



Nutritional Health Benefits of Salmon

White Paper Report

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Farmed Salmon- Health and Nutrition Benefits

Salmon is a versatile food enjoyed by many cultures for its wonderful gourmet appeal and unique taste. Salmon is a popularly featured menu item for many restaurant meals from sushi to smoked salmon to seafood pasta. Many families choose salmon as a main healthy meal option for dinners at home. The popularity of salmon is well deserved since it is a rich source of high quality protein, healthy omega 3 fats, vitamins and minerals (13). Consuming cold water fish in the daily diet contributes many nutritional properties in favour of better health. Higher intake of fish is associated with a reduced risk for diabetes, cardiovascular disease, better immune health, improved cognitive health, prevention of digestive disease, and proper fetal development (19). Current scientific studies are clearly demonstrating that a diet rich in cold water fish offers valuable health protective properties unique to its provision of healthy omega 3 fats eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) (14). Salmon is an excellent source of these healthy long chain polyunsaturated fats. Evidence also shows that the health benefits attained from salmon far exceed any potential health risk associated with possible contamination (15). Following is a detailed review of the evidence supportive of the many unique nutrition and health benefits associated with the dietary intake of salmon.

Salmon- An Important Source of Healthy High Quality Protein and More

Protein is the main structural component of all cells within the body. Protein is an essential energy nutrient required for many physiological functions including hormone synthesis, neurotransmitter production, muscle repair, muscle strength, wound healing, enzyme synthesis and immune health (26). In general, 15% of calories from protein are required for health and well being which equates to 0.8 g per kilogram body weight per day for both men and women (26). Therefore, roughly 56 grams of protein daily are required for an adult weighing 70 kg.

Complete proteins contain all essential amino acids required to build body proteins and are critical for human health. Complete, high quality forms of protein are typically derived from animal sources. It is well known that commonly consumed animal protein foods such as beef, poultry and high fat dairy products are also the predominant sources of saturated fats (26). These foods and their high content of saturated fats are associated with elevated blood levels of unhealthy cholesterol including total and LDL cholesterol, increasing the risk for cardiovascular events (27). Thus, healthier sources of protein are encouraged due to the potential cardiovascular risks associated with diets high in common animal protein sources. Fish is a rich source of complete protein, with a higher protein quality rating than beef (26). In fact, the chemical score for fish is ranked third next to Egg and Cow's milk, with a protein efficiency ratio (PER) higher than most other protein sources (Table 1.2). Simply stated Salmon is an excellent source of complete protein, and is low in saturated fats. Most varieties of salmon contain between 17-19 grams of protein per 75grams, with only 0.6-1.9 grams of saturated fats.

As known with other sources of fish, salmon is considered a very healthy protein alternative (see table 1.1).

Table 1.1 Nutrient Levels of Common Fish (Modified from Nutrient Value of Some Common Foods)²¹

Food Name	Measure g	Energy Kcal	Saturated Fat g	Protein g
Cod, Atlantic, baked or broiled	75	79	0.1	17
Halibut, Atlantic and Pacific, baked or broiled	75	105	0.3	20
Ocean Perch, Atlantic, baked or broiled	75	91	0.2	18
Salmon, Atlantic, farmed, baked or broiled	75	155	1.9	17
Salmon, king or Chinook, smoked, canned	75	113	N/A	17
Salmon, pink, canned, drained with bones	75	102	0.6	17
Salmon, sockeye, baked or broiled	75	162	1.4	20

Table 1.2 Protein Quality of Common Protein Sources (Modified from Williams SR 1992)²⁶

Food	Chemical score*	PER**
Egg	100	3.92
Cow's milk	95	3.09
Fish	71	3.55
Beef	69	2.30
Soybeans	47	2.32

*The higher the chemical score rating of a food the higher its complete essential amino acid pattern.

**PER (Protein efficiency ratio) is based on weight gain of a growing test animal in relation to its protein intake. This reflects the protein utilization of a food by the body.

In addition to its excellent protein profile, fish is the most significant source of naturally occurring vitamin D. Health Canada estimates that 100 grams of Salmon provides more than the Adequate Intake (AI) of vitamin D for those between the ages of 2-50 years (13). Vitamin D is essential for proper bone health, and may help with the prevention of osteoporosis, multiple sclerosis, and colorectal cancer (4, 11, 18, 24). Fish also contributes essential dietary minerals including iodine, selenium, iron, copper, and magnesium (13). Trace minerals are critical for many physiological functions including growth, repair, blood sugar regulation, and antioxidant activities (22).

Salmon Protects the Heart

Cardiovascular disease is among the leading causes of mortality in North America. Although many conventional medications are instrumental in its management, nutrition and lifestyle are crucial to its prevention and treatment. Numerous studies clearly show that consuming more fish protects against cardiovascular disease. The healthy omega 3 fats EPA and DHA unique to fish are thought to be the primary long chain polyunsaturated fatty acids responsible for improving heart health; showing up to 35% decrease in mortality due to heart disease (table 1.3). The American Heart Association (AHA) strongly recommends the consumption of oily fish and its associated omega 3 fats for the secondary prevention of cardiovascular events in people with documented coronary artery disease (16).

In accordance with these recommendations a recent study review, involving 32 000 participants, had shown that the supplemental intake of omega 3 fish fats EPA and DHA

substantially reduced cardiovascular events by 19%-45%. The authors of the study stated that the intake of these healthy omega 3 fats should be increased by those with heart disease or at risk for heart disease, from either fish or fish oil supplements (16). A minimum intake of 2 meals of oily fish weekly will provide 500 mg/day of EPA and DHA, the amounts suggested to be adequate for cardiovascular prevention (16). Some researchers feel that only 250 mg daily of EPA and DHA are needed to afford cardiovascular protection (Table 1.3).

Salmon is a rich source of healthy omega 3 fats, providing up to two times more than other species of fish. A 75 g serving of Salmon provides up to 530 mg of DHA and 400 mg of EPA (21). Therefore, 2-3 servings (75 g servings) weekly of salmon will easily provide the minimum of 250 mg daily of healthy omega 3 fats. This level of modest fish consumption may reduce the risk for coronary death by 36% and total mortality by 17%, with favourable benefits to other health outcomes (19).

Table 1.3 Summary of Evidence for Cardio-protective Effects of Fish or Fish Oil (Modified from Mozaffarian D and Rimm EB 2006)¹⁹

Outcome	Clinical Effect	Strength of Evidence	Comment
CHD mortality	35%-50% decrease	Strong	Most risk reduction occurs with modest intake (250 mg/day with EPA+DHA), with little additional benefit with higher intakes
Ischemic Stroke	30% decrease	Moderate	Strong evidence from prospective cohort studies

Abbreviations: CHD, coronary artery disease; DHA, docosahexaenoic acid; EPA, eicosapentaenoic acid

Salmon Protects the Heart in Many Ways

The healthy fats EPA and DHA found in salmon and other oily fish have been suggested to prevent heart disease in a variety of ways. Higher dietary intake of EPA and DHA enhances the cell membrane phospholipid concentrations of these healthy fats. Higher membrane concentrations of omega 3 fatty acids ultimately support healthier blood pressure levels, improve arrhythmic thresholds, decrease platelet aggregation, modify blood cholesterol levels and positively affect autonomic tone (16). Table 1.4 presents a summary of the ways in which fish fats protect against cardiovascular events.

A meta-analysis of 22 double blind studies reported that 4.0 g/day of omega 3 fish fat was associated with a significant 1.7 and 1.5-mm Hg reduction in systolic and diastolic blood pressures, respectively. Evidence shows that lowering systolic blood pressure by as little as 2 mm Hg can lower mortality due to heart disease by 4% (16).

Consumption of dietary omega 3 EPA and DHA at a dose level of 3.0-4.0 g/day show antiplatelet, anti-inflammatory and triglyceride lowering effects which are all markers for protecting against a heart attack. Dietary EPA+DHA are especially helpful at keeping inflammatory markers at bay.

A recent study showed that omega 3 fats EPA and DHA induce favourable effects on blood lipids. Omega 3 fish fats were found to enhance the cholesterol lowering effects of simvastatin therapy, as reflected by additional 29.5 % and 9.0 % reductions of triglyceride levels, and non-HDL cholesterol levels respectively, while significantly increasing HDL cholesterol. The improvement of blood cholesterol levels is well known to reduce the risk for heart disease (1).

Table 1.4 Possible Ways in which Fish fat Protect the Heart (Modified from Lee JH et al. 2008)¹⁶

Antiarrhythmic effects	Decreased blood pressure
Modulation of autonomic function	Ant-inflammatory effects
Decreased platelet aggregation	Plaque stabilization
Vasodilation	Decreased triglycerides, and blood cholesterol

Omega 3 Fats Found in Salmon Improve Infant Neurodevelopment and Adult Cognitive Health

DHA is required for cerebral, cognitive and visual acuity development for both the fetus and infant (19). It is important that a mother's diet include adequate levels of these healthy fats so that her body reserves provide for healthy fetal and neonatal (infant) development.

Furthermore, these long chain polyunsaturated fats improve the quality of pregnancy (7). It has been reported that the offspring of mothers that consumed more fish during pregnancy (4 ounces 1-3 times/week) experienced higher developmental and language comprehension scores (7). Similar to the positive effects on brain health for growing infants, beneficial cognitive effects are reported with most life stages including adults and seniors.

According to a recent prospective cohort study of elderly men those that consumed fish with moderate dietary levels of DHA and EPA (400 mg/day) experienced significant protection against 5 year subsequent cognitive decline. The authors concluded that fish fats may postpone cognitive decline in elderly men (23).

Omega 3 fish fats have been suggested to support cognitive health in a variety of ways. It appears that the cardiovascular benefits associated with fish offer similar protection to cognition. EPA and DHA lower blood lipids including triglycerides, they improve platelet aggregation and endothelial function, reduce arrhythmia, and stabilize atherosclerotic plaque. In addition, these fats reduce inflammation, stimulate synaptic plasticity, and enhance neurotransmission. Simply put, omega 3 fats appear to improve cellular communication in the central nervous system. Altogether, the mentioned physiological changes support cognition and prevent memory decline. 6 servings weekly of a lean fish or 2 servings of a fatty fish (such as salmon, mackerel or herring) will provide the amounts of omega 3 fats required for these potential cognitive benefits (23).

Omega 3 Fats May Support the Management of Digestive Disorders

The healthy fats associated with Salmon are also considered to play an important role in support of digestive health. Inflammatory bowel conditions such as ulcerative colitis and Crohn's disease are very debilitating digestive conditions that require strong medications for therapeutic treatment (17). Preliminary studies are demonstrating that the omega 3 fats present in fish may benefit inflammatory bowel disorders. According to a recent systematic review, supplemental intake with enteric coated omega 3 fats (DHA+EPA) supports the maintenance of remission in Crohn's disease. Future large scale clinical trials are warranted to further explore this possible nutritional benefit (2). EPA and DHA inhibit arachidonic acid (AA) metabolism thereby reducing the levels of inflammatory eicosanoids. It is believed that these anti-inflammatory properties of omega 3 fats may help with the management of severe conditions such as Crohn's disease (3).

Furthermore, populations that consume higher intakes of fatty fish report lower incidence of colorectal cancer. It is speculated that EPA and DHA exert anti-neoplastic effects as expressed by favourable regulation of cell expression, and cell apoptosis (5). In a nutshell, these properties reduce the likelihood of cellular mutations thereby potentially reducing the risk of cancer.

Salmon and Other Oily Fish Provide the Most Nutritionally Active Form of Omega 3 Fats

Although vegetarian diets are lower in saturated fats, cholesterol, total fat, and are higher in the intake of fruit vegetables and other plant foods associated with health protection; they are inadequate in the provision of the healthy omega 3 fatty acids found in fish. The latter is particularly true for strict vegetarians. Many vegetarians claim that the plant form of omega 3 fatty acids known as alpha linolenic acid (ALA) is equally beneficial to health as the omega 3 fats found in fish. Although plasma ALA is biochemically converted to (0.2%) EPA and (<0.05%) DHA in the body, this conversion is very limited and considered inefficient (8). The lack of efficient conversion has been confirmed in a recent study of breastfeeding mothers whereby intake of flaxseed oil rich in ALA was associated with no effects on plasma, erythrocyte and breast milk levels of DHA (10). DHA is a long chain omega 3 fatty acid that is critical for human health. The authors concluded that maternal intake of fatty fish and or fish oil is the most effective way to increase DHA levels in breast milk to support infant nutrition. Fish fats are the only concentrated sources of the most active forms of the omega 3 fatty acids EPA and DHA (10). Therefore, dietary intake of fatty fish such as salmon is imperative for optimal nutrition.

The Health Benefits of Farmed and Wild Salmon Exceed Any Potential Risk from Contamination

Although the dietary intake of healthy omega 3 fatty acids from fatty fish such as salmon provides many nutritional benefits to health, concern has arisen over the potential contamination associated with fish. There have been reports of contamination of some species of fish with methylmercury (organic form of mercury), dioxins, and polychlorinated biphenyls (PCBs), resulting in public controversy and confusion regarding the safety of consuming fish. For this reason, extensive studies have been conducted to determine the relative risk of dietary intake of fish. Relative risk weighs the overall health benefit vs. the risk to health (19).

According to a recent clinical review, the health benefits for adults and women of childbearing age, associated with moderate consumption of fish, exceed the potential risk to health. This is especially the case with smaller or shorter lived species such as shellfish and salmon, which have very low concentrations of methylmercury and PCB's (Table 1.5). It is clear that smaller fish such as wild and farmed salmon, contain very low levels of contaminants, and are safe for daily consumption.

For instance, the FDA safety detection limit (action limit) for mercury is 1.0 ug/g, and salmon contains < 0.05 ug/g, which is far below this safety limit (19). However, intake of certain larger, longer living species of fish including shark, barracuda, marlin, fresh or frozen tuna, and swordfish should be limited due to higher tissue concentrations of methylmercury (19). This is especially the case for women of childbearing years, and younger children (12 years of age and under).

Table 1.5 Levels of N-3 Fatty Acids and Contaminants in Commonly Consumed Fish, and Shellfish (Modified from Mozaffarian D and Rimm EB, 2006)¹⁹

	EPA + DHA, mg/serving	Selenium, ug/g	Mercury, ug/g	PCBs, ng/g	Dioxins, TEQ pg/g
FDA action levels*	NA	NA	1.0	2000	None
Salmon farmed (6 oz.)	4504	0.41	<0.05	15-58	0.33-0.87
Salmon wild (6 oz.)	1774	0.46	<0.05	0.5-5	0.03-0.34
Shark (3 oz.)	585	0.34	0.99		
Swordfish (3.7 oz.)	868	0.62	0.98		
Tuna white (3 Oz.)	733	0.66	0.35	100	0.23
Snapper (6 oz.)	546	0.49	0.19		

* Levels considered unsafe

BC Salmon Is Confirmed Safe

To steer on the side of caution Canadian safety limits for methylmercury concentrations are even more conservative than the United States, where 0.5 ug/g is the safety limit. Farmed and wild salmon in British Columbia are confirmed to be relatively low, meeting the more conservative safety guidelines in Canada (15). Furthermore, according to summary data for salmon samples tested by the Canadian Food Inspection Agency, most salmon varieties contained less than 0.2 ug/g methylmercury (13), a level of very reasonable safety. It has been suggested that BC salmon contributes < 2% of the total dietary mercury intake, where other foods such as fruits, vegetables, chicken and beef contribute 68-99%. Authors conclude that BC salmon remains a safe source of healthy omega 3 fats for cardio-protection and other health benefits (15).

White Paper Summary- Take Home message

In summary, farmed and wild salmon are tasty food options for many Canadians. They are low in saturated fat, and cholesterol while providing rich sources of healthy omega 3 fats, high quality protein, vitamins, and minerals. Unlike other common protein staples in the Canadian diet, salmon offers additional health protection against heart disease. The rich levels of unique healthy omega 3 fats EPA and DHA provided by salmon are known to cause many physiological changes that reduce the risk for heart disease. Similarly, these favourable changes may also reduce the risk for other serious diseases including colon cancer and age related cognitive decline. Further, it is well known that the fish fat DHA supports proper fetal neurodevelopment, and visual acuity. Pregnant women are therefore encouraged to consume oily fish such as salmon as a part of a healthy diet.

Health authorities strongly recommend modest dietary intake of fish for its nutritional benefits to health. Two servings weekly of salmon will provide enough healthy omega 3 fats required for health prevention. Extensive safety tests clearly show that most varieties of salmon, including BC farmed salmon, are very safe to consume whereby nutritional benefits far exceed any potential health risk from contamination.

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