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Review Article

A review on consumption of Seafood

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ABSTRACT

Fish and fish are phenomenal wellsprings of supplements, for example, omega-3 unsaturated fats, Vitamin D, and selenium. Despite the fact that fish is viewed as a significant piece of a fair eating routine, numerous public food utilization overviews propose that fish isn't eaten inadequate sums. Lately, in created nations and all over the planet, way of life-related illnesses has turned into a major issue. The most normally detailed hindrances to fish utilization were cost, trailed by tactile or actual obstructions, well being, nourishing convictions, propensities, accessibility, and cooking abilities. The most normally detailed impacts were convictions about the commitment of fish to wellbeing, natural impacts, and individual inclinations.

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1. Introduction

Consumption of fish has expanded in the course of the last ten years, without a corresponding expansion in revealed sickness. This expanded utilization pattern is relied upon to proceed both for planning and for new or frozen assortments. Most of the fish supply was collected from wild populaces. The hydroponics part of this supply will most likely increment. The shopper perceives that fish and shellfish are nutritious and healthy food sources. They are seen as a phenomenal wellspring of top-notch protein, containing lipids with significant degrees of unsaturated fats, and maybe adding to the upgrade of human wellbeing by lessening the gamble of cardiovascular infection. Similarly, fish is naturally delicate, effectively processed, and a decent wellspring of numerous significant minerals and nutrients.¹ Albeit the properties of a fish draw in a more well being cognizant customer,

they likewise uphold assumptions for improved security. Studies looking at dietary propensities have uncovered the medical advantages of fish utilization. Fish contains useful parts that are absent in earthbound organic entities. These parts incorporate n-3-polyunsaturated unsaturated fats, for example, eicosapentaenoic corrosive and docosahexaenoic corrosive, which help in the counteraction of arteriosclerotic and thrombotic sickness. Furthermore, fish is a predominant wellspring of different supplements, like protein, amino acids, fiber, nutrients, and minerals. Since the provisions of numerous sorts of fish are somewhat little and territorial, enormous quantities of people, utilizing an assortment of vessels that reach from little boats to huge industrial facility ships, are involved. The fish gathering industry is profoundly divided. Both finfish and shellfish are exposed to pollution and cross-tainting right at home, as well as anytime during taking care of, handling, conveyance, or readiness.²⁻⁴ The fish-borne disease has been accounted for because of regular poisons, microbial tainting, parasites, unfortunate fish dealing with, and compound toxins.⁵⁻¹³ In

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light of the essential dependence on restricted information revealing frameworks by means of state divisions of general wellbeing, and in the long run, the Centers for Disease Control (CDC), the degree of the general wellbeing hazard because of aggregate openness to microorganisms, normal poisons, and synthetic impurities can't be surveyed effectively, particularly with regards to adding up to dietary openness.

Throughout recent years, fish and fish utilization went through a significant change. In 2008, catch fisheries and hydroponics provided in excess of 140 million tons of fish all over the plane¹⁴ around 115 million tons of which were for human utilization. Albeit the assessed per capita supply was around 10 kg during the 1960s, by 2008 it had expanded to a normal of 17kg.¹⁴ Grown-ups require 60 g of protein every day; roughly half of this sum can be provided by 150 g of fish. In 2007, fish provided 15.7% of the animal protein and 6.1% of all protein consumed.¹⁴ Over only a couple of years in China, the per capita fish supply expanded quickly and was roughly 26 kg in 2008. Asia represented 66% of human utilization; 36.9 million tons were eaten external China and 33.6 million tons were eaten in China.¹⁴ The normal fish utilization per capita for North America, Central America and the Caribbean, South America, Oceania, and Europe was 24.1, 9.5, 8.4, 20.8, 24.5, and 20.8 kg, respectively.¹⁴ Fish and fish utilization shifted by more than 100-overlay between the various regions of the world as well as between the inland and seaside areas of nations. Throughout the course of recent years, the food security of fish has been worked on because of innovative advancements in handling, circulation, transportation, and capacity. These upgrades acknowledged cost-saving and improved wellbeing and quality. Additionally, the advancement of enormous scope, significant distance refrigerated transport, and quicker shipments rejuvenated global exchange and brought about the utilization of a more extensive assortment of species and new fish. In created nations, customers requested superior grade, comfort, dependability, and security. Customers in these nations likewise search out food that has well being-advancing characteristics. For instance, in Japan, the utilization of domesticated animals' food items, like dairy items, meats, and handled food varieties, has expanded. This might prompt an expanded rate of CVD because of ways of life-related illnesses, like hyperlipidaemia, atherosclerosis, diabetes, and hypertension.¹⁵

Epidemiological and exploratory reports have exhibited a connection between diet and the occurrence of CVD (Pereira et al., 2004; Osler et al., 2002).^{16,17} Consequently, dietary treatment is viewed as the best option therapy for arteriosclerotic infection and is perceived as being pretty much as significant as a clinical treatment. Numerous analysts have exhibited that fish has nourishing qualities that keep up with and advance well being.^{18,19} Specifically, the

medical advantages of fish have chiefly been related to high admissions of n-3 PUFAs, for example, eicosapentaenoic corrosive (EPA) and docosahexaenoic corrosive (DHA).²⁰ Fish oil contains bountiful EPA and DHA and is sold as a useful food that can advance predominant wellbeing. Numerous other bioactive parts got from fish are additionally sold and are being worked on as practical food varieties.²¹ Practical food is by and large devoured as customary food that frames a piece of the day-by-day diet. Useful food gives fundamental nourishing capacities and lessens the gamble of the sedentary way of life-related illnesses. Fish and its determined bioactive parts can assist with working on imbalanced dietary propensities and forestall sedentary life-related sicknesses. In this survey, we talk about fish utilization all over the planet and look at the proof for the valuable impacts of the different parts got from fish.

2. Well being Effects of Seafood Consumption

Epidemiological proof accumulated from around the world has shown that the admission of marine creature items is successful in the avoidance of CVD (Kagawa et al., 1982; Bang et al., 1980). One environmental review revealed that high-recurrence fish and fish utilization diminished the gamble of type 2 diabetes in populaces with an overweight gathering.²² Numerous different examinations from an assortment of nations have likewise announced that fish utilization safeguards against the sedentary way of life-related sicknesses. A meta-investigation uncovered that people who consumed fish once seven days had a 15% lower hazard of CVD mortality contrasted and people who consumed no fish.²³ Various epidemiological investigations have analyzed the connection between dietary marine items and CVD.^{24–26} In one report, people who consumed greasy fish had a 34% decrease in CVD in a three-companion study,²⁷ and 35g/day of fish utilization came about in diminished CVD mortality.²⁸ Adequate fish utilization in youth has been shown to assist with guaranteeing great fetal neuron advancement and baby and youngster mental and visual turn of events^{29,30} notwithstanding, whether or not these beneficial outcomes go on into adulthood has not been affirmed. The health advantages of fish utilization have likewise been inspected as they relate to fiery sicknesses,^{31,32} certain tumors^{33–35} dementia,^{36,37} and mental status.³⁸

2.1. Health benefits of seafood consumption

Marine organic entities have numerous bioactive parts, for example, n-3 PUFAs, protein, fiber, taurine, sterol, and shades; they additionally contain extraordinary parts that are absent in earthbound organic entities. Supplements and other bioactive parts got from fish and marine life forms might become useful food fixings that have clinical

attributes and give medical advantages.

2.1.1. *n-3 PUFA*

The different gainful impacts of fish have principally been credited to *n-3* PUFAs like EPA and DHA. Marine living beings have been recognized as the main food varieties that contain a normally high measure of these unsaturated fats. This emerges from the way that marine phytoplankton has a high proportion of EPA and DHA, and subsequently, these unsaturated fats are amassed in the well-established pecking order. The absolute satisfaction of EPA and DHA in fish fluctuates relying upon the kind of fish and their environment. The extent of *n-3* PUFAs in fish muscle is higher in greasy fish, like mackerel, herring, and salmon than in slender fish, like cod, haddock, and halibut. What's more, shellfish, like crab, shrimp, and lobster, have low degrees of *n-3* PUFAs.³⁹ The metabolites of EPA are the most notable and incorporate eicosanoids, like the 3-series prostaglandins, prostacyclins, and thromboxanes, and the 5-series leukotrienes.⁴⁰ There is likewise an expanding measure of proof that recommends that diets containing fish and additionally EPA/DHA might safeguard against the advancement of Alzheimer's infection⁴¹ and prostate disease.⁴² Moreover, *n-3* PUFAs effects affect fat tissue in large people through decreased muscle versus fat mass and invigorated lipid oxidation⁴³ improvement in body weight and satiety guideline,⁴⁴ enhancement of the cytokine profile, including leptin and adiponectin,⁴⁴ and a decrease of irritation,⁴⁵ rheumatoid joint inflammation,⁴⁶ foundational lupus erythematosus,⁴⁷ Crohn's sickness,⁴⁸ ulcerative colitis,⁴⁹ and immunoglobulin A nephropathy.⁵⁰

2.1.2. *Phospholipids*

Albeit most of the fat in fish is TG, around 10% comprises phospholipids (PLs). Various examinations utilizing creature models have recommended that dietary PLs might be good for human wellbeing. For instance, phosphatidylcholine, which is a significant part of dietary PLs, can diminish blood all-out lipids⁵¹ and further develop mind work.⁵² Phosphatidylethanolamine and phosphatidylserine can likewise diminish blood cholesterol⁵³ and further develop mind work.⁵⁴ Results demonstrate that krill oil supplementation was very much endured and caused beneficial expansions in plasma and cell film EPA and DHA levels.^{55,56} Besides, PL-containing *n-3* PUFAs are valuable in that they can assist with reducing heftiness related messes⁵⁷ and go about as a calming⁵⁸ cell reinforcement⁵⁹ and antitumor specialists⁶⁰ in creature tests. Past investigations have proposed that PL-containing *n-3* PUFAs got from squid mantle muscle diminished serum and liver TG and cholesterol levels contrasted and that instigated by soybean PL-or TG-containing *n-3* PUFAs.⁶¹ In spite of the fact that examination in this field is as yet in the underlying stage, it has been getting expanding

consideration because of the acknowledgment that PL-containing *n-3* PUFAs might give crucial results and work with progress in the plan of helpful clinical treatments for people.

2.1.3. *Protein, peptide, and non-protein nitrogen compounds*

A fish protein, which is a significant micronutrient in fish, assumes a significant part in human sustenance around the world and has been utilized as the primary fixing in handled fish, for example, kamaboko (Japanese fish glue) and fish hotdog.⁶² Fish proteins have amazing amino corrosive scores and absorbability qualities. These comprise roughly 10 to 25% of sorts of fish and can be delegated sarcoplasmic, myofibrillar, and stroma types. As a general rule, amino corrosive creations and the bioavailability of creature protein are more reasonable than plant protein, and the protein nature of most fish proteins might be equivalent to that of an ideal protein like lactalbumin and surpass that of earthbound meat.⁶³ It is for the most part acknowledged that fish is an excellent wellspring of protein and that fish utilization gives medical advantages to developing kids, teenagers, and the older. Typical dietary propensities incorporate fish oil as well as entire fish, which give numerous extra supplements. Dietary *n-3* PUFAs decline serum TG, despite the fact that they don't bring down serum cholesterol.⁶⁴ Thusly, there is plausible that the wellbeing capacity of fish-based food sources isn't exclusively connected with EPA and DHA.

A past report proposed that dietary fish protein diminished serum cholesterol through the restraint of cholesterol and bile corrosive ingestion and the improvement of cholesterol catabolism in the liver.⁶⁵ One more part of the job of fish proteins in human wellbeing relates to their potential impacts on lipid digestion.

Non-protein nitrogen (NPR) compounds are likewise present, to different degrees, contingent upon the species. The dull muscles of fish for the most part contain a higher measure of NPR compounds than the light muscles. NPR compounds in muscle tissues are made out of free amino acids, amines, nucleotides, guanidine, and their breakdown items, urea, and ammonium salts.⁶⁶ The commitment of NPR mixtures to the flavor of fish is significant.

2.1.4. *Taurine*

Taurine plays numerous significant parts in a few fundamental natural cycles, like calcium balance, bile corrosive formation, antioxidation, layer adjustment, and invulnerability.^{67–69} People eat taurine to a great extent through fish, which contains high measures of taurine contrasted with meat.⁷⁰ Taurine manufactured action in people is more fragile than that in guinea pigs and rodents, and dietary reliance on taurine is high. Henceforth, taurine is a superfluous however restrictively fundamental amino

corrosive in the human body.⁶⁹ Specifically, taurine is especially plentiful in a few marine invertebrate creatures: shellfish tissue has 1/100g of the taurine substance, while the taurine substance in earthbound plants is low or missing.⁷¹ Taurine has useful antihypertensive,^{72,73} anti-hypercholesterolemia,⁷⁴ and mitigating impacts on sedentary way of life-related sicknesses.⁷⁵

2.1.5. Fiber

As a general rule, muscle-based fish contains almost no carbs and fiber. Be that as it may, eatable kelp contains a ton of dietary fiber (25-75% dry weight), and water-solvent fiber establishes around 50 to 85%.⁷⁶ Based on their pigmentation, kelp is characterized into three primary gatherings. Green kelp is green because of the presence of chlorophyll and ulvan, which is a significant polysaccharide part.⁷⁶ Red kelp has phycoerythrin and phycocyanin as their chief shades; they likewise contain agars and carrageenans as the essential polysaccharides.⁷⁷ Earthy-colored kelp is prevalently brown due to fucoxanthin and has essential polysaccharides, for example, fucans, cellulose, alginates, and laminarins.^{78,79}

2.1.6. Phytosterols

Phytosterols are regularly used to foster quality food, including low-fat and without fat yogurt, milk, juices, spreads, grains, and bread.⁸⁰ The construction of phytosterols is likewise like cholesterol, with just minor contrasts in the overall place of ethyl and methyl gatherings. Not many investigations have analyzed the connection between high-portion phytosterols and the decrease in fat-dissolvable nutrients, cell reinforcements, and carotenoids.^{81,82} Moreover, the hypo-cholesterolemic impacts related to an admission of specific eatable microalgae have been exhibited to be brought about by phytosterols, and microalgae have been sent off as modern makers of phytosterols.^{83,84} The lipid-bringing down system of phytosterols is remembered to happen when phytosterols rival the ingestion of cholesterol by restricting to micelles in the digestive tract.⁸⁵ Their presence in the digestive system subsequently antagonistically influences the adjustment of cholesterol into micelles, consequently diminishing cholesterol ingestion.

2.1.7. Carotenoids

Carotenoids are fat-solvent and have splendid yellow and orange colors. They act to change light energy into compound energy and cancer prevention agents that inactivate the destructive responsive oxygen types of photosynthetic life forms, microscopic fish, and growths.⁸⁶ Quite possibly the main organic element of carotenoids, for example, β -carotene in the human body is their capacity to shape vitamin A.⁸⁷

2.2. The dangers related to seafood consumption

The medical advantages connected with the decrease in hazard of CVD have set off the mass utilization of fish.¹⁴ Fish utilization, in any case, likewise conveys specific dangers related to openness to ecological poisons. For example, the main openness to methylmercury is through eatable marine items. Free mercury effectively processes methylmercury by microorganisms and is collected in the fish at the head of the pecking order. Methylmercury openness influences the profoundly delicate sensory system. The creating fetal and baby sensory systems are likewise exceptionally touchy to methylmercury. Methylmercury initiates focal sensory system harm that relies upon the sum ingested.^{88,89} Fish utilization suggestions for pregnant ladies and youngsters are joined by alerts with respect to how a lot and what sort of fish ought to be devoured.⁶² Further, the dioxins and polychlorinated biphenyls contained in fish have caused concerns connected with the wellbeing impacts of fish utilization.^{90,91} The adjusting of the medical advantages and dangers of fish admission is a significant issue.⁹² A few analysts have announced that the utilization of fish gives helps that offset the dangers, with the exception of shark, swordfish, and eatable creatures and plants from regions with significant degrees of ecological pollutants.^{89,93,94}

3. Discussion

Lifestyle-related illnesses, like corpulence, diabetes, hypertension, and hyperlipidemia, are inescapable and expanding in created nations. Metabolic condition incorporates a group of indications that are connected with the sedentary way of life infections and is related with an expanded gamble of type 2 diabetes, a few kinds of tumors,⁹⁵ cardiovascular illness (CVD),⁹⁵ and nonalcoholic greasy liver.⁹⁶ Along with the quick expansion in the quantity of more seasoned individuals with a sedentary way of life illnesses, these have become genuine public issues, both restoratively and monetarily. Expanded dietary sugar and fat advance stoutness and diabetes.^{97,98} Fish is profoundly respected for its wealth of top-notch proteins, n-3 polyunsaturated unsaturated fats (PUFAs), and different supplements, like minerals, minor components, and nutrients.¹⁴ These supplements are fundamental for physical processes and are gainful to development, the mind, and the sensory system; they likewise have hostile to malignant growth properties.⁹⁹ Fish has eased food emergencies in many non-industrial nations, giving an important enhancement to an assorted and nutritious eating regimen. As of late, fish utilization has slowly expanded all through the world.¹⁴ Various nations have tried to improve the worth of their fish items by establishing projects to guarantee item quality.

4. Conclusion

Nutrition and supportability objectives can be better adjusted by expanding the consciousness of fish that is solid and reasonable. For well being experts to unhesitatingly make proposals, or distinguish compromises, more proof-based data should be made open through gatherings, for example, dietetic associations, industry gatherings, and sustenance programs. Empowering individuals to eat more fish can offer an immediate, savvy approach to further developing by and large well-being results. Notwithstanding, dietary proposals to increment fish utilization have been censured after worrying over the limit of the fish business to satisfy expanded needs while keeping up with maintainable fish stocks. The present purchaser is evolving quickly. Rather than single-pay families, it is progressively more normal to have all kinds of people working. The size of the family is diminishing. Upwards of one-fourth of all families are involved by one individual. This implies more customers and cafes, most with a brief period for home arrangement.¹⁰⁰ The fish collected by industry is divided, expanded, occasional, complex, and challenging to make due. Studies are expected to screen changing utilization patterns and examples. The handling, appropriation, and promotion of finfish and shellfish will require more accentuation to lessen cross-pollution. Consideration should be provided to hydroponics to deliver top calibre, reliably accessible species. Consideration should likewise be centered around the reaping, dealing with, conveyance, and planning of casually gathered fish to guarantee customer well being. More accentuation ought to be put on teaching the business and the customer about safe taking care of practices that can decrease potential food-dealing issues.

Various examinations have demonstrated that the absolute best wellsprings of magnificent fats, protein, nutrients, and minerals that advance well being can be found in fish. Tragically it required countless years for the medical advantages of fish to be understood. Later on, an increment in a sedentary way of life-related illnesses, most of which are a consequence of dietary propensities, is normal in both created and agricultural nations. There is proof that the expanded utilization of fish and bio active parts got from fish, shellfish, and ocean growth could emphatically affect the soundness of individuals all over the planet. Consequently, the job of fish in the support and upgrade of well being might develop further, given the issue of sedentary life-related sickness and the nearby food climate. In total, it is of foremost significance to advance the utilization of fish and decrease in high-sugar and high-fat food, including cheap food and sodas (sugar, specifically), soaked unsaturated fats, and n-6 PUFAs, which is as of now over the top.

5. Conflict of Interest

None.

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None.

References

1. NRC (National Research Council). 1989. Diet and Health: Implications for Reducing Chronic Disease Risk. Committee on Diet and Health. Washington, D.C: National Academy of Sciences; 1989.
2. Haas E, Heiman D, Jones M. The Great American Fish Scandal: Health Risks Unchecked. Washington, D.C: A report by Public Voice for Food and Health; 1986.
3. Newton S. Seafood Production, Distribution, and Consumption. Prepared Foods (July); 1989. p. 96–102.
4. NOAA (National Oceanic and Atmospheric Administration). Pascagoula, Miss: Meeting the Challenge: New Directions in Seafood Inspection; 1990.
5. CDC (Centers for Disease Control). 1981. a. Salmonella Surveillance, Annual Summary, 1978. HHS Publ. No. (CDC) 81-8219. Atlanta, Ga: Public Health Service, U.S. Department of Health and Human Services; 1978.
6. CDC (Centers for Disease Control). 1981. b. Annual Summary of Foodborne Disease, 1978. HHS Publ. No. (CDC) 81-8185. Atlanta, Ga: Public Health Service, U.S. Department of Health and Human Services.
7. CDC (Centers for Disease Control). 1981. c. Annual Summary of Foodborne Disease, 1979. HHS Publ. No. (CDC) 81-8185. Atlanta, Ga: Public Health Service, U.S. Department of Health and Human Services.
8. CDC (Centers for Disease Control). 1983. a. Food-Borne Disease Outbreaks, Annual Summary of Foodborne Disease, 1980. HHS Publ. No. (CDC) 83-8185. Atlanta, Ga: Public Health Service, U.S. Department of Health and Human Services.
9. CDC (Centers for Disease Control). 1983. b. Food-Borne Disease Outbreaks, Annual Summary of Foodborne Disease, 1981. HHS Publ. No. (CDC) 83-8185. Atlanta, Ga: Public Health Service, U.S. Department of Health and Human Services.
10. CDC (Centers for Disease Control). 1984. Food-borne disease outbreaks, Annual summary of foodborne disease, 1983: Reported morbidity and mortality in the United States. *Morbidity and Mortality Weekly Rep.* (annual suppl).
11. CDC (Centers for Disease Control). 1985. Annual Summary of Food-Borne Disease, 1982. HHS Publ. No. (CDC) 85-8185. U.S. Atlanta, Ga: Department of Health and Human Services.
12. CDC (Centers for Disease Control). 1989. Annual Summary of Food-Borne Disease (unpublished dates from 1983 to 1986). U.S. Atlanta, Ga: Department of Health and Human Services; 1989.
13. FDA (Food and Drug Administration). 1989. Safe Seafood: An Analysis of FDA Strategy. Food and Drug Administration. Washington, D.C.
14. Food and Agriculture Organization of the United Nations, World Health Organization. Report on the Joint FAO/WHO Expert Consultation on the Risks and Benefits of Fish Consumption. FAO Fisheries and Aquaculture Report No. 978; 2010.
15. Tushima H. Coronary artery disease trends in Japan. *Jpn Circ J.* 1994;58(3):66–72. doi:10.1253/jcj.58.166.
16. Pereira MA, O'Reilly E, Augustsson K. Dietary fiber and risk of coronary heart disease: a pooled analysis of cohort studies. *Arch Intern Med.* 2004;164(4):370–6. doi:10.1001/archinte.164.4.370.
17. Osler M, Andreasen AH, Heitmann B. Food intake patterns and risk of coronary heart disease: a prospective cohort study examining the use of traditional scoring techniques. *Eur J Clin Nutr.* 2002;56(7):568–74.
18. Mozaffarian D, Rimm EB. Fish intake, contaminants, and human health: evaluating the risks and the benefits. *J Am Med Assoc.* 2006;296(15):1885–99.

19. Hu FB, Bronner L, Willett WC. Fish and omega-3 fatty acid intake and risk of coronary heart disease in women. *J Am Med Assoc.* 2002;287(14):1815–21.
20. Dyerberg J, Bang HO, Stoffersen E. Eicosapentaenoic acid and prevention of thrombosis and atherosclerosis. *Lancet.* 1978;2(8081):117–9. doi:10.1016/S0140-6736(78)91505-2.
21. Harris WS. Fish oil supplementation: evidence for health benefits. *Cleve Clin J Med.* 2004;71(3):208–10. doi:10.3949/ccjm.71.3.208.
22. Nkondjock A, Recheur O. Fish-seafood consumption, obesity, and risk of type 2 diabetes: an ecological study. *Diabetes & Metabolism.* 2003;29(6):635–42. doi:10.1016/s1262-3636(07)70080-0.
23. He K, Song Y, Davi GL. Accumulated evidence on fish consumption and coronary heart disease mortality: a meta-analysis of cohort studies. *Circulation.* 2004;109(22):2705–11.
24. Guallar E, Sanz-Gallardo MI, Veer P. Mercury, fish oils, and the risk of myocardial infarction. *N Engl J Med.* 2002;347(22):1747–54.
25. Krauss RM, Howard RH, Howard B, Appel LJ, Daniels SR, Deckelbaum RJ, et al. AHA Dietary Guidelines: revision 2000: A statement for healthcare professionals from the Nutrition Committee of the American Heart Association. *Circulation.* 2000;102(18):2284–99. doi:10.1161/01.cir.102.18.2284.
26. Singh RB, Niaz M, Sharma JP. Randomized, double-blind, placebo-controlled trial of fish oil and mustard oil in patients with suspected acute myocardial infarction: the Indian experiment of infarct survival-4. *Cardiovasc Drugs Ther.* 1997;11(3):485–91.
27. Oomen CM, Feskens EJ, Räsänen L, Fidanza F, Nissinen AM, Menotti A, et al. Fish consumption and coronary heart disease mortality in. *Am J Epidemiol.* 2000;151(10):999–1006.
28. Davi GL, Stamler J, Orenca AJ. Fish consumption and the 30-year risk of fatal myocardial infarction. *N Engl J Med.* 1997;336(15):1046–53.
29. Ryan AS, Astwood JD, Gautier S, Kuratko CN, Nelson EB, Jr NS, et al. Effects of long-chain polyunsaturated fatty acid supplementation on neurodevelopment in childhood: a review of human studies. *Prostaglandins Leukot Essent Fatty Acids.* 2010;82(4-6):305–14. doi:10.1016/j.plefa.2010.02.007.
30. Carlson SE. Docosahexaenoic acid supplementation in pregnancy and lactation. *Am J Clin Nutr.* 2009;89(2):678–84.
31. Gopinath B, Buyken AE, Flood VM. Consumption of polyunsaturated fatty acids, fish, and nuts and risk of inflammatory disease mortality. *Am J Clin Nutr.* 2011;93(5):1073–9.
32. Rosell M, Rydin WAM, K. EIRA study group. Dietary fish and fish oil and the risk of rheumatoid arthritis. *Epidemiology.* 2009;20(6):896–901.
33. Szymanski KM, Wheeler DC, Mucci LA. Fish consumption and prostate cancer risk: a review and meta-analysis. *Am J Clin Nutr.* 2010;92(5):1223–33. doi:10.3945/ajcn.2010.29530.
34. Dewailly E, Mulvad G, Pedersen HS, Hansen JC, Behrendt N, Hansen JPH, et al. Inuit are protected against prostate cancer. *Cancer Epidemiol Biomarkers Prev.* 2003;12(9):926–7.
35. Zhang J, Sasaki S, Amano K. Fish consumption and mortality from all causes, ischemic heart disease, and stroke: an ecological study. *Prev Med.* 1999;28(5):520–9.
36. Cederholm T, Palmblad J. Are omega-3 fatty acids options for prevention and treatment of cognitive decline and dementia? *Curr Opin Clin Nutr Metab Care.* 2010;13(2):150–5. doi:10.1097/MCO.0b013e328335c40b.
37. Robinson JG, Ijioma N, Harris W. Omega-3 fatty acids and cognitive function in women. *Womens Health (Lond).* 2010;6(1):119–34. doi:10.2217/whe.09.75.
38. Appleton KM, Rogers P, Ness AR. Updated systematic review and meta-analysis of the effects of n-3 long-chain polyunsaturated fatty acids on depressed mood. *Am J Clin Nutr.* 2010;91(3):757–70. doi:10.1161/10.3945/ajcn.2009.28313.
39. Shahidi F, Hernandez E, Hosokawa M. Omega-3 Oils Applications in Functional Foods. Illinois: AOCS Press; 2011. Omega-3 Fatty Acids in Health and Disease. Illinois; 2011.
40. Calder PC. Dietary fatty acids and the immune system. *Nutr Rev.* 1998;56(1 pt 2):70–83. doi:10.1111/j.1753-4887.1998.tb01648.x.
41. Morris MC, Evans DA, Bienias JL, Tangney CC, Bennett DA, Wilson RS, et al. Consumption of fish and n-3 fatty acids and risk of incident Alzheimer disease. *Arch Neurol.* 2003;60(7):940–6. doi:10.1001/archneur.60.7.940.
42. Terry P, Lichtenstein P, Feychting M. Fatty fish consumption and risk of prostate cancer. *Lancet.* 2001;357(9270):1764–6. doi:10.1016/S0140-6736(00)04889-3.
43. Couet C, Delarue J, Ritz P. Effect of dietary fish oil on body fat mass and basal fat oxidation in healthy adults. *Int J Obesity Related Metabolic Disord.* 1997;21(8):637–43.
44. Abete I, Astrup A, Martínez JA. Obesity and the metabolic syndrome: role of different dietary macronutrient distribution patterns and specific nutritional components on weight loss and maintenance. *Nutr Rev.* 2010;68(4):214–31.
45. Das UN. A defect in the activity of Delta6 and Delta5 desaturases may be a factor predisposing to the development of insulin resistance syndrome. *Prostaglandins Leukot Essent Fatty Acids.* 2005;72(5):343–50. doi:10.1016/j.plefa.2005.01.002.
46. Volker D, Fitzgerald P, Major G. Efficacy of fish oil concentrate in the treatment of rheumatoid arthritis. *J Rheumatol.* 2000;27(10):2343–6.
47. Walton AJ, Snaith ML, Locniskar M, Cumberland AG, Morrow WJ, Isenberg DA, et al. Dietary fish oil and the severity of symptoms in patients with systemic lupus erythematosus. *Ann Rheum Dis.* 1991;50(7):463–6. doi:10.1136/ard.50.7.463.
48. Belluzzi A, Brignola C, Campieri M. Effect of an enteric-coated fish-oil preparation on relapses in Crohn's disease. *N Engl J Med.* 1996;334(24):1557–60. doi:10.1056/NEJM199606133342401.
49. Stenson WF, Cort D, Rodgers J, Burakoff R, DeSchryver-Keckskemeti K, Gramlich TL. Dietary supplementation with fish oil in ulcerative colitis. *Ann Intern Med.* 1992;116(8):609–14. doi:10.7326/0003-4819-116-8-609.
50. Donadio JV, Jr BEJ, Offord KP. A controlled trial of fish oil in IgA nephropathy. *Mayo Nephrology Collaborative Group The New England Journal of Medicine.* 1994;331(18):1194–1203.
51. Mastellone I, Polichetti E, Grès S, de la Maisonneuve C, Domingo N, Marin V, et al. Dietary soybean phosphatidylcholines lower lipidemia: mechanisms at the levels of intestine, endothelial cell, and hepato-biliary axis. *J Nutr Biochem.* 2000;11(9):461–6. doi:10.1016/s0955-2863(00)00115-7.
52. Chung SY, Moriyama T, Uezu E, Uezu K, Hirata R, Yohena N, et al. Administration of phosphatidylcholine increases brain acetylcholine concentration and improves memory in mice with dementia. *J Nutri.* 1995;125(6):1484–9. doi:10.1093/jn/125.6.1484.
53. Imaizumi K, Mawatari K, Murata M, Ikeda I, Sugano M. The contrasting effect of dietary phosphatidylethanolamine and phosphatidylcholine on serum lipoproteins and liver lipids in rats. *J Nutr.* 1983;113(12):2403–11. doi:10.1093/jn/113.12.2403.
54. Mcdaniel MA, Maier SF, Einstein GO. Brain-specific" nutrients: a memory cure? *Nutrition.* 2003;19(11):957–75. doi:10.1016/S0899-9007(03)00024-8.
55. Wang L, Xue C, Wang Y. Extraction of proteins with low fluoride level from Antarctic krill (*Euphausia superba*) and their composition analysis. *J Agricultural Food Chem.* 2011;59(11):6108–12.
56. Maki KC, Reeves MS, Farmer M. Krill oil supplementation increases plasma concentrations of eicosapentaenoic and docosahexaenoic acids in overweight and obese men and women. *Nutr Res.* 2009;29(9):609–15. doi:10.1016/j.nutres.2009.09.004.
57. Shirouchi B, Nagao K, Inoue N. Effect of dietary omega 3 phosphatidylcholine on obesity-related disorders in obese Otsuka Long-Evans Tokushima fatty rats. *J Agricultural Food Chem.* 2007;55(17):7170–6. doi:10.1021/jf071225x.
58. Ikemoto A, Ohishi M, Sato Y. Reversibility of n-3 fatty acid deficiency-induced alterations of learning behavior in the rat: level of n-6 fatty acids as another critical factor. *J Lipid Res.* 2001;42(10):1655–63.
59. Hiratsuka S, Ishihara K, Kitagawa T. Effect of dietary docosahexaenoic acid connecting phospholipids on the lipid peroxidation of the brain in mice. *J Nutr Sci Vitaminology.* 2008;54(6):501–6.

60. Hosokawa M, Sato A, Ishigamori H. Synergistic effects of highly unsaturated fatty acid-containing phosphatidyl-ethanolamine on differentiation of human leukemia HL-60 cells by dibutylryl cyclic adenosine monophosphate. *Japanese J Cancer Res.* 2001;92(6):666–72. doi:10.1111/j.1349-7006.2001.tb01146.x.
61. Hosomi R, Fukunaga K, Arai H. Effect of phospholipid n-3 polyunsaturated fatty acids on rat lipid metabolism. *Eur J Lipid Sci Technol.* 2010;112(5):537–44. doi:10.1002/ejlt.200900239.
62. Food and Drug Administration. What you need to know about mercury in fish and shellfish; 2004. Available from: <http://www.fda.gov/food/foodsafety/product-specificinformation/seafood/foodbornepathogenscontaminants/methylmercury/ucm115662.htm>.
63. Friedman M. Nutritional Value of Proteins from Different Food Sources. A Review. *J Agric Food Chem.* 1996;44(1):6–29. doi:10.1021/jf9400167.
64. Balk EM, Lichtenstein AH, Chung M. Effects of omega-3 fatty acids on serum markers of cardiovascular disease risk: a systematic review. *Arteriosclerosis.* 2006;189(1):19–30. doi:10.1016/j.atherosclerosis.2006.02.012.
65. Hosomi R, Fukunaga K, Arai H. Effects of dietary fish protein on serum and liver lipid concentrations in rats and the expression of hepatic genes involved in lipid metabolism. *J Agricultural Food Chem.* 2009;57(19):9256–62. doi:10.1021/jf901954r.
66. Shahidi F. Functional seafood lipids and proteins. In: Mazza G, editor. *Functional Foods*. Pennsylvania: Technomic publication; 1998. p. 381–98.
67. Schuller-Levis GB, Park E. Taurine and its chloramine: modulators of immunity. *Neurochemical Res.* 2004;29(1):117–26. doi:10.1023/B:NERE.0000010440.37629.17.
68. Huxtable RJ. Expanding the circle 1975-1999: sulfur biochemistry and insights on the biological functions of taurine. *Adv Exp Med Biol.* 2000;483(1):1–25. doi:10.1007/0-306-46838-7_1.
69. Huxtable RJ. Physiological actions of taurine. *Physiol Rev.* 1992;72(1):101–63.
70. Tsuji K, Yano S. Taurine/cholesterol ratio of well-consumed animal foods. *Sulfur Amino Acids.* 1984;7:249–55.
71. Kataoka H, Ohnishi N. Occurrence of taurine in plants. *Agricultural Biol Chem.* 1986;50(7):1887–8. doi:10.1271/abb1961.50.1887.
72. Schaffer SW, Jong C, Ramila K. Physiological roles of taurine in heart and muscle. *J Biomed Sci.* 2010;17(1):S2. doi:10.1186/1423-0127-17-S1-S2.
73. Harada H, Tsujino T, Watari Y, Nonaka H, Emoto N, Yokoyama M, et al. Oral taurine supplementation prevents fructose-induced hypertension in rats. *Heart Vessels.* 2004;19(3):132–6. doi:10.1007/s00380-003-0757-1.
74. Matsushima Y, Sekine T, Kondo Y, Sakurai T, Kameo K, Tachibana M. Effects of taurine on serum cholesterol levels and development of atherosclerosis in spontaneously hyperlipidaemic mice. *Clin Exp Pharmacol Physiol.* 2003;30(4):295–9. doi:10.1046/j.1440-1681.2003.03828.x.
75. Jerlich A, Fritz G, Kharrazi H. Comparison of HOCl traps with myeloperoxidase inhibitors in prevention of low density lipoprotein oxidation. *Biochimica et Biophysica Acta.* 2000;1481(1):109–18. doi:10.1016/s0167-4838(00)00112-6.
76. Robic A, Gaillard C, Sassi JF. Ultrastructure of ulvan: a polysaccharide from green seaweeds. *Biopolymers.* 2009;91(8):652–64. doi:10.1002/bip.21195.
77. Mchugh DJ. A guide to the seaweed industry. FAO Fisheries Technical Paper; 2003.
78. Goñi I, Valdivieso L, Gudiel-Urbano M. Capacity of edible seaweeds to modify in vitro starch digestibility of wheat bread. *Nahrung.* 2002;46(1):18–20.
79. Haugan JA, Liaaenjenen S. Algal Carotenoids 54. Carotenoids of Brown-Algae (Phaeophyceae). *Biochemical Syst Ecol.* 1994;22(1):31–41. doi:10.1016/0305-1978(94)90112-0.
80. Demonty I, Ras RT, Van Der Knaap HC. Continuous dose-response relationship of the LDL-cholesterol-lowering effect of phytosterol intake. *J Nutr.* 2009;139(2):271–84. doi:10.3945/jn.108.095125.
81. Musa-Veloso K, Poon TH, Elliot J. A comparison of the LDL-cholesterol lowering efficacy of plant stanols and plant sterols over a continuous dose range: results of a meta-analysis of randomized, placebo-controlled trials. *Prostaglandins Leukot Essent Fatty Acids.* 2011;85(1):9–28. doi:10.1016/j.plefa.2011.02.001.
82. Katan MB, Grundy S, Jones P, Law M, Miettinen T, Paoletti R, et al. Efficacy and safety of plant stanols and sterols in the management of blood cholesterol levels. *Mayo Clinic Proceedings.* 2003;78(8):965–78. doi:10.4065/78.8.965.
83. Plaza M, Herrero M, Cifuentes A. Innovative natural functional ingredients from microalgae. *J Agricultural Food Chem.* 2009;57(16):7159–70. doi:10.1021/jf901070g.
84. Rasmussen HE, Blobaum KR, Jesch E, Ku CS, Park YK, Lu F, et al. Hypocholesterolemic effect of *Nostoc commune* var. *Sphaeroides* Kützing, an edible blue-green algae. *Eur J Nutr.* 2009;48(7):387–94. doi:10.1007/s00394-009-0025-y.
85. Jones PJ, Raeini-Sarjaz M, Ntanios F. Modulation of plasma lipid levels and cholesterol kinetics by phytosterol versus phytostanol esters. *J Lipid Res.* 2000;41(5):697–705.
86. Lesser MP. Oxidative stress in marine environments: biochemistry and physiological ecology. *Annu Rev Physiol.* 2006;68:253–78. doi:10.1146/annurev.physiol.68.040104.110001.
87. García-González M, Moreno J, Manzano JC. Production of *Dunaliella salina* biomass rich in 9-cis-beta-carotene and lutein in a closed tubular photobioreactor. *J Biotechnol.* 2005;115(1):81–90. doi:10.1016/j.jbiotec.2004.07.010.
88. Clarkson TW, Magos L, Myers GJ. The toxicology of mercury-current exposures and clinical manifestations. *New Engl J Med.* 2003;349(18):1731–7.
89. Yoshizawa K, Rimm E, Morris J. Mercury and the risk of coronary heart disease in men. *New Engl J Med.* 2002;347(22):1755–60.
90. Arisawa K, Matsumura T, Tohyama C. Fish intake, plasma omega-3 polyunsaturated fatty acids, and polychlorinated dibenzo-p-dioxins/polychlorinated dibenzo-furans and coplanar polychlorinated biphenyls in the blood of the Japanese population. *Int Arch Occup Environ Health.* 2003;76(3):205–15. doi:10.1007/s00420-002-0400-y.
91. Arisawa K, Takeda H, Mikasa H. Background exposure to PCDDs/PCDFs/PCBs and its potential health effects: a review of epidemiologic studies. *J Med Invest.* 2005;52(1-2):10–21. doi:10.2152/jmi.52.10.
92. He K. Fish, long-chain omega-3 polyunsaturated fatty acids and prevention of cardiovascular disease—eat fish or take fish oil supplement? *Prog Cardiovasc Dis.* 2009;52(2):95–114. doi:10.1016/j.pcad.2009.06.003.
93. Dewailly E, Ayotte P, Lucas M. Risk and benefits from consuming salmon and trout: a Canadian perspective. *Food Chem Toxicol.* 2007;45(8):1343–8. doi:10.1016/j.pcad.2009.06.003.
94. Yaktine AL, Nesheim M. *Seafood choices—balancing benefits and risks*. Washington: The National Academies Press; 2007.
95. Cerchiotti LC, Navigante A, Castro MA. Effects of eicosapentaenoic and docosahexaenoic n-3 fatty acids from fish oil and preferential Cox-2 inhibition on systemic syndromes in patients with advanced lung cancer. *Nutr Cancer.* 2007;59(1):4–20. doi:10.1080/01635580701365068.
96. Hwu CM, Hsiung CA, Wu KD. SAPPHERE Study Group. Diagnosis of insulin resistance in hypertensive patients by the metabolic syndrome: AHA vs. IDF definitions. *Int J Clin Pract.* 2008;62(9):1441–7. doi:10.1111/j.1742-1241.2008.01818.x.
97. Byrne CD. Fatty liver: role of inflammation and fatty acid nutrition. *Prostaglandins Leukot Essent Fatty Acids.* 2010;82(4-6):265–71. doi:10.1016/j.plefa.2010.02.012.
98. Linseisen J, Welch AA, Ocké M, Amiano P, Agnoli C, Ferrari P, et al. Dietary fat intake in the European Prospective Investigation into Cancer and Nutrition: results from the 24-h dietary recalls. *Eur J Clin Nutr.* 2009;63(4):61–80. doi:10.1038/ejcn.2009.75.
99. Cordain L, Eaton SB, Sebastian A. Origins and evolution of the Western diet: health implications for the 21st century. *Am J Clin Nutr.* 2005;81(2):341–54.

100. Liao IC, Chao N. Aquaculture and food crisis: opportunities and constraints. *Asia Pacific J Clin Nutr.* 2009;18(4):564–9.

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