Can Two Wrongs Make a Right? Mercury and Selenium in Fish

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Last Modified: 5th May 2013

(Note: Many of links in this article lead to scientific reports, some of which are behind ***paywalls*** *; our apologies for this.)*

Introduction

Big Halibut

Current recommendations suggest that pregnant women and children not eat much of large halibut such as this one.

Most people are aware that eating fish with too much mercury (Hg) can cause nerve damage and other health problems. Guidelines help people make choices to prevent overconsumption of mercury (e.g., by the **EPA** or **FDA**). Common recommendations include avoiding tilefish, shark, swordfish, and king mackerel while limiting consumption of many other fish. For recreational and **subsistence** harvesters of fish, there are numerous local recommendations, based on mercury levels in local waters (e.g., **Alaska guidelines** for children and pregnant women).

But what if something in the fish was detoxifying the mercury? Recent research suggests this might be occurring.

How is mercury toxic?

Mercury toxicity impacts proteins in the body, where elements and element groups (compounds) make chains in specific formations, with just the right molecular bends, turns, and pockets to enable cells to function. Important elements in the protein chains include sulfur (S) and selenium (Se). When mercury (Hg) binds to sulfur or selenium, it can disrupt the protein chain to the point of impairing cell function and damaging cells, affecting organs, muscles and neurological functions.

Where did the mercury recommendations come from?

In the 1950s, fishermen in Minimata, Japan caught and ate fish contaminated by large-scale industrial dumping, **resulting in severe and even lethal effects** . Animals and humans alike suffered devastating neurological damage in the decades that followed. This incident spurred three major studies of other communities worldwide to understand mercury poisoning through fish consumption. However, the study results proved confusing:

--**Faroe island study (1986-7)** – This study, which now forms the basis for US recommendations, demonstrated the expected negative impacts of mercury consumption. The work was based on correlations of mercury in umbilical cord blood and test scores of those children at age 7.

--**Seychelles study (Early 90s through 2011)** – This study uncovered no negative impacts. (numerous scientific articles). This research was focused on following children through time whose mothers consumed an average of a dozen fish meals a week while pregnant.

--**New Zealand study (1998)** – This study found no compelling evidence either way. This work also focused on correlating measures of child development with mercury exposures in their mothers.

Critics of the Faroe Island study most commonly point out that some members of the community ate large amounts of pilot whale, a species which contains extremely high levels of mercury (25 times the amount

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commonly found in tuna). While these levels are far below what people in Minimata were exposed to, they far exceed what most people are likely to encounter in their lives. Other concerns about the Faroe Island study are the techniques used, the genetics of the various populations, the different diets of the populations, and the possibility of other contaminant present in pilot whale.

What's the relationship between selenium and mercury?

Selenium , **toxic at high levels** , is nonetheless essential in small amounts for cell function in both animals and humans.

More significantly, the current opinion among researchers is that mercury itself is not directly toxic, but by binding to selenium, it depletes the supply of selenium available for proteins and enzymes in cells. Even if the body has the right amount of selenium under normal conditions, it might need more if exposed to mercury, to make up for the amount tied up by the mercury.

Recent research has observed certain protective effects of selenium in regards to mercury in **Norwegian trout** , **Argentinean trout** , **multiple fish species in the western US** , and **fish in the Savannah River** , among others. In particular, fish that benefited from a selenium-rich diet showed lower levels of mercury in their tissues than would be expected.

Selenium to mercury ratio

These results **have been used to argue** that it is the ratio of selenium to mercury that matters, regardless of the absolute levels of mercury. That is, as long as there is more selenium than mercury, mercury will not affect proteins or disrupt cell function.

Measurements of this ratio (e.g., **here** , **here** , and **here**) **have shown** that almost all fish have a selenium-to-mercury ratio of 1 or greater, suggesting that impacts from mercury consumption could be minimized in most cases. Likely the only exceptions to this would be swordfish and some species of shark, both of which have a low ratio of selenium to mercury as well as a high absolute amount of mercury. Note that it is the total amount of both mercury and selenium consumed over time that likely matters more than the levels within a given fish.

Conclusions

The question of mercury toxicity from fish consumption therefore remains very much an open one, both scientifically and politically (see Box). While it is beyond doubt that mercury is toxic at high levels, it is less clear whether low levels of long-term exposure have similar impacts. The possibility of protection by selenium further complicates the picture, since the levels of selenium present in most fish might mitigate the effects of mercury. The net health benefits of fish consumption are a balance between demonstrated health benefits on one hand, and risks associated with mercury and other contaminants on the other. As more research is conducted on the influence of selenium on mercury contamination, that may tilt the balance in either direction.

Date Created: 5th May 2013

Box: A Complex Debate

Readers curious about the more technical aspects of this debate should first skim **this scientific article** (2012) about mercury in mice and **this scientific article** (2012) about mercury in Finnish communities, followed by **this analysis** of those two studies concluding that selenium has no protective effect and **this podcast** rebutting that analysis.