

Table S2. Substances with antioxidant activity derived from marine biota

Substances with antioxidant activity	Origin	Biological activity Potential applications	Ref.
Antioxidant peptides			
Short chain hydrophobic peptides	Fish skin Hydrolysates	Different (dependant on the amino-acid composition and sequence)	[103]
Leu-Trp-His-Thr-His (LWHTH)	<i>Styela clava</i> Peptic hydrolysate	Antihypertensive Functional food	[104]
Peptide-reach protein hydrolysate	Sea cucumber, <i>A. japonicas</i> Peptic hydrolysate	Reducing reactive oxygen species (ROS) animal model	[106]
Swim bladder peptides	Atlantic cod (<i>Gadus morhua</i>)	Antioxidant Anti-aging	[107]
Peptide fractions	Oyster soft tissue Enzymatic hydrolysate	Antioxidant Anti-inflammatory	[108]
Low molecular peptide fractions	Rocky Shore Crab (<i>Grapsus albacarinos</i>) Protein hydrolysate	Antioxidant Anti-cancer	[109]
From byproducts and wastes			
Biopeptides	Fish discards	Health promotion Alternative foods	[110]
Hydrophilic peptide fraction (molecular weight of 3–10 kDa, sequence of twenty peptides, containing 6–16 amino acids)	Red tilapia (<i>Oreochromis sp.</i>) ground scales Enzymatic hydrolysates	Antioxidant	[111]
Bioactive peptides	Fish skin, bones, heads, viscera Enzymatic hydrolysates	Antioxidant Antihypertensive Anticoagulant Immunomodulatory Anti-spoilage Modifying solubility Water-holding, Gelation Pharmaceutical ind. Food	[112]
New discovered peptides			
Asn-Asp-Ala-Glu-Tyr-Gly-Ile-Cys-Gly- Phe.	Brown-golden marine microalga <i>Isochrysis Zhanjiangensis</i> Enzymatic hydrolysates (chymotrypsin, trypsin, pepsin) <i>in vitro</i> gastroin- testinal digestion	Anti-alcohol in HepG2 cells	[113]
ALSTWTLQLGSTSFASPM	Mackerel (<i>Scomber japonicus</i>) muscle Protein hydrolysates	Antioxidant Pharmaceutical industry (functional ingredients)	[114]
Multifunctional peptides	<i>Trachinus Draco</i> myofibrillar proteins Protein hydrolysates	Antioxidant Metal chelating	[115]

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Gly-Phe-Hyp-Gly-Ala-Asp-Gly-Val-Ala, Gly-Gly-Pro-Gln-Gly-Pro-Arg, Gly-Ser-Gln-Gly-Ser-Gln-Gly-Pro-Ala	Yak (<i>Bos grunniens</i>) bone Papain and alcalase hydrolysates	Strong antioxidant	[116]
Antioxidant peptides	Atlantic red seaweed <i>Porphyra dioica</i> <i>Conchocelis</i> Protease hydrolysates (Prolyve® and Flavourzym combination)	Antioxidant (2.5-fold improved)	[117]
Amino-acids			
Mycosporine-like amino acids (MAAs)	Cyanobacteria and red alga	Antioxidant Photo-protective Cosmeceutical	[119]
MAAs Palythine Porphyra-334	Red alga <i>Dulse palmaria palmata</i> (Usujiri, Hokkaido, Japan) Water/methanol extracts	Antioxidant Radicals scavenging	[118]
Polysaccharides			
L-Fucose	Brown macro-algae <i>Padina gymnospora</i> Extracts (ethanol, acetone)	High free radical scavenging	[124]
Dermatan sulphate	Ascidian <i>Phallusia nigra</i>	Antioxidant Neuroprotection Anti-cancer	[125]
Chitosan dimers (with different sequences)	-	For the first time revealed sequence effect on antioxidant activity	[126]
Sulphated polysaccharides	Brown algae <i>Turbinaria ornata</i> Hot water extracts	Antioxidant Free-radical scavenging	[129]
Fucoidans	Brown macro algae <i>Undaria pinnatifida</i> , <i>Fucus vesiculosus</i> Extracts	Topical benefits (comparative <i>in vitro</i> and double-blind, placebo-controlled clinical studies)	[130]
Four fucoidan fractions (fucose, rhamnose, xylose, mannose, glucose, and galactose in different mole ratios)	Brown seaweed <i>Sargassum pallidum</i> (Yellow sea) Water extracts	Pharmaceutical resource Functional food	[131]
Fucoidans	Brown seaweeds <i>Sargassum ilicifolium</i> , <i>Sargassum angustifolium</i> (Qeshm Island, Iran) Extracts	Antioxidant Antimicrobial Nutraceutical industry	[40]
Sulphated polysaccharides	brown algae <i>Padina boryana</i> (Maldives) Extracts (celluclast enzyme assisted extraction; ethanol precipitation)	Antioxidant (<i>in vitro</i> and in Zebrafish model <i>in vivo</i>)	[132]

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Fucoidan (sulfated polysaccharides and small amounts galactose, xylose, glucose, and mannose)	Brown seaweed <i>Sargassum filipendula</i> Extracts	Free radical scavenging (dependent on the extraction method, temperature, time and solvent concentration)	[133]
A-Carrageenan	Red algae <i>Saccharina japonica</i> Extracts	Anti-coronaviruses	[138] [139] [140]
New sulphated polysaccharides	Red algae <i>Gracilaria caudate</i> (SP-Gc) Enzymatic extraction	Antioxidant Hydrocolloids	[141]
Sulphated polysaccharides, (molar ratio galactose:3,6-anhydro-galac- tose = 1.2:1.0; sulphate content about 3.8%)	Alga <i>Porphyra haitanensis</i>	Radical scavenging	[142]
Terpens			
New scalarane-type sester-terpenes: hyrtioscalarane A hyrtioscalaren B	Demosponge <i>Hyrtios erectus</i> Organic extracts	Antioxidant Anti-inflammatory (selectivity index higher than that of Ibuprofen)	[143]
Monoterpenoid (–)-Loliolide	seaweed <i>Sargassum horneri</i>	Antioxidant (at Vero cells and in Zebrafish models)	[144]
Thyrsiferol	red algae genus <i>Laurencia</i>	Anti-viral Anti-tumour	[49]
Carotenoid Astaxanthin (red pigment)	-	Antioxidant (10-fold greater than other carotenoids)	[146]
Saproxanthin Myxol (rare marine monocyclic carotenoids)	Bacteria family <i>Flavobacteriaceae</i>	Antioxidant (stronger than of Zeaxanthin and β -carotene)	[147]
Polyphenols			
Bromophenols Phenolic acids Flavonoids Florotannins	-	Antioxidant (on different mechanisms) Singlet oxygen and free radicals scavenging Chelating	[151]
Ovothiols (thiol histidine derivatives)	Synthesized by two enzymes: sulfoxide synthase OvoA, sulfoxide lyase Ovo B.	Unusual antioxidant Anti-proliferative Anti-fibrotic	[153]
Enzymatic antioxidants			
Recombinant superoxide dismutase metallo-enzyme	Pacific abalone <i>Haliotis discus hannai</i> Ino (<i>P. pastoris</i>)	Antioxidant Endogenous, Exogenous free radicals scavenging	[155]
New digestive α -amylase	Blue Crab <i>Portunus segnis</i> Viscera	New features (compared to other marine-derived enzymes)	[157]

Substances with antioxidant activity	Origin	Biological activity	Ref.
		Potential applications	
		Oat flour antioxidant potential	