How Safe Is Seafood?

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Abstract

This study was initiated to see if the atomic absorption method could be used to measure mercury levels in seafood. The Cold Vapor Atomic Absorption method was used to quantitatively measure the level of mercury present in the seafood samples. Samples were taken from canned albacore solid white tuna in water and canned albacore light tuna in water, shrimp, and crab to see which type of seafood retains the most mercury. The study also included the accumulation of mercury in different parts of the animals and to show if plants have the ability of retaining mercury. With this data we can determine the amount that can be ingested by humans who eat seafood on a regular basis. The study is still ongoing; more results are soon to be reported.

Introduction

Mercury (Hg) a naturally occurring element is found as a liquid at room temperature. It is highly poisonous and can enter the body through the respiratory tract, the digestive tract or directly through the skin. It accumulates in the body, eventually causing severe illness or death.

Not easily found alone in nature, it is primarily obtained from the mineral cinnabar (HgS). Mercury compounds and vapors can be used to produce useful materials such as thermometers, barometers and other scientific instruments. Mercury can also be used for making streetlights, fluorescent lamps and advertising signs. Methylmercury [CH3Hg+] is the most toxic form. It is composed of a methyl group bonded to a mercury atom. Its exposure affects the immune system, alters genetic and enzyme systems, and damages the nervous system, including coordination and the senses of touch, taste, and sight.

Exposure to methylmercury is usually by ingestion, and it is absorbed more readily and excreted more slowly than other forms of mercury. People are exposed to methylmercury almost entirely by eating contaminated fish and wildlife that are at the top of aquatic food chains.

CH_3Hg^+ is introduced into the environment mainly through the burning of fossil fuels. Large fish such as marlins, sharks, swordfish and tuna tend to carry the highest concentrations of methylmercury and they are known to be of the largest dietary source.

Perkins-Elmer FIMS-100 Atomic Absorption Spectrometer

Composed of: Flow Injection Mercury System 106 with auto sampler + Win Lab 32 software

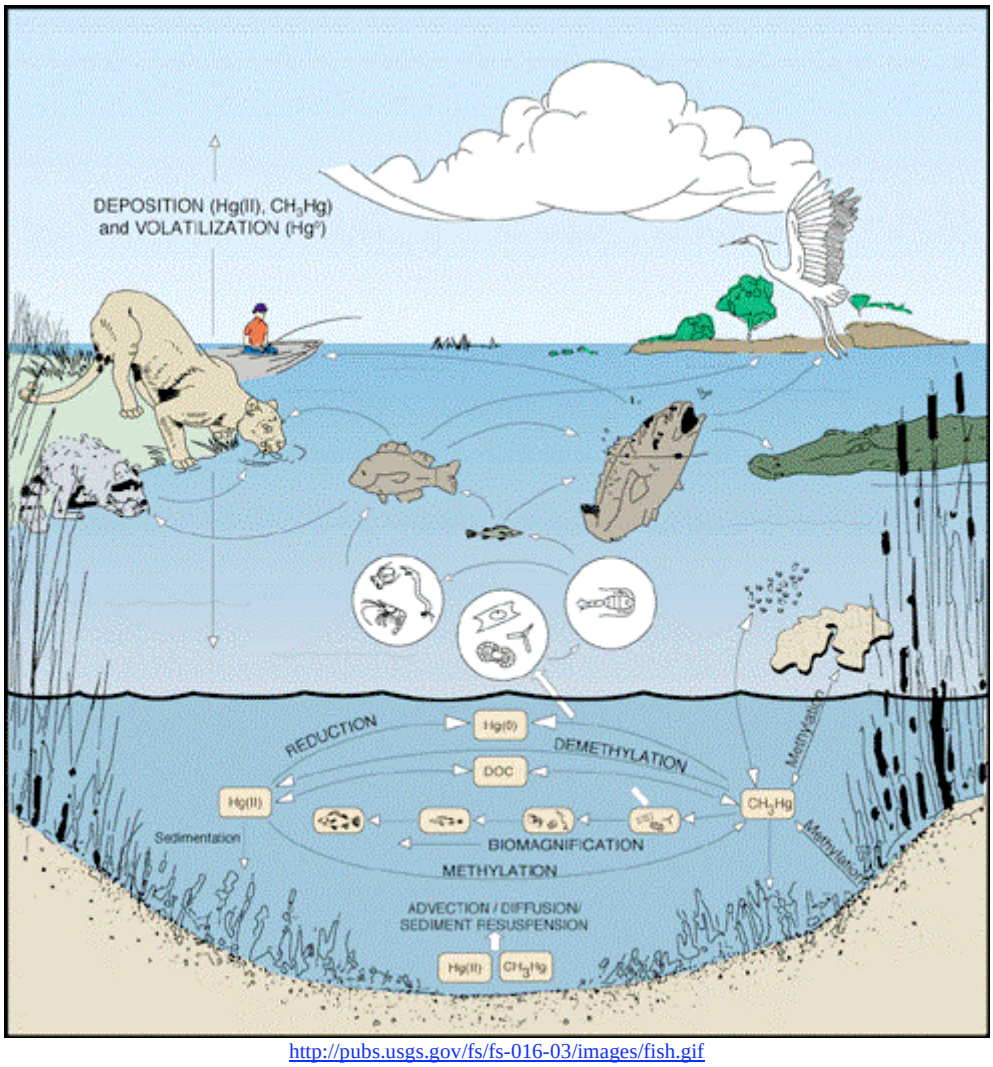
The FIMS-100 is capable of detecting total mercury in the ppb range. Elemental mercury is delivered to the detector by a carrier gas (argon) and measured by cold vapor atomic absorption

Cold Vapor Atomic Absorption method was used to quantitatively measure the level of mercury present in the seafood samples. **Cold Vapor** is the method by which a cloud of atoms is produced from a

solution containing Hg ions. Hg in the +2 state is reduced by the addition of stannous chloride and then swept by a flow of inert gas into a quartz-ended absorption cell kept at ~ 200 degrees C. (prevents water condensation). In addition, mercury concentration is measured in parts per million by atomic spectroscopy. 3% HCl is used to carry the sample into the spectrophotometer. Measurements are reported in μg/g using a formula that takes into account the mass, volume, and absorbance reading of the sample.

The Environmental Protection Agency (EPA) suggests that 1ppm is an acceptable level for the intake of mercury by any human. According to the EPA, mercury can be found in many rocks such as coal. When coal is burned, mercury is released into the environment. Coal-burning power plants are considered to be one of the largest human caused sources for the releasing of mercury into the air.

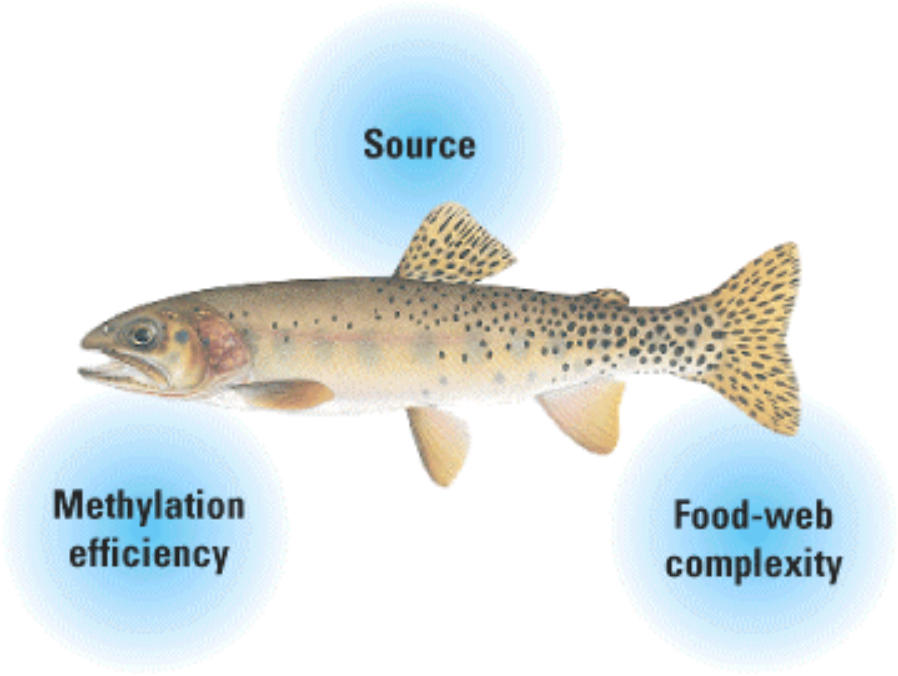
Sources of Mercury



http://pubs.usgs.gov/fs/fs-016-03/images/fish.gif

In this diagram, the most important fact that we should focus on is that the mercury in the air settles into the soil and sediments of lakes and oceans. Once settled, it undergoes methylation, the process in which bacteria converts elemental mercury into its most toxic form **Methylmercury**. The

bacteria now exposed are eaten by fish which are in turn eaten by larger fish and travel up the food chain and eventually eaten by humans and other mammals. Now the larger predators (mammals) are going to get exposed and the cycle continues.



- Fish is considered to be the main natural source for all exposures to methylmercury.

Materials & **M**ethods

Mercury Extraction Method

1. Weigh 0.4g of sample

2. Add 5mL of RGW and
   5mL of aqua regia (ratio 3:1 sulfuric acid & nitric acid)

3. Heat for 2 min @ 95°C, then cool

4. Add 50mL RGW and
   15mL of the oxidizer 5% Potassium Permanganate ($KMnO_4$)

5. Mix for 30 min @ 95°C

6. Cool, add 6mL of sodium chloride hydroxylamine sulfate to reduce excess $KMnO_4$

7. Filter and analyze within 1-28 days

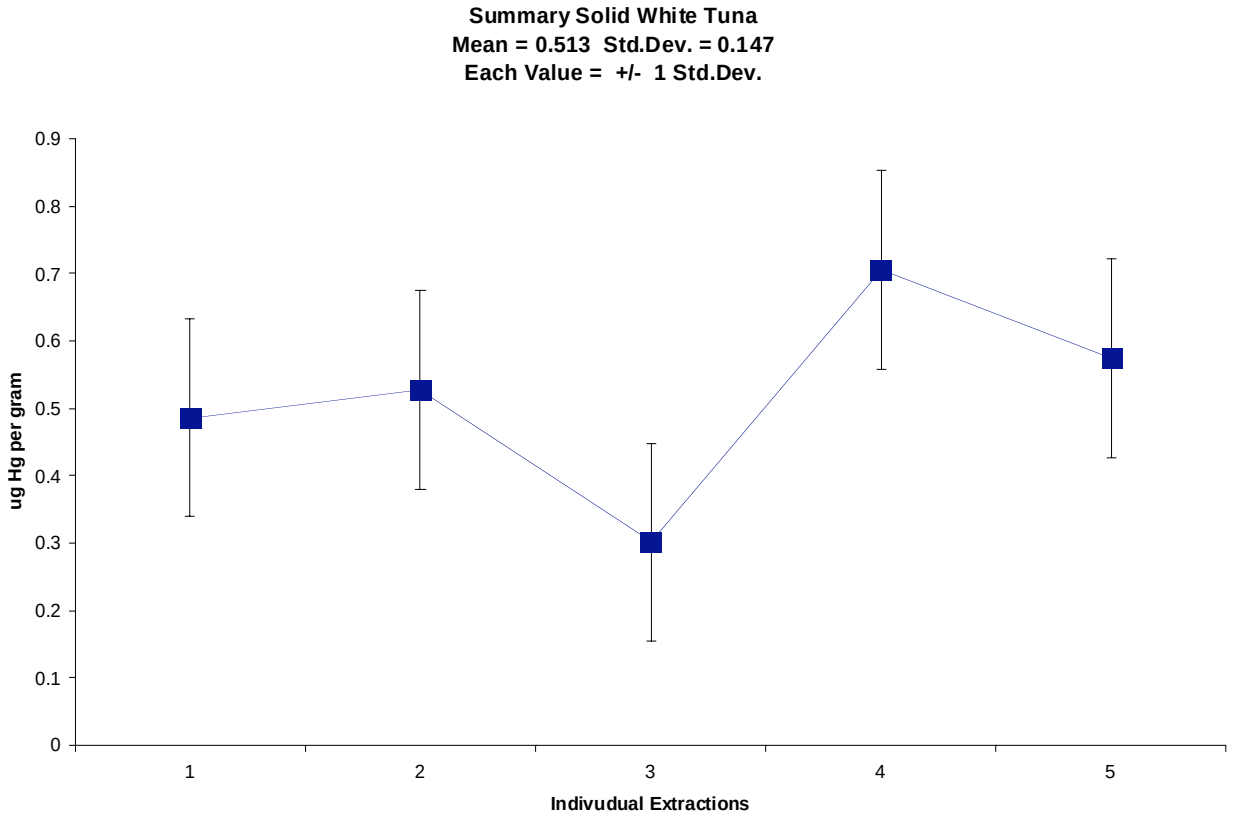
8. $\mu g/g = \frac{\text{(Mean FIMS reading [}\mu g/L\text{]) (0.081L)}}{\text{Gram of sample}}$

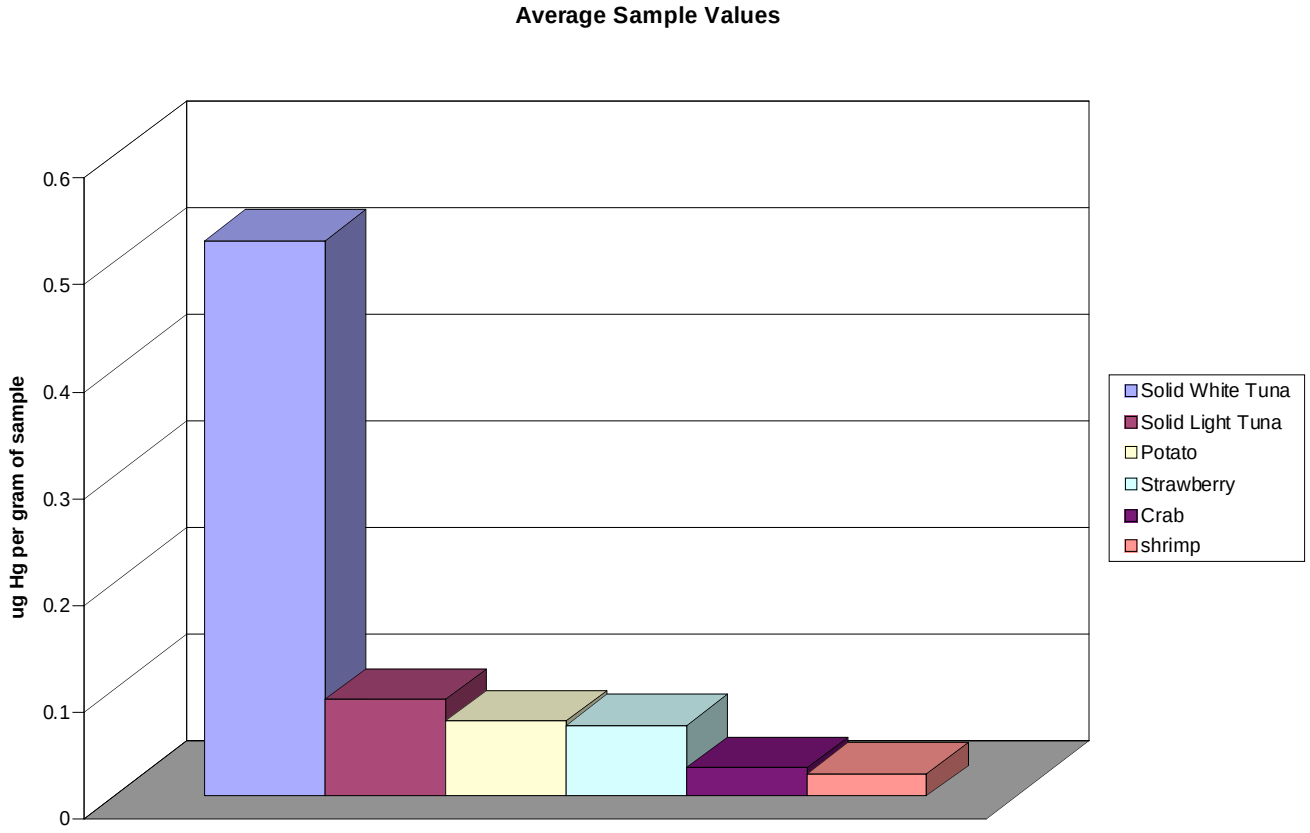
Materials

1. The PerkinElmer Flow Injection Mercury System (FIMS)
2. Reagent Grade Water
3. 5% Potassium Permanganate
4. Sodium Chloride Hydroxylamine Sulfate
5. Temperature Control Water Bath

Results

- After analyzing various cans of tuna it was found that white albacore tuna carries approximately 5.73 times more Hg than that of light tuna.
- Mercury in tuna contains approximately 26 times more Hg than that of shrimp and crab.
- Preliminary studies were not able to show accumulation in plants, fruits and vegetables.




Average Sample Values
ug Hg per gram of sample
0.6
0.5
0.4
0.3
0.2
0.1
0
Solid White Tuna
Solid Light Tuna
Potato
Strawberry
Crab
shrimp

Discussion

The results show that mercury accumulation and exposure does vary in different aquatic animals. This supports the hypothesis that mercury does accumulate differently in different parts of the animal and the fact that all types of seafood binds mercury in a way that each retains a different amount.

In the first graph labeled Summary Solid White Tuna, the x-axis indicates individual extractions. The y-axis represents micrograms/ per gram. The graph shows five separate extractions, each containing four cans of tuna. The data point represents the average of four cans per batch.

The second diagram shows the average sample values for all the samples extracted. Based on the data shown we can say that the solid white albacore retains the most mercury and less amounts of it should be consumed for a lower exposure to methylmercury.

Conclusion

Preliminary results suggest that FIMS atomic absorption method is an accurate means of quantizing levels of Hg in seafood. Albacore solid white tuna resulted in having a greater concentration of mercury than crab which in turn had more than shrimp. It was found that white albacore tuna carries a larger concentration of methylmercury than light tuna. The plants, potato and strawberry tested did not show the ability to retain Mercury.

Future Work

Future studies are planned to analyze different parts of fish and to analyze other species of fish suspected of retaining mercury. (sharks, swordfish, ect.) An attempt will be made to explain how mercury is retained in certain parts of animals and how mercury binds to aquatic animals as compared to mammals.

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