Nutritional Discrepancies in Salmon: Fighting Over Omega-3s and PCB’s

Objectives

The primary objective of this paper will look at the ways in which two nutritional aspects of salmon play into the health of the consumer. Secondarily, this paper will spotlight three political action groups and the ways in which they attack the nutritional standing of farmed salmon.

Summary of Findings

Political Backlash Against Farmed Salmon

Arguments over health from environmental groups

Marion Nestle, in her book *What to Eat*, states that “salmon farming has become so controversial that it has spawned its very own opposition groups” and mentions a “Farmed and Dangerous campaign to encourage you to think twice before eating salmon-raised salmon” (Nestle 208). Farmed and Dangerous is an outreach program powered by Coastal Alliance for Aquaculture Reform (CAAR), one of four environmental organizations working towards “more sustainable production methods” in the salmon industry. Their website makes claims that eating farmed salmon is worse off for American consumers than eating wild caught salmon for human health, environmental, and economic reasons. Below is a list of problems with farming for salmon, taken directly from their website (Farmed and Dangerous):

The Environmental Impacts of Salmon Farming
- Sea Lice
- Chemical Treatments: SLICE
- Disease
- Algae Blooms
- Marine Mammal Deaths
- Marine Debris
- Waste on the Ocean Floor
- Escapes & Alien Species
- Fish Feed

The Human Health Impacts of Salmon Farming
- PCB’s & Contaminants
- Excessive Antibiotic Use & Resistance
- Healthy Fats From Healthy Oceans
- Chemical Dependence
- Organic Farmed Salmon?
Another seafood watch group, Slow Fish (a substitute of Slow Food), is in the same boat as Farmed and Dangerous. Slow Fish names “over-exploitation” and “fishing or farming…[that] is harmful to the environment” as main targets of their movement. On their website they make the bold claim that:

“Though often recommended as one of the best animal sources of omega-3 fatty acids, [farmed] salmon should not be eaten frequently. Like all the large fish near the top of the food chain, salmon flesh contains significant amounts of mercury and other pollutants. Additionally, the disinfectant and antibiotic residues left in farmed salmon can affect consumers’ health and increase their resistance to antibiotics” (Wild Atlantic and Farmed Salmon).

Monterey Bay’s Seafood Watch program is another like group, geared towards consumers and businesses looking to “make choices for healthy oceans.” They are not shy to promote their success as a political action group, claiming that they have “distributed tens of millions of pocket guides, [their] iPhone application has been downloaded more than 240,000 times, and [they] have close to 200 partners across North America, including the two largest food service companies in the U.S” (What is Seafood Watch?). They advise consumers whether or not products are a “best choice,” “good alternative,” or should be avoided. For salmon, they encourage people to avoid Atlantic salmon farmed in ocean pens. Wild caught salmon is a “Good Alternative”, and Coho, Sake, and Silver salmon farmed in tanks are “Best Choice.” They also include a ranking mark entitled “The Super Green List”, “a list of wild and farmed seafood that’s healthy for people and the oceans” (What is Seafood Watch?).

It is interesting to note that the primary mission of all three of these powerful political action groups is to retain or improve environmental conditions. Which, in almost every way, would mean the removal of open ocean pens and nets. These farming methods can be devastating to the ecological, environmental, and economical worlds in varying degrees. While these issues are severely problematic, they are outside the scope of this paper. I would refer you to Lucas Morrill’s paper to learn more about the possibility of farming alternatives (or more sustainable farming measures), and Arielle Koshkin’s report on the environmental impacts of both wild caught and farm raised salmon.

In this report, it is most interesting to look at the ways these political action groups attack salmon farming form a nutritional point of view. Farmed and Dangerous lists PCB’s and contaminants as a major problem with salmon farming (bolded above), and Nestle has an entire section dedicated to “The PCB Problem” and how it relates to salmon (Nestle 204). The Slow Fish movement states that “salmon flesh contains significant amounts of mercury* and other pollutants” PCB’s and other dioxins, it appears, do have a significant health risk that should be examined.

(*Methylmercury is a serious and prevalent toxin in a wide variety of carnivorous fish, but it will not be discussed in this paper. The reason for this is that multiple studies have placed indicated that salmon contains negligible amounts of the toxin, ranging from 50 to 10 times less than the dietary guidelines set by American and Canadian health standards (Mercury Levels in Commercial Fish).
PCB’s and Other Toxins

What are PCB’s?

Below I have provided a background of PCB’s, as provided by the Wisconsin Department of Natural Resources.

“PCB’s, or polychlorinated biphenyls, are a group of man-made chemicals. They were widely used in electrical equipment, in industrial processes, and in the manufacture and recycling of carbonless copy paper until research revealed that they pose risks to human health, wildlife and the natural environment. The federal government banned the production of PCB’s in 1976, but PCB contamination remains widespread in the environment today because of improper disposal of products containing the chemicals and byproducts of the processes used to make such products.” (What are PCB’s? 2008).

PCB’s are hydrocarbons, meaning that they interact with non-polar molecules over polar molecules, like water, much more readily. For this reason, they are especially important to talk about when thinking about the biological trends in nature and accumulation of toxins. PCB’s (or the organic, energy containing compounds in which they have been associated to) will work their way up the food chain, accumulating in flesh, rather than be expelled as waste, because of their strong chemical attraction to non-polar substituents in flesh (i.e., fat), over polar (water). This is very similar to the accumulation of methylmercury in other fish species high on the food chain.

In humans, PCB’s and other dioxins have been found to cause development disorders in children, harm to reproductive organs, harm to the immune system, and possibly carcinogenic developments (What are PCB’s? 2008). Dioxins have been shown to alter the behavior in laboratory animals and humans, and have shown to decrease in the abilities of monkeys to lean certain tasks. Likewise in lab animals, dioxins have proven to increase the risk of cardiovascular disease, increase the rate of diabetes, and more. The list goes on and on, partly because the term “dioxin” is far stretching, covering a variety of toxic compounds, and partly because these industrial chemicals are very harmful to the human body (Foran 2005). These toxins are now banned from industry, and different organizations have set different limits on the regulation of dioxins in products.

Does farm raised salmon have more PCB’s?

In 2005, a report by the National Institute of Environmental Health Sciences found that:

Concentrations of dioxins, PCB’s, polybrominated diphenyl ethers, and pesticides, including toxaphene and dieldrin, among other contaminants, are significantly higher in farm-raised salmon than in wild Pacific salmon and that salmon raised on European farms have significantly higher contaminant concentrations than do those raised on North and South American farms.

They go on to put it that “many farmed Atlantic salmon contain dioxin concentrations that, when consumed at modest rates, pose elevated cancer and noncancer health risks” (Kelly Et. Al. 2008). Attached is their advisory for how much salmon one should consume on a monthly basis with respect for dioxins. According to the chart, wild caught sources have much
more leeway in terms of how much fish you can consume. (Figure 2) A publication in *Science* magazine in 2004 found similar results, noting (Hites 2004):

> Having analyzed over 2 metric tons of farmed and wild salmon from around the world for organochlorine contaminants, we show that concentrations of these contaminants are significantly higher in farmed salmon than in wild. European-raised salmon have significantly greater contaminant loads than those raised in North and South America, indicating the need for further investigation into the sources of contamination.

In terms of toxicity, there is validity behind the statements made by Farmed and Dangerous and other environmental action groups. Multiple independent scientific studies have agreed that farmed salmon is substantially higher in toxic than its wild counterpart. The FDA does not have limits on fish products, but applying their regulations from eggs and poultry products to salmon products actually places both farmed and wild caught in the safe zone (Nestle 210). The EPA has their own limits for dioxin toxicity in fish products, for which farmed salmon does not pass. As you can imagine, environmental and health groups like to use the EPA’s regulations and proponents of farming use the FDA’s values. This leads to cloudiness in when it comes to promoting a safe or hazardous message to consumers. Ultimately, what matters is that PCB’s and other dioxins are at higher levels in farmed fish, and that these substances can have debilitating effects on humans, no matter how impactful.

**Can you Farm “Superfood”?**

Over the last two decades, the health benefits of salmon have been commonplace in American culture. Popular media and product advertising, as well as governmentally funded health reports, are two of the ways in which this “Superfood” image has been plastered onto the salmon’s image. The rise in healthful food culture, driven by media across television, magazines, blogs, and books has been a key component of the heart-saving image of salmon. This “Superfood” image usually claims a variety of nutritional benefits from salmon; it is a great lean protein source, has high levels of important essential fats, and contains other important vitamins and minerals. For now, we will look at the nutritional values of salmon products besides essential fats.

**Vitamins, Minerals, and Other Benefits**

Salmon meat is very high in a number of biologically important compounds. An average 4oz. portion of salmon can contribute a great deal to the daily values of many nutrients:

- 250% vitamin D
- 100% DV vitamin B12
- 109% DV tryptophan (amino acid)
- 60% protein
- 60% selenium
- 35% vitamin B3
And, as is the case with many other predatory fish, salmon contains miniscule levels of the metal-toxin methylmercury. According to a study done by the environmental toxology and chemistry department at the University of Singapore, “Methylmercury in all salmon samples (range, 0.03-0.1 µg/g wet wt) were below the 0.5 µg/g guideline set by Health Canada” (Kelly 2008).

Importance of Omega-3 Fatty Acids

As of 2010, The American Heart Association recommends eating two servings of particularly fatty fish per week (Kris-Etherton at. al. 2002). This recommendation comes on the heels of research linking omega-3 fatty acid intake with a reduced risk of coronary heart disease in both men and women. The George Mateljan Foundation, a “not-for-profit foundation with no commercial interests or advertising,” compiled a list of health benefits linked to consuming omega-3 fatty acids (Omega-3 Fatty Acids).

- Reduce inflammation throughout your body
- Keep your blood from clotting excessively
- Maintain the fluidity of your cell membranes
- Lower the amount of lipids (fats such as cholesterol and triglycerides) circulating in the bloodstream
- Decrease platelet aggregation, preventing excessive blood clotting
- Inhibit thickening of the arteries by decreasing endothelial cells’ production of a platelet-derived growth factor (the lining of the arteries is composed of endothelial cells)
- Increase the activity of another chemical derived from endothelial cells (endothelium-derived nitric oxide), which causes arteries to relax and dilate
- Reduce the production of messenger chemicals called cytokines, which are involved in the inflammatory response associated with atherosclerosis
- Reduce the risk of becoming obese and improve the body’s ability to respond to insulin by stimulating the secretion of leptin, a hormone that helps regulate food intake, body weight and metabolism, and is expressed primarily by adipocytes (fat cells)
- Help prevent cancer cell growth

These poly-unsaturated fats are divided into three main types, alpha-linolenic acid, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). All three are directly related to the integrity of cell membranes, but EPA and DHA are especially important as anti-inflammatory agents. Salmon and sardines are the only two fish considered “excellent” sources of omega-3 fatty acids, and an average four ounce portion of salmon contains over 60% of one’s daily intake, and of those omega-3s about half are EPA. In 1999, the National Institute of Health recommended that omega-3s take up 2% of one’s caloric intake. For a 2,000-calorie diet, this means consuming four grams of omega-3 lipids per day. Americans, on average, eat enough omega-3 fats to reach .7% of their caloric intakes (1.6 grams/day), almost three fold less than the recommended total (Kris-Etherton at. al. 2002). And, of the 1.6 g/d of omega-3s we consume, 1.4 grams comes in the form of alpha-linoleic acid and only .2 grams comes from EPA and DHA (Omega-3 Fatty Acids). In terms of omega-3 value, salmon is a uniquely healthful food product.

Do farmed salmon have these healthy fats?

Farmed salmon actually contain more omega-3 fatty acids per serving than wild salmon. The American Heart Association released information from a study they conducted comparing
various levels of the “special” omega-3s (EPA and DHA) in various salmon sources (Kris-Etherton et. al. 2002). For intensive purposes, all Pacific salmon are wild caught in this figure.

<table>
<thead>
<tr>
<th>Type of Salmon</th>
<th>Grams EPA and DHA/3oz.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chum</td>
<td>0.68</td>
</tr>
<tr>
<td>Sockeye</td>
<td>0.68</td>
</tr>
<tr>
<td>Pink</td>
<td>1.09</td>
</tr>
<tr>
<td>Chinook</td>
<td>1.48</td>
</tr>
<tr>
<td>Atlantic, farmed</td>
<td>1.09–1.83</td>
</tr>
<tr>
<td>Atlantic, wild</td>
<td>0.9–1.56</td>
</tr>
</tbody>
</table>

What about omega-6s?

Back to the Farmed and Dangerous website, they claim that omega-3s “also have the ability to balance the functions of omega-6s” (Farmed and Dangerous). Omega-6 fatty acids are also essential for survival, but we do not have any problem finding them. Nuts, seeds, and vegetable oil are full of these fats. The AHA advises us to consume 5-10% of our daily calories in omega-6s and the average American easily accomplishes this. The problem with omega-6s is that they accomplish the opposite physiological function of omega-3s in the body—they promote inflammation, and in higher concentrations has been linked to heart disease (Hensrud 2011).

Biologically, the same cellular functions are at play for metabolizing both omega fatty acids. For this reason, the ratio of omega-3s to omega-6s is arguably more important than the amount you consume. Americans consume about ten times as many omega-6s as omega-3s, so finding sources with high omega-3 to omega-6 fats is important. All salmon products have more omega-3s than omega-6s. A study of coho salmon at the Oregon State University showed that wild caught salmon have fifteen times more omega-3s, but farmed salmon only have three times as many omega-3s (Nettleton).

Conclusion

The nutritional value of wild caught salmon is measurably superior to the farmed variety. It is hard to quantitatively express exactly how much better these fish are for you because farmed salmon come from such a diverse market. Farmed salmon quality differs greatly depending on the methods used by farmers. Just as humans “are what we eat,” so too are salmon. Varieties in feed pellets are the biggest factor in these differences. That being said, even the farmed salmon products of highest nutritional quality have higher levels of PCB’s and lower omega-3 to omega-6 ratios. That alone makes wild caught salmon a better health choice for your dinner plate.

Calling wild salmon the superior product does not mean that farmed salmon should be avoided for nutritional reasons. In terms of polyunsaturated fat intake, there are few better sources and the impact of dioxins is arguably non-consequential, or can be avoided by limiting your rate of consumption. Even though Slow Fish’s advice to “[never] eat wild Atlantic salmon and farmed salmon” is directly below their health impacts section, it should not be directly associated to nutritional reasons. The ultimate motives of groups like Slow Fish and CAAR is to
conserve the environment and promote sustainable products, so claims to avoid farmed products (all of which oppose their values) should be seen in this light.

Appendix

Figure 1.

Source: All data are FAO Fishstat+ data except that data (used to calculate North American wild salmon catches) for Alaska are CFEC Alaska Salmon Summary Data 1980-2005 and data for the Pacific Northwest are NMFS catch data. “Farmed trout” includes only farmed rainbow trout raised in salt water.
Figure 2.

Figure 1. Risk-based consumption advice for Atlantic salmon purchased from farms, farmed Atlantic salmon purchased from retail stores, and wild Pacific salmon. Solid bars indicate the number of meals per month to limit dioxin intake to 1 pg TEQ/kg/day, the lower end of the WHO TDI (1–4 pg TEQ/kg/day). Patterned bars indicate the number of meals per month to limit dioxin intake to 20% above the average (65 pg TEQ/day) U.S. adult intake level. Abbreviations: AK, Alaska; BC, British Columbia; SE, southeastern. Edible tissue levels of DLCs were reported by Hites et al. (2004a). Wild salmon capped at a practical consumption rate of 60 meals/month or approximately 2 meals/day.

Works Cited


Nettleton, Joyce A. "Fatty Acids in Cultivated and Wild Fish." *Oregon State University*. Print.


