

## Biomedical Applications in Seafood

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### Abstract

There is a considerable body of literature suggesting a wide range of health benefits associated with diets high in seafood. However, the demand for seafood across the world now exceeds that available from capture fisheries. The health benefits of seafood consumption have primarily been associated with protective effects against cardiovascular diseases (CVD). However, intake of seafood has also been associated with improved faetal and infant development, as well as several other diseases and medical conditions. The health promoting effects have been chiefly attributed to the long-chain n-3 polyunsaturated fatty acids (n-3 PUFA), eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). This paper keypoints review of the biomedical applications in seafood.

**Keywords:** EPA; DHA; CVD; Seafood; Vitamin D

### Fish Proteins

Fish proteins are incorporated as a protein supplement in human diet. High content of highly digestible protein, available lysine, methionine and cysteine and minerals makes fish protein a highly nutritious product. Fish proteins lessen the risk of microalbuminuria. It improves blood lipid profile of animals and humans. Fish protein powder is used to formulate infant foods, soups and protein containing beverages to enhance their protein content and nutritive value. It is also used as a milk replacer. Fish protein hydrolysate has inhibitory effect on both lipooxygenase and cyclooxygenase. It exerts synergistic effect when used with synthetic antioxidants. Fish protein hydrolysate contains some important bioactive peptide fraction like gastrin, calcitonin gene related peptides (CGRP) and some growth promoting peptides which play a key role in our metabolic pathways. Fish protein hydrolysate suppresses both hypertension and atherogenesis.

### Marine Lipids

#### Poly Unsaturated Fatty Acids (PUFA)

Fish and other marine life are rich sources of w-3 Fatty acids (Eicosapentaenoic Acid (EPA) and Docosahexaenoic acid (DHA)]. EPA and DHA constitute 70 - 75% of total PUFA. Marine organisms accumulate this through their food chain.

#### Antilipidemic activity

EPA and DHA play a major role in maintaining health by regulating the lipid metabolism. They exert hypolipidemic activity by decreasing cholesterol, triglycerides, LDL and VLDL-cholesterol in the systemic circulation. Also they are capable of elevating HDL-cholesterol, which lowers the rate of Coronary Heart Diseases (CHD) and reduces the risk of atherosclerosis and stroke. Accumulation of cholesterol along with a depot of other metabolic materials on and in the vessel walls surrounding the heart is described as atherosclerosis. Stroke refers to blockage of blood flow to a part of the Brain. These w-3 fatty acids also regulates prostaglandin metabolism. They also have influence on kidney function by modulating the retention of water and removal of excess sodium.

**Anticancer and anti-arthritis property**

Though etiology of cancer is uncertain, complex and multifactorial, 35% of all cancer is related to the way we eat. It is well evident from experimental and clinical investigations that consumption of EPA and DHA are beneficial in alleviating a wide range of cancers. Intake of w-3 fatty acids also reduce the activities of cartilage destroying enzymes responsible for joint destruction in rheumatoid arthritis.

**Antidiabetic activity**

Impaired insulin production and/or function leading to impaired glucose metabolism is characteristic of adult onset Type-II diabetes. Excess weight can be controlled with diet and exercise. Diet containing w-3 fatty acids will allow tissue to more efficiently absorb and metabolize glucose in the absence of insulin. The diseases such as asthma, diabetes, psoriasis, thyrotoxicosis, multiple sclerosis etc. can be moderated by w-3 fatty acids. DHA is critical to normal eye and vision development. Along with another fatty acid called Linoleic acid it makes > 1/3<sup>rd</sup> of fatty acids in human brain and retina. Accumulation of DHA in brain takes place at the last trimester of pregnancy. DHA is a membrane component required for the growth of Dendrites. It also increases memory power. A person can expect good health if he or she consumes 0.5 - 1g of PUFA/day.

**Squalene**

Squalene, an isoprenoid molecule present in shark liver oil in higher quantities, has been reported to possess antilipidemic, antioxidant and membrane stabilizing properties. It is directly involved in the lipid metabolism not only as a precursor molecule of cholesterol biosynthesis, but also as a feedback inhibitor of HMG CoA reductase in regulating cholesterol metabolism. Squalene has been shown to suppress the growth of tumor and that exposure to squalene over a period of time was reported to inactivate carcinogenic substances. Squalene also plays a role in enhancing health through its part in the building blocks of hormones and cholesterol and as anti-oxidant. In humans, squalene is useful to enhance the effects of some cholesterol-lowering drugs. The combination of Pravastatin and Squalene has been shown to be very effective in reducing total and LDL-cholesterol and increasing HDL-cholesterol.

Squalene revitalizes weakened body cells and helps to revive cell generation. Its chief attribute is the protection of cells from oxidation reactions. The human body has about six billion oxygen reliant cells. Oxygenation to the cells promotes good health to the most basic level of life. Squalene helps to clean, purify, and detoxify the blood from toxins, facilitating circulation. It cleanses the gastrointestinal tract and kidneys, causing better bowel movement and urination. Many diseases are cured if the blood is purified, by supplementing squalene.

As squalene prevents cellular damage, healthy cells are produced, which are linked together with lipoproteins, later forms lipofuscin, an anti-aging substance. It prevents the formation of harmful lipid peroxide, which destroys various kinds of Vitamins. Squalene carries oxygen in the cellular level, causing further improvement in organ function through cellular metabolism, preventing the acidotic cell syndrome where cells become acidic, deteriorate and die due to lack of oxygen. There is a significant relationship between the degree of one's health and the amount of oxygen consumption by body cells. In today's polluted environment, lack of exercise and poor lifestyle, squalene gives a beneficial source of oxygen for our body.

Squalene's terpene gives a sterilizing effect, combating the growth of various microorganisms such as coliform Bacilli, dysentery Bacilli, *Micrococcus pyocyanus*, *Staphylococcus*, hemolytic *Streptococcus*, and *Candida albicans*. Squalene naturally increases male potency and vitality through a better body. It also helps regulate the female menstrual cycle and improves irregular and abnormal cycles.

Squalene is used as bactericide, intermediate in the manufacture of pharmaceuticals, organic coloring matter, rubber chemicals, aromatics and surface-active agents. Squalene is now extensively used as an additive in pharmaceutical preparations and certain foodstuffs. A health food called squalene powder is popular. It is prepared by adding proteins, carbohydrates, flavoring agents etc. to squalene. This is soluble in water and stable during storage. Another important use is in finishing natural and artificial silk to which imparts an unusually

brilliant sheen. It is an excellent lubricant and also used widely in filling certain types of thermometers. As it contains a number of isoprene units, it is an excellent raw material for preparation of various chemicals, particularly aromatics, by condensation and cyclisation. It is also used in synthesis of a number of steroid hormones of immense use to the mankind.

Sebum provides normal lubrication for hairy and non-hairy skin. It keeps skin supple and forms a protective bacterial and fungicidal coating of skin and in pilosebaceous apparatus. This fatty cover helps to keep moisture on the skin surface. Squalene occurs naturally in human sebum. Thus, it is essential to have adequate dose of squalene to maintain the integrity of skin and also acts as an antiaging compound. Squalene is now used as an immunoprotector. Squalene reduces various aches and pains, helps body organs such as the kidney, liver and gall bladder and digestive system to function properly, helps hemorrhoids to shrink and curb obesity. It also acts as a relaxant, giving added vigor and vitality without the hyper-activity associated with other food supplements, generates hair and smoothens skin. It exhibits penetrating action with immediate effect on topical applications and helps to prevent various kinds of diseases and speeds up the healing process in most conditions of ill health.

### **Collagen**

Collagen is found in skeleton, fins, skin and air bladder (source of pure collagen) of fish. It is possessing properties like abundance, biocompatibility, non-antigenic and non-toxic nature, strength, biodegradability etc. which has tremendous applications in different fields. It is widely used in the production of anti-thrombogenic surfaces, burn cover dressings and controlled drug delivered systems. It is also used as a bone filling material. Premature ageing of skin due to hyperglycemia attack in diabetic patients can be cured using collagen. Surgical sutures are prepared from fish gut collagen. Collagen-chitosan membrane is used as a barrier device for guided tissue regeneration in human periodontal infrabony and furcation defects.

### **Chitin and Chitosan**

#### **Applications in food and nutrition**

NAG moiety present in human milk promotes the growth of *Bifidobacteria* which produces lactase required for digestion of milk lactose. Cow's milk contains limited amount of NAG moiety. Some infants fed on cow's milk may have indigestion. Chitosan supplementation helps to overcome lactose intolerance in humans and animals by changing micro flora of gut. Chitosan has hypolipidemic and hypocholesterolemic activity.

#### **Medical and pharmaceutical applications of chitin and chitosan**

Partially deacetylated Chitin like 6-O-carboxymethyl Chitin, which is readily soluble in water and having remarkably higher susceptibility by lysozyme than Chitin and Chitosan can be fabricated into gels and films as self-regulated drug delivery system. Floating and swelling properties of Chitosan in acidic medium are used for the preparation of Chitosan granules with internal cavities for sustained release of drugs. Chitin and Chitosan are useful for enhancement of dissolution properties of poorly soluble drugs such as Griseofulvin, Phenytoin, Flufenamic acid and Indomethacin. Chitin and Chitosan can be used as a substitute for the widely used microcrystalline cellulose (MCC) in tablet preparation. Albumin blended Chitosan membrane can be used for haemodialysis. Chitin powder can be used for wound dressing. Chitosan can be used for the treatment of burns. Chitosan forms a tough, water absorbent and biocompatible film on the burn. It provides a cool and pleasant soothing effect when applied in open wounds. Chitosan film has oxygen permeability sufficient to prevent oxygen deprivation of tissues. It is slowly degraded by enzymes and film need not be removed periodically from wound.

#### **In ophthalmology**

Chitosan is used for making ideal contact lens. It has all the characteristics required such as optical clarity, mechanical stability, sufficient optical correction, gas-permeability (particularly oxygen), wettability and immunological compatibility. Antimicrobial and wound healing property along with excellent film forming capability make Chitosan suitable for ocular bandage lens.

#### **In dentistry**

Chitosan could be used as a transparent membrane or as a thin powder soaked in antibiotic solution. Its incorporation as a support matrix accelerates wound healing, promote regular fibrin formation and favour the epithelialisation. Chitosan is also used for the treatment of gingivectomy.

### **Chondroitin Sulfate**

Chondroitin sulfate obtained from shark cartilage is used for the treatment of arthritis. It is part of a large protein molecule (proteoglycan) that gives cartilage elasticity. Shark corneas are used for human corneal transplants.

### **Glucosamine**

Hydrolysis of Chitin with concentrated acids under drastic conditions gives relatively pure amino sugar D-glucosamine. Glucosamine, which occurs naturally in the body, plays a key role in the construction of cartilage-the tough connective tissue that cushions the joints. Glucosamine stimulates the production of glycosaminoglycans (the key structural components of cartilage) as well as the incorporation of sulfur into cartilage. Sulfur is necessary for making and repairing cartilage. Glucosamine is effective for easing osteoarthritis pain, aiding in the rehabilitation of cartilage, renewing synovial fluid, and repairing joints that have been damaged from osteoarthritis. Glucosamine has antiulcer effects.

### **Amino acids**

Fish contain all the essential amino acids in required proportion and hence have a high nutritional value. Non-protein amino acid taurine is found to be rich in free amino acid pool and is beneficial in treating heart disorders. Excellent source of sulphur containing amino acids cysteine and methionine. Histidine content is high in proteins of mackerel.

### **Vitamins**

Fish meat is a good source of B Vitamins (red meat and white meat). Fish liver, eggs and milk are good sources of B1, Riboflavin, Pyridoxine, Folic acid, Biotin and B12. Hence it is involved in prevention of various anemias including pernicious anemia. Fatty or semi fatty fishes are excellent sources of Vitamin D. Hence it plays an important role in calcium and phosphorous metabolism. Anti-hemorrhage factor Vitamin-K is also present in fish. In fish flesh Vitamin E occurs as  $\alpha$ -Tocopherol, a potent antioxidant Vitamin involved in counteraction of free radical mediated oxidative damage to the cell membranes. Large quantity of Vitamin E (500 - 3000 IU) is present in liver and body oils. Hepatic reserves of Vitamin A is much greater in fish compared to mammals and birds. Liver oils from shark and tuna are rich in Vitamin A and D.

### **Minerals**

Fish and shellfish are valuable sources of Ca, P, and also contains Fe, Cu and Se. Calcium powder from back bone of tuna can be used to combat calcium deficiency in diet, particularly of children. Calcium deficiency can lead to bone failure and spine curvature in children. Salt water fish have high content of iodine and is good for brain and Thyroid function. Sodium content is low which makes it suitable for low sodium diets. Snails and tuna are sources of macro mineral Mg, which contributes to hardness of bone and acts as co-factor for certain enzymes which are important in nerve and muscle function. Tuna is an important source of essential antioxidant trace element Se which provides protection against heavy metal poisonings and a variety of carcinogens. Crustaceans and shellfish are richest source of Cu which is essential for normal blood formation, maintenance of blood vessels, tendons and bones and health of central nervous system.

### **Conclusion**

In conclusion, marine organisms are potential sources of variety of compounds with varied biomedical and pharmaceutical applications. Yet very little has been explored in this aspect. Further researches have to be carried out to utilize the wealth of ocean for the welfare of mankind. As discussed, a diet high in seafood has been linked to beneficial outcomes for an increasing number of diseases and medical conditions. The shift from communicable to non-communicable diseases has been a trend for several decades and will probably continue in the future due to an ageing population, and because global improvements are made in health care and medical treatments. Thus, the role of seafood in combating these health challenges may be strengthened as more evidence accrues regarding the health promoting effects of seafood. Its contribution to improved food security and malnutrition may also be enhanced.

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