Cooking does not reduce methylmercury — and why this matters for consumer messaging

Karen Pendergrass · · Heavy Metal Index, Institute of Contaminant Standards

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CORRESPONDENCE

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Abstract

A widespread consumer misconception is that thorough cooking — frying, grilling, baking, broiling, smoking, canning, pickling — reduces the methylmercury (MeHg) content of fish. It does not. Methylmercury binds covalently to cysteine residues in muscle protein and survives every conventional cooking method intact. This means species selection at the point of sourcing is the only lever that meaningfully reduces dietary MeHg exposure; no kitchen practice substitutes for it. The consumer-protection significance is direct: the cooking-as-mitigation misconception leaves a household that assumes its tuna-heavy diet is safe because the fish is cooked well exposed to the full dietary MeHg load.

1 | Overview

This synthesis page consolidates the mechanism evidence and the comparative measurements across cooked-and-processed forms that establish the finding.

2 | The mechanism

Methylmercury (CH_3Hg^+) in fish muscle is not free or loosely bound. Approximately 80-95% of total fish-muscle mercury is in the methylated form, and essentially all of that fraction is covalently bound to the thiol (-SH) group of cysteine residues in muscle protein. The Hg-S bond is among the strongest covalent bonds in biochemistry (binding energy ~70 kcal/mol). Heat-denaturing the protein matrix during cooking changes the protein's tertiary structure but does not cleave the Hg-S bond. The MeHg remains in the cooked muscle, available for intestinal absorption (>90% bioavailability in mammals per Farina et al. 2011) upon consumption.

This mechanism explains why canning, smoking, pickling, and other industrial processes also fail to reduce MeHg. Even autoclave-grade thermal treatment in commercial canning processes (typically 116-121°C for 30-90 minutes) leaves MeHg-protein binding intact. The matrix change is structural, not chemical.

3 | The comparative evidence

BfR 2024 (German Federal Institute for Risk Assessment MEAL study) measured tHg and MeHg in pool samples of ready-to-eat fish across 30+ species and preparation forms. The MeHg/tHg ratio across the entire dataset cluster between 76% and 113% (the >100% values reflect measurement uncertainty at LOQ, not real >100% fractions). Comparing across preparation forms for the same species:

- Cod, baked: 0.02 mg/kg tHg, 0.02 mg/kg MeHg (ratio 95-96%)
- Cod, fish fingers: 0.01 mg/kg tHg, MeHg <LOQ (ratio 76%, below-LOQ noise)
- Eel, fresh: 0.10 mg/kg tHg, 0.10 mg/kg MeHg (ratio 94-96%)
- Eel, smoked: 0.08 mg/kg tHg, 0.08 mg/kg MeHg (ratio 97%)
- Herring, fresh: ~0.05 mg/kg tHg, MeHg in same range
- Herring, smoked: 0.08 mg/kg tHg, 0.07 mg/kg MeHg (ratio 91%)
- Herring, fried/pickled: 0.05 mg/kg tHg, 0.05 mg/kg MeHg (ratio 95%)
- Herring in sauce: 0.04 mg/kg tHg, 0.03 mg/kg MeHg (ratio 77%)
- Herring, pickled (Matjes/Bismarck): 0.03 mg/kg tHg, 0.03 mg/kg MeHg
- Halibut, fresh: 0.08 mg/kg tHg, 0.08 mg/kg MeHg (ratio 103%)
- Halibut, smoked: 0.11 mg/kg tHg, 0.09 mg/kg MeHg (ratio 108%)

The pattern is consistent: smoked vs fresh, pickled vs raw, fried vs baked, canned vs fresh — the MeHg content does not measurably shift with preparation. Where small variations appear (smoked halibut tHg slightly higher than fresh; herring-in-sauce slightly lower than fresh), they reflect lot-level sampling variability across different processing batches, not a process-driven reduction in MeHg per se.

Aguilar-Miranda et al. 2024 documents canned-tuna tHg across 60 samples in three Ecuadorian brands (means 0.14, 0.25, 0.41 mg/kg). The literature range cited by Aguilar-Miranda spans 0.005-1.4725 mg/kg across Latin American canned-tuna studies. Per the same source, ~89% of canned-tuna tHg is MeHg (citing Burger and Gochfeld 2004, Médieu et al. 2022). Canning — a rigorous thermal-and-pressure process — does not change this fraction.

Across the wiki's broader fish-and-seafood evidence base, the MeHg/tHg ratio in muscle of finfish consistently sits at 80-95% regardless of preparation form. Where preparation does shift the apparent MeHg content (e.g., a sauce that dilutes the per-gram concentration by adding non-MeHg matrix mass), the per-serving MeHg intake is similarly diluted because the consumer is eating a sauce-and-fish mixture, not pure fish.

4 | What does reduce MeHg exposure

Three levers are documented; none of them are cooking practices:

1. **Species substitution** — replacing apex-predator fish (tuna, swordfish, shark, marlin, king mackerel, tilefish-Gulf of Mexico, bigeye tuna) with low-trophic species (salmon, sardine, anchovy, herring,

mackerel-Atlantic, tilapia, US-farmed catfish) shifts the per-serving MeHg load by 5-10× to as much as 100× depending on the pair. This is the lever with by far the largest documented effect on per-serving MeHg.

2. **Trophic-level differentiation within species —** within a single species (e.g., tuna), MeHg burden varies by individual size and age. Specifying skipjack (smaller, shorter-lived) over albacore or bluefin (larger, longer-lived) within the canned-tuna sub-category reduces per-serving MeHg by 50-70%.

3. **Consumption-frequency reduction —** reducing the number of fish meals per week reduces cumulative weekly MeHg intake proportionally. FDA-EPA "Best Choices / Good Choices / Avoid" framework operationalizes this as species-stratified meal-frequency guidance. EFSA PTWI (1.3 µg MeHg/kg body weight/week) and EPA RfD (0.1 µg MeHg/kg body weight/day) calibrate the safe upper bound; consumption-frequency caps below these levels are the operative consumer-protection lever in advisory frameworks.

5 | What this synthesis does not yet rest on

The mechanism is well-established and the comparative MeHg-vs-preparation-form measurements are consistent across multiple jurisdictions (German MEAL, Latin American canned tuna, US/Canadian freshwater fish surveys). What is less well-characterized:

- **Selenium-MeHg interaction during cooking.** Whether cooking releases Se from the matrix in a way that shifts the Se:Hg molar ratio at the point of intestinal absorption is an open question. See se-hg-molar-ratio--certification-debate for the broader Se:Hg framework discussion.
- **Industrial fermentation of fish products** (fish sauce, garum, anchovy paste, surstromming, hákarl). MeHg in fermented fish products has limited measurement in the wiki's current corpus; fermentation may produce small shifts via microbial activity (the gut-microbiome MeHg-demethylation work in Coe et al. 2023 is suggestive at low orders of magnitude), but no systematic body of evidence yet establishes whether fermented fish products differ meaningfully from fresh.
- **High-temperature super-extended cooking** (>4 hours at >100°C, e.g., long-pressure-canning of bone broths) is not well-represented in the measured-cooked-fish literature. The default assumption is that even these conditions do not cleave Hg-S bonds, but direct measurement would strengthen the claim.

6 | Consumer-protection significance

The cooking-doesn't-reduce-MeHg finding sits alongside two other load-bearing findings in the seafood MeHg-exposure literature: species selection is the dominant lever, and sensitive populations require stricter consumption-frequency caps. The misconception that "cooking destroys the mercury" is widespread enough across general-population dietary advice that consumer messaging which does not explicitly correct it leaves a documented exposure pathway unaddressed.

The narrow exception worth naming: certain Pb and Cd content in finfish, primarily concentrated in skin and subcutaneous fat, can be modestly reduced (10-20%) by skinning and trimming before cooking. This is a small effect that primarily matters for whole-fish preparations where skin would be consumed; it does not generalize to MeHg.

7 | Downstream pages updated

- seafood — Levers to reduce contamination section includes the "cooking does not reduce MeHg" finding under Processing levers.

- canned-fish — same, with explicit note that canning is a thermal-and-pressure process that does not reduce MeHg.
- fresh-fish — same, with note that freezing/thaw cycles and all cooking methods leave MeHg intact.
- fish-containing-baby-foods — same finding applies; infant-feeding messaging especially benefits from explicit treatment.
- mercury-methyl — Toxicology and Analytical methods sections cover the mechanism.

8 | Anchor sources

- bfr2024-methylmercury-fish-seafood-germany — BfR MEAL study; pooled-sample MeHg-vs-tHg ratios across 30+ species and preparation forms; load-bearing comparative evidence.
- aguilar-miranda2024-thg-canned-tuna-ecuador — Canned-tuna tHg/MeHg fraction evidence; literature-range citation across Latin American studies.
- farina-rocha-aschner-2011-mehg-mechanism — Mechanism reference for MeHg-cysteine binding, intestinal absorption rate.
- coe2023-gut-microbiome-methylmercury-demethylation — Gut-microbiome MeHg demethylation evidence; relevant for fermented-fish open question.

9 | How this page was promoted

Established 2026-05-18 from the seafood-axis ingest and synthesis work. The mechanism evidence (cysteine-binding, intestinal absorption) is decades-established in the toxicology literature; the comparative MeHg-vs-preparation-form measurements were consolidated in the wiki's evidence base during the 2026-05-18 manual-fetch corpus ingest.

References

[1] Mechanisms of Methylmercury-Induced Neurotoxicity: Evidence from Experimental Studies
Farina M, Rocha JBT, and Aschner M · Life Sciences 89(15-16):555-563 · 2011 · doi.org/10.1016/j.lfs.2011.05.019
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[3] Total mercury exposure through canned tuna in water sold in Quito, Ecuador
Aguilar-Miranda A, Fernández L, Yánez-Jácome GS, Alcoser-Pinto B, Zambrano H, Paz-Suconota F, et al. · Scientific Reports · 2024 · doi.org/10.1038/s41598-024-79430-y
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[4] Assessing the Role of the Gut Microbiome in Methylmercury Demethylation and Elimination in Humans and Gnotobiotic Mice
Genevieve L. Coe, Ian N. Krout, Mason Munro-Ehrlich, Catherine R. Beamish, Daria Vorojeikina, Daniel R. Colman, et al. · Archives of Toxicology, Vol. 97, pp. 2399-2418 · 2023 · doi.org/10.1007/s00204-023-03548-7
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STATUS AND LICENCE

COMPETING INTERESTS

Editorially reviewed in-house; no external peer review has been completed on this finding. Published as a preprint with its review state tracked on the article page.

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DATA AVAILABILITY

Every source behind this finding is listed with its own extraction record at https://heavymetalindex.com/synthesis/-cooking-does-not-reduce-mehg#sources, each linking to the ingest receipt, the extracted values, and the file hash of the document it was built from.

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