**Review Article**

**Nutritional and Health benefits of Seafood for Human: A Review**

**Abstract:**

Seafood is any form of sea life regarded as food by humans, especially fish and shellfish. Shellfish include various species of molluscs (gastropods, bivalves and cephalopods), crustaceans, and echinoderms. It also includes edible sea plants such as some seaweed and microalgae are widely eaten as sea vegetables around the world, especially in Asia. Seafood is a popular part of the chilled product range and more people are turning to fish as a healthy alternative to meat. Seafood is an important source of (animal) protein in many diets around the world, especially in coastal areas. Seafood consumption is significant for human health, offering various benefits, particularly for heart health, intellectual development, and overall well-being. It's a good source of protein, vitamins, and minerals, including omega-3 fatty acids, which are crucial for improved heart health, better brain function, potential weight management, and reduced risk of certain diseases. The present review compiles the recent information from the available literature relating to the nutritional and health benefits of seafood to humans concerning biochemical constituents, health benefits, and nutritional benefits. It is recommended that seafood intake for an adult is 225g per week, whereas for those who are pregnant, breastfeeding, or children, about 225 to 340g of seafood intake is recommended per week.

**Keywords:**

Seafood; Nutrition; Human health; PUFAs; Vitamins; Minerals

**1. Introduction**

“Humans have dependent upon marine ecosystems as resources of food, water and materials. Human populations are both moving to and growing in coastal areas globally” (Sea Change, 2020). “Consequently, there is an increased reliance on, and use of, these coastal resources, ranging from fishing and aquaculture activities to desalination for drinking water and recreational use of beaches and coastal areas” (Marushka et al, 2018). “The Ocean makes planet Earth a habitable place to live and the marine environment is a source of vital human health benefits such as food, medicine, climate Regulation, economy, recreation, transportation, etc”. (Badoni et al, 2021).

“Maintaining good health and a sense of well-being are top priorities for many people today. Both health and well-being are strongly related to diet. The relationship of diet to overall health and the effect of diet on the incidence of certain chronic illnesses, such as heart disease, diabetes and cancer, continue to be active areas of nutrition research” (Dong, 2009; Troell et al, 2019). “People today are generally more careful in managing their diets to reduce the chances of contracting life-threatening diseases. People also pay more attention to better manage any diseases and to change their lifestyles to sustain longer and healthier lives” (Reames, 2017).

“Seafood is any form of sea life used as food by humans and includes mainly the seaweeds, microalgae, fin fishes and shellfishes” (Sioen et al, 2007). “Edible shellfish include species of crustaceans (e.g. shrimp, crabs, and lobster), gastropods (e.g. limpets, trochids, whelks, sacred chank, olives, green snail etc), bivalves (e.g. clams, oysters, mussels), cephalopods (e.g. octopus, squids), and echinoderms (e.g. sea cucumbers and sea urchins). Edible sea plants include some seaweed and microalgae which are widely eaten as sea vegetables” (Reames, 2012; Jayasekara et al, 2020).

Shalders et al (2022) noted that, seafood represents a major role in human nutrition and is a primary source of protein and essential nutrients for people (Viji et al, 2018). It is an essential human food due to presence of high-quality proteins, essential micronutrients, lipids, and low caloric density (Abera and Adimas, 2024). “Major nutrients available in seafood includes carotenoids, fiber, minerals, omega-3 polyunsaturated fatty acids [PUFAs: docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA)], phospholipids, phytosterols, proteins with amino acids taurine and choline, and vitamins” (EPA/AHA/NAS, 2010; Hassan et al, 2020).

According to Aakre et al (2019); “seafood as a whole food is highly nutritious and benefits the human health for multiple bodily organs and physiological functions. In the global food industry, depending upon the type of product produced, seafood undergoes different types of processing. Further, consumption of seafood is a significant source of exposure to a number of environmental pollutants such as toxic metals, polychlorinated dibenzo-p-dioxins and furans (PCDD/Fs) and polychlorinated biphenyls (PCBs)” (Marques et al, 2021).

Venugopal and Gopakumar (2017) described that; “seafood is one of the most important foods in human diet due to its high nutritional quality. They are the well-known source of a group of PUFAs which can prevent atherosclerosis, thrombosis, coronary heart diseases, autoimmune disorders, arrhythmias, lowering plasma triglyceride levels and blood pressure” (Pal et al, 2018; Balami et al, 2019). “Processed seafood products contain significant amounts of essential nutrients. Fatty fish products and lean fish products may be good sources of EPA, DHA, and vitamin D. Monitoring of nutrient composition in seafood products is important as they are in continuous development” (FAO, 2013; Aakre et al, 2019).

“Recommendations to eat seafood are included in most national dietary guidelines, due to the positive health effects related to seafood consumption. Seafood is an important dietary source of proteins of high biological value, vitamin D, vitamin E, iodine and long chain omega-3 PUFAs (LC n-3 PUFAs), and is low in saturated fatty acids” (Pandey and Upadhyay, 2022). “Further, consumption of LC n-3 PUFAs can be associated with several health benefits, e.g. reduction of the risk of coronary heart diseases, decrease in mild hypertension, prevention of certain cardiac arrhythmias and sudden death” (Sioen et al, 2007; McManus and Newton, 2011).

Seafood Health Facts (2020) reported that; “seafood is a healthy food choice for people of all ages. It provides key nutrients for infants and children and is a healthy protein source for adults. Today’s need for seafood is constantly growing due to both population growth and recommendations by experts for its consumption. Most of the nutrients present in the seafood constitute an optimal amount for the human organism” (FAO, 2018). “Seafood contains the same key nutrients, however, in different amounts. Seafood is a high protein food, low in calories and fat, and a valuable source of vitamins and minerals”(Dujmic et al, 2021).

Zachary et al (2022) concluded that; “seafood plays the potential role in healthy and sustainable diets along with a critical role in addressing deficiencies of vitamin A, calcium, vitamin B12, iron and zinc. Seafood provides crucial nutrients for healthy development, particularly for the expectant mothers who face demanding nutritional needs” (Vilain and Baran, 2016). “Consumption of seafood by the expectant mothers aids their children’s neurodevelopment. Seafood consumption has increased from 9 kg per capita in 1961 to approximately 20 kg per capita today” (Oehlenschlager, 2012; Aquarium of the Pacific, 2017).

“Seafood is a precious source of high-quality proteins, healthy lipids, vitamins, and minerals in the human diet. In particular, they represent the main source of precious long-chain omega–3 PUFAs, which play several physiological roles that are important for human health” (Chamorro et al, 2024). Regular consumption of seafood is important for good health state at any age. There is an inverse relationship between seafood consumption and incidence of cardiovascular and cerebrovascular diseases, diabetes, metabolic syndrome, obesity, and neurological disorders (Elavarasan, 2018). “Therefore, dietary guidelines all over the world recommend the inclusion of seafood at least twice a week within a balanced diet” (Durazzo et al, 2022).

According to Hosomi et al (2012); “seafood is a high‐protein food that is lower in calories, total fat, and saturated fat when compared to other protein‐rich animal foods. High in vitamins and minerals, seafood has been shown to have useful nutrients and health benefits. Further, eating seafood can decrease the risk of heart attack, stroke, and hypertension. Seafood also provides essential nutrients for developing infants and children” (Seafish, 2009). “Therefore, as a highly nutritious food, seafood consumption is highly recommended for children and expectant mothers for normal growth and development” (Maulu et al, 2021).

“The health benefits of seafood are becoming increasingly well known. Intake of seafood and marine animal products is effective in the prevention of cardiovascular disease and helps to protect against lifestyle-related diseases” (Karuppasamy et al, 2015). “These foods represent healthier options to consume with respect to protein content and other health benefits throughout the life course” (CRFM/CNFO, 2013). “In addition to the health benefits for the general public, a specific amount of seafood to eat is of particular importance during foetal growth and development, as well as in early infancy and childhood” (FAO, 2018; Sedyaaw et al, 2024).

The aim of this review is to update recent information from the available literature relating with ‘Nutritional and Health benefits of Seafood to Human’ with respect to biochemical constituents, health benefits, and nutritional benefits.

**2. Literature Search Methods**

This review was carried out by collecting information on relevant research findings with the help of Internet search engines like Google, Google Scholar, PubMed, ScienceDirect, and ResearchGate and other published articles, reports, and monographs. A total of 42 published articles have been reviewed and the related information was gathered for this current study. The keywords used for reviewing the literature were the ones that refer to the issues concerning the ‘Nutritional and Health benefits of Seafood to Human’. For literature search, keyword "seafood" is combined with: biochemical constituents, nutritional benefits, and health benefits.

**3. Major Biochemical Constituents of Seafood**

“Seafood is a good source of protein, vitamins, minerals, and omega-3 fatty acids. Key components include protein, essential amino acids, omega-3 fatty acids (EPA and DHA), and various vitamins and minerals like B12, iodine, and selenium. Seafood is also a source of bioactive compounds like taurine and phospholipids. The major biochemical components or nutrient groups reported in seafood includes the energy-yielding nutrients (Carbohydrates, lipids, and proteins), and micronutrients (minerals and vitamins)” (Gatlin III, 2010; Hassan et al, 2020).

“Seafood is a valuable source of several key nutrient groups, including proteins, lipids (fats), vitamins, and minerals. Specifically, it's rich in high-quality protein, omega-3 fatty acids, and essential vitamins and minerals like B12, D, iodine, and selenium” (Gatlin III, 2010; Elavarasan, 2018; Shalders et al, 2022). Summaries of various components of the nutrient groups reported in seafood with their sources is summarised in Table 1.

Table 1 Major nutrient group in seafood with their components and sources

|  |  |  |  |
| --- | --- | --- | --- |
| **Nutrient Groups** | **Components** | **Types** | **Significant Elements** |
| Energy-yielding nutrients | Carbohydrates | Simple sugars | Glucose  |
|  |  | Complex carbohydrates | Glycogen, Chitin |
|  |  | Dietary fibers  | Soluble fibers: Chitin, Chitosan, Carrageenan, Agar, Alginic acid, Inulin, Xanthan gum |
|  | Neutral lipids (fats and oils)  | Triacylglycerols (TAGs), Sterols,Phospholipids | Free fatty acids: Long-chain PUFAs (omega -3 PUFAs) - Eicosapentaenoic (EPA) and Docosahexaenoic (DHA) acids |
|  | Proteins (structural, sarcoplasmic, connective tissue proteins) | Indispensable/Essential amino acids | Arginine, Histidine, Isoleucine, Leucine, Lysine, Methionine, Phenylalanine, Valine, Threonine, Tryptophan |
|  |  | Dispensable/Nonessential amino acids | Alanine, Asparagine, Aspartic acid, Cystine, Glutamic acid, Glutamine,Glycine, Proline, Serine, Tyrosine  |
|  |  | Non-protein Nitrogenous (NPN) compounds | Free amino acids, nucleotides, urea, guanidine derivatives, trimethylamine oxide (TMAO), other nitrogen-containing molecules |
| Micronutrients | Minerals | Macro-minerals | Calcium, Chloride, Phosphorus, Magnesium, Sodium, Potassium, Sulphur |
|  |  | Micro-minerals/Trace minerals | Cobalt, Chromium, Copper, Iodine, Iron, Manganese, Zinc Selenium  |
|  | Vitamins | Fat-soluble vitamins | Vitamin A (Retinol), Vitamin D (Cholecalciferol), Vitamin E (Alpha-tocopherol), Vitamin K |
|  |  | Water-soluble vitamins | Vitamin C (Ascorbic acid), Biotin, Choline, Folic acid, Inositol, Niacin, Pantothenic acid, Pyridoxine, Riboflavin, Thiamine, Vitamin B12 |
| Carotenoids  | Organic pigments | Contribute vibrant colours to seafood  | Alloxanthin, Astaxanthin, β-carotene, Canthaxanthin, Diatoxanthin, Fucoxanthin, Lutein, Peridinin, Zeaxanthin,  |

**4. Nutritional benefits of Seafood to Human**

“Seafood represents a food of high digestibility and nutritional value for the purpose of human nutrition” (Viji et al, 2018). “Recently the worldwide consumption of seafood has steadily increased due to its influence on health promotion and maintenance. It offers a valuable complement to a healthy and nutritious diet” (Seafood Health Facts, 2020). Since the human diet needs a balance of nutritional components to maximise health benefits, reliance on seafood is increased due to global population growth (Shalders et al, 2022).

Table 2 Nutritional benefits derived from the consumption of seafood to human

(Source: Shalders et al, 2022).

|  |  |
| --- | --- |
| **Nutrient groups** | **Importance to Human Nutrition** |
| Carbohydrates | * Primary food-based energy source for humans.
 |
| Proteins  | * Essential for growth and development, tissue repair & maintenance and the production of enzymes and hormones.
* Key nutritional property of seafood.
 |
| Lipids | * Contribute to sensory quality through flavour & palatability.
* Source of fatty acids, vitamins, and biologically-active components.
* The most concentrated form of energy in the human body.
 |
| Fatty acids  | * Provide a structural and functional role in organisms.
* PUFAs are important to maintain good neurological function and cardiovascular health.
* PUFAs reduce the risk of chronic illnesses (cancer, inflammatory and cardiovascular diseases)
* Vital for reproduction, osmoregulation and stress responses.
 |
| Minerals  | * Balanced intake is crucial for overall health.
* Building and maintaining tissues, regulating nerve and muscle function, and facilitating enzyme and hormone production.
* Crucial for proper growth and development, particularly during childhood and adolescence
* Energy metabolism and the production of ATP (adenosine triphosphate).
* Essential for human nutrition and supports bone and tooth health, fluid balance, and energy production.
* Essential for the proper clotting of blood.
* Play vital roles in human health, particularly for bone health, immune function, and overall well-being.
 |
| Vitamins | * Contributes in overall health of body.
* Help in wound healing and regulating hormones.
* Important in bodily functions, such as energy production, nerve health, immune functions, and bone health.
* Play crucial roles in maintaining overall health, supporting brain function, and reducing the risk of certain diseases.
 |

“Seafood play a great role in the nutrition because they are rich source of nutrients and provide a good balance of protein, vitamins and minerals, and a relatively low caloric content. The polyunsaturated fatty acids has beneficial effects in reducing the risk of cardio-vascular diseases and are linked with positive benefits in many other pathological conditions particularly, certain types of cancer and arthritis” (Pal et al, 2018) (Table 2).

“Seafood as a whole food is highly nutritious. Benefits to human health associated with the consumption of seafood are noted for multiple bodily organs and physiological functions” (McManus and Newton, 2011). “Several processed seafood products may contribute significantly to the recommended intake for several essential nutrients, such as EPA, DHA, vitamin D, vitamin B12, iodine and selenium, if included in the diet” (Aakre et al, 2019).

**5. Health benefits of Seafood to Human**

“Seafood is a high-protein food with lower in calories, total fat and saturated fat and also contains vitamins (A, B-complex, and D) and minerals (selenium, iodine, iron and zinc) that have been linked to various health benefits. Eating seafood can decrease the risk of heart attack, stroke and hypertension” (McManus and Newton, 2011). Also, it is associated with reduced cancer incidence, diminished development of neurodegenerative diseases, improved neurological health and development, as well as in protection of cardiovascular and ocular health (Liu and Ralston, 2021).

Table 3 Health benefits of seafood to human (Source: Dujmic et al, 2021)

|  |  |
| --- | --- |
| **Nutrient**  | **Health Benefits to Human**  |
| Carbohydrates(Shalders et al, 2022) | * Fuel brain, kidneys, heart muscles, and central nervous system.
* By-products of carbohydrates are involved in the immune system, blood clotting, and reproduction.
* Add fibre to the diet which helps protect against some diseases.
 |
| Proteins (Dujmic et al, 2021) | * Forms functional and structural components of all body cells.
* Important in building muscles, skin, blood, and internal organs.
* Necessary for proper body functioning.
* Play crucial role in growth, regeneration, and production of enzymes and hormones.
* Maintain health of muscles, bones, fingernails, and hairs.
* Important in bone health, regulation of body composition, glucose metabolism, satiety, cell signalling, gastrointestinal health and bacterial flora.
 |
| Lipids(Pandey and Upadhyay, 2022) | * Forms the structural components of cells.
* Facilitate absorption of fat-soluble vitamins (A, D, E, and K).
* Important in biological functions including growth and development.
 |
| Fatty acids (omega-3 fatty acids)(McManus and Newton, 2011) | * Important role and positive effects on bodily processes.
* Lowers risk of coronary heart disease.
* Maintain immune function, heart health, and brain function.
* Play crucial role in brain and retinal foetal development, cognitive development, and mental health improvements (depression, schizophrenia, dementia and attention deficit hyperactivity disorder).
* Protection against heart arrhythmia, greater plaque stability and anti-thombosis properties.
* Reduce inflammation for the treatment of all forms of inflammatory arthritis.
* Reduction of the risk of coronary heart diseases (CHD), decrease in mild hypertension, prevention of certain cardiac arrhythmias and sudden death.
 |
| Minerals (Marques et al, 2021) |
| Calcium | * Important for developing and maintaining bones and teeth.
* Support the healthy functioning of muscles, nerves and the heart.
* Important in body functions such as intracellular messaging.
 |
| Iodine | * Effective functioning of the thyroid gland and thyroid hormone production.
* Facilitate normal growth, metabolism, cell oxygen consumption and the development of the central nervous system.
 |
| Iron  | * Plays a vital role in facilitating the transportation of oxygen throughout the body within the haemoglobin complex.
* Associated with growth, healing and immune function.
* Critical for energy production within cells and DNA synthesis.
 |
| Magnesium | * Needed for normal nerve and muscle function.
* Regulates blood sugar and blood pressure.
 |
| Selenium | * Prevents cellular damage and is protective against oxidative stress.
* Regulate the function of the thyroid.
* Supports healthy immune function.
 |
| Zinc | * Acts as a catalyst for over 100 specific enzymes necessary for human metabolism.
* Plays a role in growth, development and functioning of the immune system.
 |
| Vitamins (McManus and Newton, 2011; Liu and Ralston, 2021) |
| Vitamin B | * Help to convert food into energy in the cells of the body.
* Required for healthy development of the nervous system.
* Important to DNA synthesis, red blood cell and neurological function.
 |
| Vitamin A | * Plays an important role in supporting normal vision, reproduction, bone growth, and immune functions.
* Healthful maintenance of the eye, respiratory and urinary tract linings, the skin and mucous membranes.
 |
| Vitamin D | * Important in thyroid function, rennin and insulin production, immunity, skin condition, and muscle strength.
* Prevention of osteoporosis and some cancers.
* Regulation of calcium and phosphorous in bone mineralization.
 |
| Vitamin E | * Highly efficacious antioxidant and is important to the skin, nervous system, heart and circulatory system.
* Protects the vitamins A and C from their oxidation.
 |
| Vitamin K | * Antioxidant activity, protecting cells from damaging effects.
* Plays a crucial role in blood clotting, bone health, and potentially heart health.
* Helps in bone mineralization and maintaining strong bones.
 |

“Regularly eating seafood benefits several aspects of health due to the many important vitamins and minerals seafood contains. This includes maintaining health of brain, eyes, and immune system; improves the eyesight and reduce the risk of developing eye diseases; boost and improve long-term brain health; properly regulate memory and emotion; promotes heart health; makes the skin and hair healthier; and ease the joint pain” (Choudhary, 2021).

“Since seafood is a significant source of nutrients with known health benefits, its consumption is promoted as a healthy food choice. The human diet needs a balance of nutritional components to maximise health benefits Other health benefits of seafood also include anti-atherosclerotic, decreases the blood triglycerides level, helps to avoid the hypertension, improves general condition; minimize the lifestyle associated diseases; and weight control and childhood cognitive development” (Marques et al, 2021).

“The nutritional value and health benefits of the seafood are unrecognized and undervalued. The superior bioavailability of nutrients in seafood reveals that seafood as a whole food is among the best dietary source of many nutrients”. (Balami et al, 2019). “Seafood is the main food source for the long-chain omega-3 fatty acids DHA and EPA. These nutrients promote healthy brain and eye development in children and reduce the risk of heart disease in adults” (Seafood Health Facts, 2020). “Dietary use of seafood provides major ingredients which are essentially required for body growth and metabolism” (Pandey and Upadhyay, 2022).

**6. Conclusion**

Overall, the results from this study suggest that seafood is a nutritional powerhouse, offering numerous health benefits due to its rich content of high-quality protein, essential fatty acids (like omega-3s), vitamins, and minerals. It plays a crucial role in maintaining cardiovascular health, supporting brain development and function, and contributing to overall well-being. It also contributes to improved heart health, brain function, vision, and overall well-being, as well as reduced risk of certain diseases. Therefore the Dietary Guidelines for Americans recommends that adults consume at least 225g of seafood per week, whereas the pregnant and breastfeeding individuals should consume 225 to 340g of seafood per week.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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