HEAVY METAL CERTIFIED · RESEARCH ANALYSIS

Why Cooking Never Lowers the Methylmercury in Fish

Karen Pendergrass · ORCID 0000-0002-2348-7259 · Heavy Metal Certified · August 2026

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Abstract

No — cooking does not reduce the methylmercury in fish, and neither does smoking, pickling, frying, or canning. Methylmercury is bound covalently to cysteine residues in muscle protein through one of the strongest bonds in biochemistry, and heat denatures the surrounding protein without cleaving that bond, so the metal stays in the cooked flesh and is absorbed at more than ninety percent when eaten. Comparative measurements across dozens of species and preparation forms show the methylmercury content essentially unchanged from raw to smoked, fresh to canned. The certification consequence is exact: the methylmercury measured on the raw product is the dose a consumer receives, so verification has to be performed on the product as sold, and consumer messaging must never imply that thorough cooking lowers the risk. Species selection at sourcing, not any kitchen practice, is the only lever that meaningfully lowers exposure. The full anchor-source evidence base lives on the Heavy Metal Index, the independent literature reference this analysis cites one way.

The Bond That Cooking Cannot Break

In fish muscle, mercury is not a free ion loosely held in the tissue. Roughly 80 to 95 percent of the total mercury is present as methylmercury, and essentially all of that fraction is bound covalently to the thiol group of cysteine residues in muscle protein [1]. The mercury–sulphur bond is among the strongest covalent bonds in biochemistry, with a binding energy near 70 kcal/mol.

Cooking works on the protein, not on that bond. Frying, grilling, baking, broiling, and smoking denature the protein's tertiary structure — they change its shape — but they do not supply the energy to cleave the mercury–sulphur bond. The methylmercury remains in the cooked muscle and is absorbed across the intestine at more than 90 percent bioavailability once eaten [1]. The transformation cooking produces is structural, not chemical, which is why no conventional kitchen method removes any measurable share of the metal.

Smoked, Pickled, Canned: The Numbers Do Not Move

The clearest test is to measure the same species prepared different ways. The German Federal Institute for Risk Assessment (BfR) did exactly this in its MEAL study, measuring total mercury and methylmercury in pooled samples of ready-to-eat fish across more than thirty species and preparation forms [2]. Across the whole dataset the methylmercury share of total mercury clusters between 76 and 113 percent, with values above 100 percent reflecting measurement uncertainty near the limit of quantification rather than a real fraction over unity.

Paired preparations of one species tell the story:

Species and form	Total mercury (mg/kg)	Methylmercury (mg/kg)
Eel, fresh	0.10	0.10
Eel, smoked	0.08	0.08
Herring, fresh	~0.05	~0.05
Herring, smoked	0.08	0.07
Herring, fried and pickled	0.05	0.05

Halibut, fresh	0.08	0.08
Halibut, smoked	0.11	0.09
Cod, baked	0.02	0.02

Smoked versus fresh, pickled versus raw, fried versus baked — the methylmercury content does not measurably shift with preparation [2]. Where small differences appear, such as smoked halibut reading slightly higher than fresh, they reflect lot-level sampling variability across processing batches, not a process that adds or removes mercury. Even the harsh conditions of commercial canning — roughly 116 to 121 °C for 30 to 90 minutes — leave the methylmercury–protein binding intact.

Canned Tuna Confirms It

Canning is the most aggressive routine treatment fish undergoes: sustained heat under pressure. If any process were going to break methylmercury down, this would be it. It does not. A 2024 study of canned tuna sold in Quito, Ecuador measured total mercury across 60 samples in three brands, with brand means of 0.14, 0.25, and 0.41 mg/kg and a wider literature range of 0.005 to about 1.47 mg/kg across Latin American canned-tuna studies [3]. Around 89 percent of that total mercury is methylmercury, a fraction the thermal-and-pressure canning process does not change [3].

The apparent per-gram concentration can fall when a preparation dilutes the fish with other matrix — a sauce, for instance — but that is dilution, not destruction: the consumer eats the added mass too, so the methylmercury per serving tracks the amount of fish on the plate, not the cooking method applied to it.

What Actually Lowers the Dose

Because cooking cannot help, exposure has to be managed before the fish reaches the kitchen. Three levers are documented, and none of them is a cooking practice.

Species selection is by far the largest. Replacing apex predators — tuna, swordfish, shark, marlin, king mackerel, Gulf tilefish — with low-trophic species such as salmon, sardine, anchovy, herring, Atlantic mackerel, or tilapia shifts the per-serving methylmercury load by roughly 5 to 10 times, and as much as 100 times for some pairings. Within a single species the same principle applies: choosing skipjack, which is smaller and shorter-lived, over albacore or bluefin lowers per-serving methylmercury by about 50 to 70 percent. Finally, eating fewer fish meals per week lowers cumulative intake proportionally; the FDA and EPA operationalise this as species-stratified "Best Choices, Good Choices, Avoid" advice [4], calibrated against reference values such as the US EPA reference dose of 0.1 µg per kg body weight per day [5] and the EFSA provisional tolerable weekly intake of 1.3 µg methylmercury per kg body weight per week [6].

One narrow trimming exception is worth naming precisely so it is not overstated: some of the lead and cadmium in finfish concentrates in skin and subcutaneous fat and can be cut by perhaps 10 to 20 percent by skinning and trimming before cooking. That effect is real for whole-fish preparations, but it does not touch methylmercury, which sits in the muscle itself.

What this means for certification

The finding collapses into a single operational rule: the methylmercury measured on the raw product is the methylmercury a consumer eats. Nothing between the loading dock and the dinner plate lowers it. That has two consequences for how a heavy-metal certification treats fish and seafood.

First, verification must be performed on the product as sold. Because no processing step reduces methylmercury, there is no cooked or canned "as-consumed" allowance to net against a raw measurement — the number on the mercury test report is the number that reaches the household. A standard cannot credit a brand for cooking, smoking, or canning, and it should benchmark predatory species and canned products against their own occurrence distributions rather than a pooled seafood average that hides the high-mercury tail. This is why the predatory-fish and canned-seafood categories each carry their own subcategory standard.

Second, consumer messaging must never imply that cooking lowers the risk. A certification mark that reassures a household about a tuna-heavy diet because the fish is well cooked would endorse a documented misconception and leave the real exposure pathway unaddressed. The honest message is that species selection at sourcing, not preparation, is the lever.

On the number itself: the default limit for any product and analyte is the strictest maximum level set by a credible government regulator, converted to the product's own basis. Because methylmercury is one of the four Tier-1 toxics the program treats most strictly — alongside lead, cadmium, and inorganic arsenic — the ceiling for predatory fish and canned seafood is set to the stricter of that government maximum and the cleaner end of the methylmercury occurrence evidence, measured on the product as it is sold.

Frequently asked questions

Does cooking remove mercury from fish?

No. Cooking — along with smoking, pickling, frying, and canning — does not reduce the methylmercury in fish. It is bound covalently to cysteine in muscle protein through one of the strongest bonds in biochemistry, so heat changes the protein's shape but not that bond, and the metal stays in the cooked flesh. It is then absorbed at more than 90 percent when eaten.

Does canning reduce the mercury in tuna?

No. Canning applies sustained heat under pressure — roughly 116 to 121 °C for 30 to 90 minutes — and still leaves the methylmercury–protein binding intact. About 89 percent of the total mercury in canned tuna is methylmercury, a fraction canning does not change. Measured canned-tuna mercury tracks the species and the source, not the processing.

If cooking does not help, how do I lower mercury exposure?

Species selection at sourcing is by far the largest lever: choosing low-trophic fish such as salmon, sardine, or herring over apex predators such as tuna, swordfish, or shark can cut per-serving methylmercury 5 to 10 times or more. Within tuna, choosing skipjack over albacore or bluefin lowers it about 50 to 70 percent, and eating fewer fish meals per week lowers cumulative intake proportionally.

Why does mercury survive cooking when other contaminants do not?

Methylmercury is chemically bonded to muscle protein, not merely dissolved in fat or water, so it cannot be cooked off, drained, or rinsed away. Some of the lead and cadmium in finfish concentrates in skin and fat and can be reduced 10 to 20 percent by trimming, but methylmercury sits in the muscle and no preparation removes it.

References

[1] Mechanisms of methylmercury neurotoxicity and cysteine–protein binding. Farina et al., 2011. Establishes that methylmercury binds covalently to cysteine thiol groups in muscle protein and is absorbed across the mammalian intestine at more than 90 percent bioavailability.

[2] Methylmercury versus total mercury across fish species and preparation forms in the BfR MEAL study. German Federal Institute for Risk Assessment (BfR), 2024. Measured total and methylmercury in pooled ready-to-eat fish across more than 30 species and preparation forms; the methylmercury-to-total ratio clusters between 76 and 113 percent and does not shift with cooking, smoking, or pickling.

[3] Total mercury in canned tuna sold in Quito, Ecuador. Aguilar-Miranda et al., 2024. Total mercury across 60 canned-tuna samples in three brands (means 0.14, 0.25, 0.41 mg/kg; literature range 0.005 to about 1.47 mg/kg); reports that roughly 89 percent of canned-tuna total mercury is methylmercury, unchanged by canning.

[4] FDA–EPA advice about eating fish: Best Choices, Good Choices, and Choices to Avoid. United States Food and Drug Administration and Environmental Protection Agency. Species-stratified meal-frequency guidance operationalising methylmercury exposure reduction through species selection and consumption frequency.

[5] US EPA reference dose for methylmercury. United States Environmental Protection Agency. Reference dose of 0.1 µg methylmercury per kg body weight per day, used to calibrate the safe upper bound of dietary exposure.

[6] EFSA provisional tolerable weekly intake for methylmercury. European Food Safety Authority. Provisional tolerable weekly intake of 1.3 µg methylmercury per kg body weight per week for the safe upper bound of dietary exposure.

[7] Heavy Metal Index — cooking does not reduce methylmercury (synthesis with full anchor-source records). The independent literature synthesis this analysis reframes, carrying the full anchor-source records for the mechanism and the comparative cooked-versus-raw measurements. · heavymetalindex.com

Cite this analysis