 1.14-1.35% of fat. Meanwhile, dried sea urchin contains 51.8-57.8% of protein and 8.53-9.36% of fat. Archana & Babu (2016) reported the result of proximate analysis from fresh *S. variolaris* and *P. lividus*. It showed that the moisture content of both samples was 77.53% ± 0.80 and 79.65 ± 0.65%, the protein content was 12.10 ± 0.41% and 12.03 ± 1.26%, the fat content was 4.98 ± 0.3% and 3.05 ± 0.5, the carbohydrate content was 1.63 ±0.18% and .02 ± 0.12%, and the ash content was 3.76 ± 0.25% and 2.25 ± 0.24%, respectively. Vilalba et al., (2021) showed the result of proximate analysis from sea urchins *Echinometra vanbruti* contained 7.7-9.6% and 9.5-12.3% of fatty acid ad protein, respectively. Other studies reported that *P. lividus* had protein content about 12.03% (Mora et al., 2008) and *S. variolaris* 4.98 ± 0.3% (Verachia et al., 2012). According to these results, the highest protein content was from *S. purpuratus* and *P. lividus*. High amount of protein was identified in the gonads of sea urchins. Therefore, this organ can be used as an alternative sources of protein diet (Fabbrocini & D'Adamo, 2011). The minerals that were

Table 1. Proximate value of various sea urchin

Proximate (%)	Type of Sea Urchin (wet weight basis)			
	S. variolaris[1)]	***P. lividus***[1)]	***S. franciscanus***[2)]	***S. purpuratus***[2)]
Protein content	12.10 ± 0.41	12.03 ± 1.26	7.7 - 9.6	9.5 - 12.3
Fat content	4.98 ± 0.3	3.05 ± 0.5	7.6–8.3	5.4–5.2
Carbohydrate content	1.63 ±0.18	3.02 ± 0.12	1.0 – 3.0	1.0 – 3.0
Ash content	3.76 ± 0.25	2.25 ± 0.24	1.6–1.5	1.3 –1.7
Moisture content	77.53 ± 0.8	79.65 ± 0.65	72.0 – 82.0	75.0 – 84.0

reported were iron (0.96%), magnesium (1.90%), and zinc (0.022%). Comprehensive proximate analysis result from various sea urchin was showed in Table1.

Diadema setosum, a species of sea urchins, reported to have a high vitamin E content (23.47 mg per 100 gr sample) and vitamin A (0.79 mg ≈ 2983.93 IU per 100 gr sample). Vitamin E and vitamin A are antioxidant that can neutralize free radicals, inhibit lipid oxidation process, dan treat or prevent malignancy (Vasanthi et al., 2012). Deficiency of vitamin E in the human can instigate arthritis, neurological ailments, malabsorption of lipid, and development of atherosclerotic plaques (Mann & Truswell, 2017). Meanwhile, consumption of vitamin E in suitable doses can restore homeostasis balance of the cell, protection against oxidative stress effect, inhibit or reducing the progression of degenerative disorders and aging (Mocchegiani et al., 2014). Vitamin A functionalize as one of the regulator of immune factors, improving visual function of the eye, and maintain epithelial tissue physiology (Hall et al., 2011).

Anticancer Activity

Sea urchins have been reported as potential source of metabolites with anticancer activity. The dichloromethane (DCM) extract and

Table 2. Anticancer activity of sea urchin

Species	Part used	Bioactive compound	Cancer cell	Doses and mechanism	Ref.
Strongylocentroutus intermedius	Intestine	3′-Sulfonoquinovosyl-1′-monoacylglycerol	Lung cancer A-549	83.5 µg mL^{-1} 75.5 µg mL^{-1} (neuroblastoma cell growth inhibition)	(Sahara et al., 2002)
Allamanda schottii	Embryos	n.m	Leukemic cell line (K562 cell line)	33.1- 103.7 µg mL^{-1} (antimitotic activity of DCM fraction)	(Sousa et al., 2009)
Allamanda schottii	Egg	n.m	Leukemic cell line (K562 cell line)	10.2 µg mL^{-1} (anti-proliferative of DCM fraction)	(Kim et al., 2005)
Lytechinus pictus	Embryos	3′-Azido3′-deoxythymidine (AZT)	primary mesenchyme cells (PMCs)	10.2 µg mL^{-1} (anti-proliferative and mitotic)	(Nishioka et al., 2003)
Hemicentrotus pulcherrimus	All parts	Sulfated polysaccharide XB-1	HeLa, MCF-7 and A549 cells	50 µg mL^{-1} (cell growth inhibition)	(Jiao et al., 2015)
trongylocentrotus nudus	Eggs	Polysaccharide	Hepatocellular carcinoma in H22-bearing mice	6 mg $kg^{-1}day^{-1}$ for 12 days (n.m.)	(Wang et al., 2011)
Diadema savignyi	Gonad	Sulfolipids steroid	promyelocytic leukaemia HL-60, prostate cancer PC-3, and colorectal cancer SNU-C5 human cancer cells	4.95±0.07 to 6.99±0.28 µM (Regulate mitogen-activated protein kinase (MAPK) signalling)	(Thao et al., 2015)
Strongylocentrotus nudus	Gonad	Lipid	Human liver cell line HEPG2	1.2 –2 mg mL^{-1} (inducing apoptosis)	(Yang et al., 2020)

steroids compounds from *D. savignyi* showed potential anticancer activity in vitro when tested against human leukimia cell line (HL-60), adenocarcinoma (PC-3), and cellosaurus cell line (SNU-C5) (Thao et al., 2015). Several compounds that have been successfully identified were bonellinin, sulfolipids, scopoletin, plumericin, ursolic acid, and sitosterol (Sahara et al., 2002; Jiao et al., 2015; Kim et al., 2005; Thao et al., 2015; Shang et al., 2014)). Polysaccharide from S. nudus gonad reported to had anticancer activity against hepatocellular carcinoma (Shang et al., 2014). Other studies reported a water-soluble polysaccharide from sea urchin intestine with anticancer activity against human gastric tumour cells (SGC-7901) and hepatoma cell (Bel-7402) (Zong et al., 2012). A sulfoquinovosyl monoacyl glycerol isolated from the intestine of sea urchin effectively inhibited the growth of solid tumours (Sahara et al., 2002). Various compounds that have been isolated from sea urchin with anticancer activity were 3′-Sulfonoquinovosyl-1′-monoacylglycerol, 3′-Azido3′-deoxythymidine (AZT), Sulfated polysaccharide XB-1, polysaccharide, sulfolipids, steroid, lipid, can be found in sea urchin reported as potential anti-tumour agent the anticancer activity of various compounds and extracts from sea urchin were shown in Table 2.

Antimicrobial Activity of Sea Urchin

The photic zone where sea urchin inhabits is a suitable area for microbial growth (Abubakar et al., 2012; Solstad et al., 2016). The microbial population may consist of some pathogenic microbial, therefore invertebrates gain innate defence system like the coelomocytes and metabolites like lectins, complement factors, antimicrobial peptides, and lysozymes to combat them (Solstad et al., 2016; Abubakar 2012).

There were reports about antibacterial activities of various sea urchin's species such as *Echinometra mathaei*, *Tripneustes gratilla*, *Echinus esculentus, Diadema setosum*, and *Strongylocentrotus droebachiensis* (Shushi-zadeh et al., 2019; Kazemi et al., 2016; Yusuf et al., 2020). The methanol and chloroform extract of *Tripneustes gratilla* gonad and gut showed antimicrobial activities against *S. aureus, E. coli*, and *S. typhi* (Abubakar 2012). Other study by Shushizadeh et al. (2019) reported that all extract from gut, gonads, tests, shell, and spines of *Echinometra mathaei* showed antimicrobial activity against Gram-negative (*Escherichia coli* and *Pseudomonas aeruginosa*), Gram-positive bacteria (*Staphylo-coccus aureus* and *Bacillus subtilis*), and fungi (*Candida albicans* and *Aspergillus niger*). The result also indicate that the test and spines extract were more effective, compare to the other organs extract. The hexane solvent procures the best MIC value compared to methanol and chloroform, 12.5 mg mL^{-1} for *E. coli*, *P. aeruginosa*, and *S. aureus* and 3.12 mg mL^{-1} for *B. subtillis*. In contrast, other study about antibacterial activity of *E. mathaei* extract showed that the spine extract did not show antibacterial potential (Kazemi et al., 2016). While the gonads showed inhibition against *S. mutans* and *S. sobrinus* and the test extract could inhibit *S. sobrinus* growth.

There was report about the antibacterial activity of the extract from the gonad and shell of *Diadema setosum* against *Salmonella*, *E. coli* and *S. aureus* (Yusuf et al., 2020). Additionally, Shamsuddin et al. (2010) showed that the inner tissue extracted of *Diadema setosum*, *D. savignyi* and *Echinomatrix calamaris* from the seabed of Pulau Bidong, Terengganu had broad spectrum antibacterial activities against both gram positive and negative bacteria.

The coelomocytes, cells residing in the coelomic fluid and tissues of sea urchin, had immunological functio. Several compounds that were identified and isolated form coelomocytes reported to had antimicrobial activity. Solstad et al. (2016) successfully identified three antimicrobial peptides (AMPs) from the coelomocytes of *Echinus esculentus* i.e., EeCentrocins 1, 2 and EeStrongylocin 2. The EeCentrocins 1 exhibited effective antibacterial activity against the Gram-positive bacteria, C. glutamicum and S. aureus (MIC = 0.78 µM against both) and the Gram-negative bacteria, E. coli and P. aeruginosa (MIC = 0.1 and 0.78 µM respectively). The MIC of EeStrongylocin 2 was found to be 1.56 µM for *C. glutamicum*, 3.13 µM for *S. aureus*, 0.78 µM for *E. coli* and 1.56 µM for *P. aeruginosa*. Because of the challenging purification, the EeCentrocin 2 was still mixed with another unidentified antimicrobial peptide, Ee4635. Still, the fraction had antibacterial activity. The coelomocytes of *Strongylocentrotus droebachiensis* was another source of potential AMP, centrocin 1 and cetrocins 2 (Li et al. 2010). Both compounds were cysteine-rich AMPs which were active against Gram negative (*L. anguillarum* and *E. coli*) and Gram positive (*C. glutamicum* and *C. aureus*) bacteria.

The in vitro antimicrobial activity test by using red spherule cells (RSC), the pigmented coelomocytes, lysates from *P. lividus* able to inhibit bacterial growth by ~45% for Bacillus sp. ($p < 0.001$), 61% for *S. cerevisiae* ($p = 0.003$), and 17.8% for E. coli ($p < 0.001$) when compared to untreated (control) microbes (Coates et al. 2018). The naphthoquinone pigment, echino-

Table 3. Antimicrobial activity of sea urchin

Species	Location	Part used	Bioactive compound	Microorganism tested	Doses	Ref.
Tripneustes gratilla	Indian Ocean at Bamburi area lagoon, Kenya	Gut, gonad	n.m.	*E. coli* *S. aureus* *S. sonnei* *S. typhi* *P. aeruginosa* *Penicillium* sp	400 mg mL^{-1} sample in chloroform and methanolic extract	(Abubakar et al.,2012)
Echinometra mathaei	Coasts of the Boushehr, Persian Gulf	Shell, gonads, gut, spines, and tests	n.m.	*B. subtilis* *E. coli* *S. aureus* *P. aeruginosa* *C. albicans* *A. niger*	50 mg mL^{-1} chloroform and methanolic extract	(Shushizadeh et al., 2019)
Diadema setosum	Cape of Palette, South Sulawesi	Gonad and shell	n.m.	*E. coli* *Salmonella* *S. aureus*	250 mg mL^{-1} methanol and ethyl acetate extract	(Yusuf et al., 2020)
Echinus esculentus	The coast of Tromsø, Norway	Coelomocytes	EeCentrocin 1	 *C. glutamicum* *S. aureus* *E. coli* #1 *P. aeruginosa* #1	MIC 0.78 µM 0.78 µM 0.1 µM 0.78 µM	(Solstad et al., 2016)
			EeCentrocin 2 heavy chain	 *B. subtilis* *C..glutamicum* *S. aureus* *S. epidemidis* #1 *S. epidemidis* #2 *E. coli* #1 *E. coli* #2 *P. aeruginosa* #1 *P. aeruginosa #2* *A. pullulans* *C. albicans* *Cladosporium sp.* *Rhodotorula sp.* *S. cerevisiae*	MIC 6.25 µM 0.78 µM 6.25 µM 3.13 µM 3.13 µM 1.56 µM 6.25 µM 0.78 µM 6.25 µM 25 µM 50 µM 12.5 µM 3.13 µM 12.5 µM	
			EeStrongylocin 2	 *C..glutamicum* *S. aureus* *E. coli* #1 *P. aeruginosa* #1	MIC 1.56 µM 3.13 µM 0.78 µM 1.56 µM	
Strongylocentrotus droebachiensis	The coast of Tromsø, Norway	Coelomocyte	Centrocin 1	 *L. anguillarum* *E. coli* *C. glutamicum* *S. aureus*	MIC 2.5 µM 1.3 µM 1.3 µM 2.5 µM	(Li et al., 2010)
			Centrocin 2	 *L. anguillarum* *E. coli* *C. glutamicum* *S. aureus*	MIC 2.5 µM 2.5 µM 1.3 µM 5.0 µM	
Echinometra mathaei	Persian Gulf	Gonad	n.m.	*S. mutans* *S. sobrinus*	600 µg acetonitrile and ethanol extract	(Kazemi et al., 2016)
	Persian Gulf	Tests	n.m.	*S. mutans*	600 µg ethanol extract	
Diadema setosum,	The sea-bed of Pulau Bidong, Terengganu, Malaysia	Inner-tissue	n.m.	*K. pneumonia* *P. aeruginosa* *E. coli* *S. aureus* *E. faecalis*	50 mg mL^{-1} ethanol extract	(Shamsuddin & Noraznawati, 2010)
				P. aeruginosa *E. coli* *S aureus*	50 mg mL^{-1} methanol extract	
		Outer layer	n.m.	*B. cereus* *S aureus*	50 mg mL^{-1} methanol extract	

Table 3. Continue

Species	Location	Part used	Bioactive compound	Microorganism tested	Doses	Ref.
D. savignyi	The sea-bed of Pulau Bidong, Terengganu, Malaysia	Inner-tissue	n.m.	*S. typhimurium* *E. coli* *S. aureus* *E. faecalis*	50 mg mL^{-1} ethanolic extract	(Shamsuddin & Noraznawati, 2010)
				K. pneumonia *P. aeruginosa* *E. coli* *S. aureus*	50 mg mL^{-1} methanol extract	
		Outer layer	n.m.	*B. cereus*	50 mg mL^{-1} methanol extract	
Echinomatrix calamaris	The sea-bed of Pulau Bidong, Terengganu, Malaysia	Inner-tissue	n.m.	*E. faecalis*	50 mg mL^{-1} methanol extract	(Shamsuddin & Noraznawati, 2010)
		Outer layer	n.m.	*S. aureus*	50 mg mL^{-1} methanol extract	

P*sammechinus miliaris coelomocytes* and deem responsible for the antimicrobial activity. RSC will release echinochrome A to sequester iron when there are microbes in the environment. The RSC prevent the systemic distribution of the microbes and trigger the release of echinochrome A which neutralize ROS and NOS. The echinochrome A which had iron-chelating properties works as a microbial deterrent and antioxidant to reduce the possibility of collateral damage.

Antioxidant Activity of Sea Urchin

The gonads of several sea urchins such as, *Arbacia lixula, Stomopneustes variolaris, Strongylocentrotus nudus, Psammechinus miliaris, Salmacis bicolor* etc, are potential source of antioxidant compounds such as carotenes, polyhydroxylated naphthoquinones (PHNQ's), and xanthophylls (Cirino et al., 2017; Archana & Babu, 2016; Qin et al., 2011; Zhou et al., 2012; Francis & Chakraborty, 2020a; Francis & Chakraborty, 2020b; Kelly et. al., 2013). They obtained the compounds through biochemical conversion from dietary precursors or from the diet. High concentration of antioxidant compounds often found in the reproductive organ because of its importance in the reproductive process (Kelly et. al., 2013). The component and concentration of the compounds were varied among species, possibly because the influence of their diet and physiological activities i.e., the reproductive phase (Cirino et al., 2017).

Astaxanthin, a xanthophyll carotenoid compound, had various health benefits for the prevention and co-treatment of metabolic syndrome, cancer, chronic inflammatory diseases, diabetes, diabetic nephropathy, cardiovascular diseases, gastric ulcers, liver diseases, neurodegenerative diseases, eye diseases, skin diseases, exercise-induced fatigue, male infertility, and $HgCl_2$-induced acute renal failure (Grimmig et al. 2017 ; Yuan et al., 2020). Cirino et al. (2017) reported that *Arbacia lixula* eggs reared in optimized condition contained astaxanthin at concentration of 27.0 µg/mg. It was significantly higher compared to the same species found in the wild (1.5 µg mg^{-1}). The DPPH antioxidant assay of the sea urchin reared extract at concentration of 10 µg/mL showed inhibition of 86.40% and it had dose-dependent characteristic, while the radical inhibition of the wild one only 47.44%, due to lower concentration of astaxanthin.

Salmachroman reported to has antioxidant and anti-inflammatory activity. This compound was isolated from the gonads of *Salmacis bicolor* (Francis et al., 2020). It has antioxidant activity when tested using ABTS and DPPH scavenging assays and had IC_{50} value of 1.19 mM and 1.24 mM, respectively. There were higher compared to the standard, α-tocopherol, which had IC_{50} > 1.50 mM. Francis and Chakraborty (Francis et al., 2020b). They also success to isolate and identified antioxidant compounds salmacembranes A and B. Salmacembranes A had IC50 of 1.57 and 1.65 mM when tested using ABTS and DPPH scavenging assay, respectively. While salmacembranes B had IC50 of 1.89 mM and 1.70 mM, respectively.

Table 4. Antioxidant activity of sea urchin

Species	Location	Part used	Bioactive compound	Doses	Ref.
Arbacia lixula	The Gulf of Naples	eggs	Astaxanthin	10 µg mL^{-1} methanol extract= 86.40% (reared); 47.44% (wild)	(Cirino et al., 2017)
Stomopneustes variolaris	Coastal area of Visakhapatnam, India	gonads	n.m.	Methanolic extract IC_{50} = 57.81 µg mL^{-1}	(Archana & Babu, 2016)
Strongylocentrotus nudus	Yellow Sea, China	gonads	n.m.	Hydrolysate EC_{50} = 13.29 mg/ml	(Qin et al., 2011; Zhou et al., 2012)
Psammechinus miliaris	Loch Creran, Scotland	tests	Polyhydroxylated naphthoquinone	n.m.	(Powell et al., 2014)
Salmacis bicolor	Kadiapattanam coast, India	gonad	Salmachroman	ABTS (IC50 1.19 mM) DPPH (IC50 1.24 mM)	(Francis & Chakraborty, 2020a)
			Salmacembranes A	ABTS (IC50 1.57 mM) DPPH (IC50 1.65 mM)	(Francis & Chakraborty, 2020b)
			Salmacembranes B	ABTS (IC50 1.89 mM) DPPH (IC50 1.70 mM)	(Francis & Chakraborty, 2020b)

Other study conducted by Archana and Babu (2016) reported that methanolic extract of *Stomopneustes variolaris* gonads had IC_{50} of 57.81 µg mL^{-1} when tested using DPPH radical scavenging assay and this result comparable to ascorbic acid activity which has IC_{50} of 33.64 µg mL^{-1}. The antioxidant activity corresponds with the availability of phenolic compound in the extract which valued 9.9 mg GAE g^{-1}. The phenolic compound had ability to lower the oxidizable compound and delay or inhibits free radicals and chelate metal ions formation, which responsible in the ROS formation and promoting lipid peroxidation (Archana and Babu 2016; Minatel et al., 2017)

Not only the extract, the hydrolysate from sea urchin gonads also had potential antioxidant capacity. The fraction of *Strongylocentrotus nudus* hydrolysate, sized below 10 kDa, showed anti-scavenging activities when tested using several methods i.e., hydroxyl radical assay (EC_{50} = 13.29 ± 0.33 mg mL^{-1}), hydrogen peroxide assay (EC_{50} = 16.40 ± 0.37 mg mL^{-1}), lipid peroxidation inhibition assay (EC_{50} = 11.05 ± 0.62 mg mL^{-1}), and Fe^{2+} chelating test (EC_{50} = 7.26 ± 0.44 mg mL^{-1}). In addition, the ex vivo study revealed that it protects mice macrophages against death induced by tert-butyl hydroperoxide (Zhou et al., 2012). Protein hydrolysate (peptide) from marine resources have gained attention for their relatively high antioxidant capacity, particularly the small size peptide (Qin et al. 2011). It was reported that peptide sized below 1kDA had the highest DPPH radical scavenging capacity and the 1–3 kDa fraction had the best reducing power compared to peptide sized below 10 kDa, 5–10 kDa, and 3–5 kDa. Low molecular sized peptide had higher hydrolysis degree therefore it has more exposed hydrophobic amino acid residue side chain that are accessible to radical's species and stabilized it.

Anti-Inflammation of Sea Urchin

The anti-inflammation test showed that *Anthocidaris crassispina* polysaccharide noticeably inhibit the growth of murine macrophage cell lines (RAW264.7) and the release of nitrite secretion at 50 µg/mL (Jiao et al., 2015). These activities mainly correlated with the linking style and space construction of the glycosidic bond in the polysaccharide, predominantly in mannose and glucose. Jiao et al. (2015) also reported that the gonads polysaccharide of *Glyptocidaris crenularis, Strongylocentrotus nudus*, and *Anthocidaris crassispina* exhibited significant inhibition to the production of LPS-stimulated nitrite oxide.

Salmachroman, an isochroman derived polyketide, isolated from the gonads of *Salmacis bicolor* exhibited potential anti-inflammatory activities through inhibition of pro-inflammatory enzymes, cyclooxygense-2 (IC50 1.29 mM) and 5-lipoxygenase (IC50 1.39 mM) (Francis et al., 2020). Salmacembrane A and B also isolated from the same species and had anti-inflammatory activity (Francis et al., 2020b). Both compound able to inhibit proinflammatory enzyme COX-2 and LOX-5. Salmacembrane A had better anti-inflammatory activity presumably

Table 5. Anti-Inflammation activity of sea urchin

Species	Location	Part used	Bioactive compound	Doses and mechanism	Ref.
Anthocidaris crassispina	China	shell	Polysaccharide:	50, 100 μg mL^{-1} Inhibition of LPS-induced nitrite secretion	Jiao et al. (2015
		shell	Polysaccharide hydrolysate	50, 100 μg mL^{-1} Inhibition of LPS-induced nitrite secretion	
Glyptocidaris crenularis	China	shell	polysaccharide	100 μg mL^{-1} Inhibition of LPS-induced nitrite secretion	Jiao et al. (2015
		shell	Polysaccharide hydrolysate	100 μg mL^{-1} Inhibition of LPS-induced nitrite secretion	
Strongylocentrotus nudus	China	shell	polysaccharide	100 μg mL^{-1} Inhibition of LPS-induced nitrite secretion	Jiao et al. (2015
		shell	Polysaccharide hydrolysate	100 μg mL^{-1} Inhibition of LPS-induced nitrite secretion	
Salmacis bicolor	Kadiapattanam coast, India	gonad	Salmachroman	IC_{50} = 1.29 mM COX-2 inhibitor IC_{50} = 1.39 mM LOX-5 inhibitor	Francis et al., (2020)
Salmacis bicolor	Kadiapattanam coast, India	gonad	Salmacembranes A	IC_{50} = 1.71 mM COX-2 inhibitor IC_{50} = 1.87 mM LOX-5 inhibitor	Francis et al., 2020b
			Salmacembranes B	IC_{50} = 1.99 mM COX-2 inhibitor	Francis et al., 2020b

because of greater binding affinities to COX-2 based on structure–activity relationship analysis.

Other Bioactivities of Sea Urchin

The acetonitrile and ethanolic extracts from gonads and an ethanolic extract from the tests of *E. mathaei* showed hemolytic activity when tested using horse red blood cells, while the spines and Aristotle's lantern extracts showed no hemolytic activity (Kazemi et al., 2016).

Based on the literature study above that were explain about the nutritional value and health benefits of sea urchin. This organism has potential compound to be used as raw material for medicine or drug. sea urchin have bioactive compound such as Plumericin, ursolic acid, Sitosterol, polysacaride, sulfolipid, slmacembranes A and B that can developed further more for human health. In the future research, we recommend to explored more deeply about how to produce these bioactive compounds in large quantities but it will not interfere wild stock sea urchin in nature, perhaps one of the solution is by cultivating of sea urchin or synthesizing chemical compounds so that it does not require sea urchin in large quantities. In

Table 6. Other bioactivity of sea urchin

Species	Location	Part used	Bioactive compound	Activity	Doses and mechanism	Ref.
Echinometra mathaei	Persian Gulf	Gonads	n.m.	Hemolytic activity	Ethanolic and acetonitrile extract= 500 μg mL^{-1}	(Kazemi et al., 2016)
		Tests	n.m.	Hemolytic activity	Ethanolic extract= 500 μg mL^{-1}	

addition, another recommend is we needs to do the toxicity test of sea urchin to determine the safety of sea urchin for humans, although many studies state that sea urchin already use as a functional food to improve the immune system in some area, but it is very important to do a toxicity test before clinical test or use as a drug

Conclusion

Sea urchin is marine organism that have some bioactive compound such as sulfoquinovosylmonoacylglycerols, polysaccharide, salmachroman, scopoletin, plumericin, ursolic acid, sitosterol etc. This compound strongly active as anticancer, antimicrobial, antioxidant and antiinflammation. Sea urchins also have high protein, vitamin, fatty acid and amino acid that usefull for human body, so this organism is very potential to develop as a food functional, nutraceutical, pharmaceutical, and biomedicine.

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