Seeing Through the Haze:
Understanding Tuna, Mercury and Health

This is a guest article from Dr. J. John Kaneko, Seafood Safety Specialist, Honolulu, HI, www.Hawaii-Seafood.org, published in the Spring 2024 issue of Pacific Islands Fishery News *by the Western Pacific Regional Fishery Management Council.*

Each spring, the same alarmist story about the dangers of mercury in fish is repeated by the media. Repeat a story enough times, it becomes true. The intent is to engage the public in support of controlling mercury pollution, especially from coal fired power plants. Tuna is the usual scapegoat in this story because it is widely consumed and catches people's attention. The story goes that the mercury in tuna is from human activities that cause mercury pollution, primarily coal and gold mining, coal burning, industry and waste processing. This ignores the fact that the source of mercury in ocean fish is from industrial and natural pollution. The ocean has always been a natural sink for mercury that was and continues to be released from volcanic activity.

The "story" continues that people are exposed to mercury primarily through seafood consumption (true), that mercury is a neurotoxin (partly true) and that eating fish with mercury concentrations typically found in commercially available tuna is harmful, especially to developing fetuses and young children (does not appear to be entirely true).

But this year, something is very different.

On March 21, 2024, the BBC reported on a study[1] that found that mercury concentrations in tuna had not changed between 1971 and 2022, which should be good news. They concluded that although mercury in fish has not increased during this 50-year period, it may in the future. The authors advocate for greater effort to control mercury pollution. Controlling mercury pollution makes sense on its own. But to do it to lower mercury levels in tuna may not, especially if the goal is to approach zero mercury.

The study indicates that mercury cycling in the ocean environment and the source of mercury in tuna are not fully understood. In 1998, I collected the sample set of Hawai'i yellowfin tuna that was analyzed for mercury concentration to compare with the sample set collected in 1971. No change in mercury levels had occurred over that 27-year period,[2] while mercury pollution increased. The conclusion was that the mercury in Hawai'i yellowfin tuna came primarily from natural and not man-made pollution.

This old story is getting tired.

When the BBC described this study for public consumption, it repeated the mantra of the dangers of mercury in tuna. This ignores the fact that there has never been a reported outbreak

CONTINUED ON NEXT PAGE

of mercury poisoning from tuna consumption. Ever. The story being repeated today also ignores the substantial scientific and empirical evidence of the beneficial net effects for consumers from inclusion of seafood in the diet. These more recent studies have evolved from those that focused on mercury alone, and treated fish, including tuna, simplistically as a mercury delivery system. But tuna (and other seafood) contains beneficial nutrients, not only mercury. These more recent studies accept this and instead strive to determine the net effects of mercury (as harmful) and beneficial nutrients from eating ocean fish.

Ocean fish in the diet provides high-quality lean protein, seafood omega-3 fatty acids (DHA and EPA) and Vitamin B12, Vitamin B6, Vitamin D, iodine, selenium and other nutrients. It is widely accepted that DHA and EPA support heart and brain development and health among many other benefits. Vitamins play essential roles in metabolism and overall health. Iodine is important to metabolism in the formation of thyroxin hormones. Selenium is an essential mineral for the production of selenoenzymes which include anti-oxidant enzymes that protect against oxidative damage.

There is strengthened evidence that seafood is health food.

The National Academy of Science, Engineering and Medicine (NASEM) is completing a systematic consensus study this year (2024) of the Role of Seafood Consumption in Child Growth and Development.[3] This study considers both potentially harmful contaminants and beneficial nutrients contained in fish. The study team presented selected conclusions recently (webinar March 26, 2024) which concluded, "Taken as a whole, the evidence reviewed by the committee indicates that higher fish consumption is associated with lower risk of adverse health outcomes or no association with health outcomes. The evidence for increased risk of adverse health outcomes associated with seafood consumption was insufficient to draw a conclusion."

The recently published 2023 Special Issue of Neurotoxicology on Fish Consumption, Mercury Exposure, and Health, provides convincing evidence that the net effects of eating seafood are beneficial to health, regardless of mercury concentrations found in commercially available seafood. One of these studies[4] reviewed the results of research that cumulatively studied dietary mercury as harmful and omega-3 fatty acids as beneficial nutrients in more than 200,000 mother-child pairs. They found overwhelmingly beneficial net effects in child development associated with maternal seafood consumption during pregnancy. Children born to fish-eating mothers had improved neurodevelopment outcomes (2-5 IQ points higher) compared to children born to non-fish eaters. They conclude that the net effects of maternal fish consumption are beneficial to children, despite mercury in fish.

Why isn't mercury in tuna a health problem?

The concern about mercury in fish stems from the tragedy that occurred in Minamata, Japan in the late 1950s and early 1960s. Birth defects and other effects were attributed to extremely high levels of mercury from eating contaminated seafood. But the Minamata disaster was a case of gross industrial mercury pollution, not naturally occurring concentrations. This industrial disaster created the concern about mercury in fish that persists today, even though a Minamata scale incident has never occurred since.

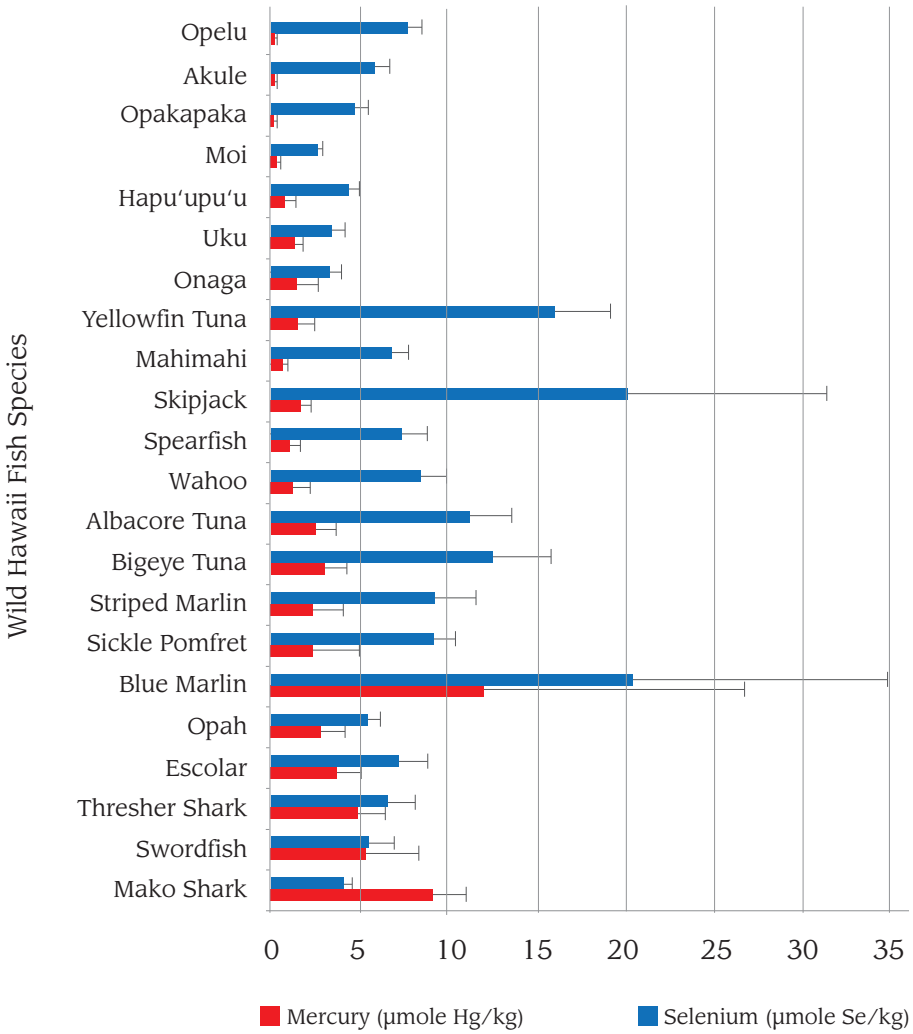
Selenium has protective effects on mercury toxicity.

Mercury is known to be a neurotoxin, causing oxidative damage to the brain. But the mechanism of how mercury is neurotoxic is still being studied. Current research continues to demonstrate that selenium can counteract or protect against the harm caused by lethal concentrations of dietary mercury in animal studies. The current evidence points to the importance of the extraordinarily strong selenium to mercury binding strength in understanding mercury toxicity. Conceptually, one molecule of selenium binds with a molecule of mercury in the body to form an inert compound, mercury-selenide. But why is this important?

CONTINUED ON BACK PAGE

Hawaii Seafood
and Your Health

Selenium and mercury molar ratios in Hawaii Seafood species



Source:

Kaneko, JJ and NVC Ralston. 2007. Selenium and Mercury in Pelagic Fish in the Central North Pacific near Hawaii. Biol Trace Elem Res 119: 242-254

Kaneko, JJ. 2012. Selenium and Mercury in Selected Seafood Products in Hawaii. Hawaii Seafood Council, NOAA Award No. NA09NMF4520175. 17 p.

Ralston, NVC, JL Blackwell and LJ Raymond. 2007. Importance of Molar ratios in selenium-dependent protection against methylmercury toxicity. Biol Trace Elem Res 119: 255-268

Prepared by the Hawaii Seafood Council with support from NOAA Award NA10NMF452034

Fish is Health Food.

Ocean fish provide us with a delicious nutrient package of lean high-quality protein with vital nutrients including omega-3's (DHA & EPA), vitamins (niacin, B-6, B-12, D) and minerals (iodine, selenium).

What about mercury?

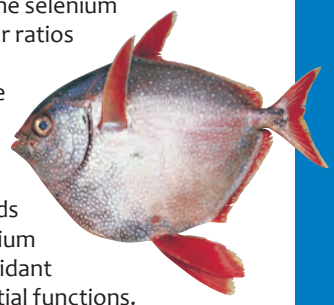
All fish contain trace amounts of mercury. Large and long-lived ocean fish species have more time to accumulate mercury. But why haven't there been any mercury poisoning outbreaks from eating open ocean fish like tuna?

Selenium is an essential nutrient.

Selenium has many health promoting functions. We need it for selenium-dependent anti-oxidant systems that protect our cells (especially brain cells) against oxidative damage. Excessive mercury in the diet is known to cause oxidative damage to the brain.

Selenium protects against mercury.

Selenium has an extraordinary attraction for mercury. When the two elements meet, they bind so strongly that neither is biologically available. This 1 to 1 molecular binding makes the selenium to mercury molar ratios in diets critical. Foods with more mercury than selenium may lead to mercury toxicity. But foods with more selenium maintain anti-oxidant and other essential functions.



What about Hawaii Seafood?

Hawaii's wild ocean fish species contain an excess of selenium over mercury and are more likely to prevent than contribute to mercury toxicity. Mako shark is the only species that contains more mercury than selenium.

HawaiiSeafood
Hawaii Seafood Council

www.hawaii-seafood.org

Seeing Through the Haze: Understanding Tuna, Mercury and Health

CONTINUED FROM PAGE 2

We know of no essential dietary need for mercury, but selenium is an essential element in the diet. Profound selenium deficiency causes oxidative damage and other health issues. In diets where mercury exceeds the selenium intake, selenium is bound to mercury, maintenance of selenium-dependent anti-oxidant enzymes is impaired, leading to oxidative damage. However, when selenium exceeds mercury in the diet, the selenium-dependent enzymes are maintained, and the brain is protected from oxidation. So, it is the ratios of selenium to mercury that determine if a food is likely to promote or protect against mercury toxic effects. This leads to the conclusion that mercury toxicity is actually selenium deficiency.

There continues to be a concern about fish consumption during pregnancy. A recently published research paper[5] studied maternal fish consumption, mercury intake, selenium status and the implications for child health. The study included 100 mother-child pairs in Hawai'i grouped by weekly fish consumption into No (0 oz/wk), Low (0-12 oz/wk) and High fish consumption (>12 oz/wk) groups. The mercury concentrations of fetal tissue (umbilical cord blood and placenta) increased with maternal fish consumption. However, the selenium concentration also increased and greatly exceeded mercury concentrations. The results support the hypothesis that ocean fish in the maternal diet provides substantial amounts of selenium to protect against the loss in availability caused by binding with mercury.

Good news for fish eaters.

Where do we get selenium? It turns out that the 16 of the top 25 food sources of selenium in the American diet are ocean fish species. For consumers of Pacific tunas and associated species which are the usual mercury story "suspects" (see figure), it should be a comfort to know that all commercially available fish species we have studied, contained an excess of health promoting selenium over mercury. Eating these fish is more likely to protect against than contribute to mercury toxicity. The only Hawai'i fish species we found that had more mercury than selenium was the mako shark, a fish that is no longer landed or sold in Hawai'i.

To conclude, we should be eating more and not less seafood, regardless of mercury, as long as there are favorable selenium-mercury ratios.

- ***Encourage greater seafood consumption to enjoy the known health benefits.***
- ***Stop vilifying tuna with unsubstantiated claims of harm caused by mercury.***
- ***Stop causing harm by scaring the public away from the health benefits of eating ocean fish.***

References

[1] Medieu, A, D. Point, J.E. Sonke, H. Angot, V. Allain, N. Bodin, D.H. Adams, D.G. Streets, P.B. Buchanan, L.E. Heimburger-Boavida. H. Pathybridge, D.O. Gillikin, F. Menard, C.A. Choy, T. Itai, P. Bustamante, Z. Dhurmeea, B.E. Ferris, B. Bourles, J. Habasque, A. Verheyden, J. Munaron, L. Laffont, O. Gauthier and A. Larrain. 2024. "Mercury mystery: Poisonous element persists in tuna." *Environ. Sci. Technol. Lett.* 2024. 11(3) 250-258.

[2] Kraepiel, A.M., L. Keller, H.B. Chin, E.G. Malcolm and F.M.M. Morel. 2003. "Sources and Variations of Mercury in Tuna." *Environ. Sci. Techn.* 2003 (37) 5551-5558.

[3] NASEM (National Academies of Sciences, Engineering and Medicine). 2024. *The Role of Seafood Consumption in Child Growth and Development*. Washington DC: The National Academies Press. https://doi.org/10.17226/27623.

[4] Spiller, P, E van Wijngaarden, H. R. Adams, J.J. Strain, E.M. McSorely, M.S. Mulhern, M.C. Conway, A.J. Yates, C Carrington, P.M. Bolger, K.M. Morgan, C. M. Taylor, N.V.C. Ralston, M.C. Crawford, J.R. Hibbeln, J. T. Brenna and G.J. Myers. "Net effects explain the benefits to children from maternal fish consumption despite methylmercury in fish." *Neurotoxicology* 99(2023) 195-205.

[5] Ralston, N. V. C., L.J. Raymond, C/L. Gilman, R. Soon, L. A. Seale, M.J. Berry. 2024. "Maternal seafood consumption is associated with improved selenium status: Implications for child health." *Neurotoxicology* 101 (2024) 26-35.