HEAVY METAL CERTIFIED · RESEARCH ANALYSIS

Dietary Nickel Is a Plant Trait, Not a Contamination Signal

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Abstract

Dietary nickel is not a contamination signal. It concentrates in a fixed, predictable set of plant staples — cocoa and chocolate, soybeans and other legumes, oats and whole-grain cereals, and peanuts and tree nuts — because those crops take nickel up from soil and store it in their seeds and grain fractions as ordinary physiology, so a multi-milligram-per-kilogram nickel result in cocoa or cashews is the commodity's botanical baseline, not evidence of pollution. Six independent datasets across four decades and five jurisdictions produce the same food ranking, and the European occurrence assessment found background diets reaching or exceeding the nickel tolerable daily intake for young children with no pollution source anywhere in the picture. The certification consequence is direct: nickel is a Tier-2 metal whose baseline is intrinsic to the crop, so a nickel standard must reflect that intrinsic distribution, and a single nickel result cannot by itself be read as contamination. The full anchor-source evidence base lives on the Heavy Metal Index, the independent literature reference this analysis cites one way.

The Same Food Ranking, Four Decades Apart

For lead, cadmium, or inorganic arsenic, an elevated concentration in a commodity usually points to something in the supply chain — contaminated soil, an industrial source, an adulterated spice. Dietary nickel does not behave this way. Its high concentrations sit in a specific and predictable set of plant staples: cocoa and chocolate, soybeans and other legumes, oats and whole-grain cereals, and peanuts and tree nuts.

The signature that this is an intrinsic plant trait rather than localized contamination is reproducibility. The European Food Safety Authority's 2015 assessment integrated 44,585 occurrence records submitted by fifteen Member States and characterized dietary nickel exposure by age class [1]. A Danish compilation of 2,221 food samples published in 1984, using entirely different samples, methods, and populations, had already produced the same commodity ranking: cocoa at the top near 9.8 mg/kg, then soybeans, walnuts, peanuts, oats, and bitter chocolate [2]. When a 1984 Danish diet study and a 2015 pan-European assessment place the same foods in the same rank order, the pattern is a property of the foods, not an artifact of any one survey or era.

Where the Nickel Actually Sits

In the European occurrence data, the distribution is sharply food-specific. Solid cocoa beans and cocoa products averaged 9,528 µg/kg (n=238), soybeans 4,624 to 4,685, peanuts 3,537 to 3,569, dried beans 3,055 to 3,077, and chocolate products 3,231 to 3,236. The aggregate legumes, nuts and oilseeds group averaged about 1,862 to 1,880 µg/kg with a 95th percentile of 7,000; grains and grain-based products averaged 271 to 321. Drinking water, meat, fish, and dairy sat far below, water lowest at 1 to 2 µg/kg [1].

Within cereals the nickel tracks the bran and germ, not the grain as a category. A Polish survey of 56 cereal products found the whole and less-refined fractions carrying the metal — cereal grains averaging 1.16 mg/kg, with millet reaching 4.80 and oat flakes 2.53 — while whole-grain flour ran up to 2.12 mg/kg and refined wheat flour fell below the limit of quantification, and whole-grain pasta reached 1.79 mg/

kg against 0.03 to 0.08 for regular pasta [3]. That gradient is milling physics: refining removes the fractions where the plant deposited the nickel. A separate Polish survey of 69 nut samples found nickel the most abundant of four toxic elements measured, averaging 6.434 mg/kg in cashews and about 4 in peanuts, with a single peanut sample at 11.20 mg/kg [4]. A product's likely nickel load can be read off its ingredient list before any measurement is taken.

The Meat Contrast

The confirmatory case is animal muscle. An Italian survey of 809 official-control muscle-meat samples found means of 0.016 mg/kg in poultry, 0.010 in beef, and 0.009 in pork — two to three orders of magnitude below cocoa, soy, and cashews — and meat consumption contributed under 1 percent of the nickel tolerable daily intake across all age groups [5]. This is exactly what a plant-uptake explanation predicts: nickel enters the food supply through plant physiology, so tissues that do not draw it from a plant-uptake pathway stay low. The meat contrast is what separates an intrinsic-plant-trait explanation from a generic assumption that everything is a little contaminated.

Background Diet Reaches the Reference Point

The load-bearing exposure finding is that ordinary diets already carry biologically meaningful nickel. Under the 2.8 µg/kg body-weight-per-day tolerable daily intake the EFSA panel derived in 2015, mean chronic exposure met or exceeded the reference point for toddlers, other children, infants, and adolescents, and 95th-percentile exposure exceeded it for every age class — with no contamination event anywhere in the picture. The dominant contributors were grains, cocoa-based drinks in the young, chocolate, and the legumes-nuts-oilseeds group; drinking water contributed a fraction of a percent [1].

Honesty requires the caveat that the reference point moved. EFSA revised the chronic tolerable daily intake upward to 13 µg/kg body weight per day in 2020, roughly 4.6 times higher. Under the 2020 value most background mean intakes fall below the reference point: a Polish analysis put cereal grains at about 13 percent of the tolerable intake for adults [3], and a Chinese total-diet study modeled an exceedance of 21.57 µg/kg body weight per day only for children aged 0 to 6 under a joint high-concentration, high-consumption scenario, where all five bean samples exceeded China's 1 mg/kg national limit under GB 2762-2022 [6][7]. Background diets clearly reach or exceed the 2015 reference point, and reach it primarily for young children under the 2020 one.

What This Means for Certification

Nickel is a Tier-2 metal in the Heavy Metal Certified program, and its baseline is botanical. That changes what a nickel result means and how a standard has to be built. Because the high concentrations are intrinsic to the crop, an elevated nickel value in cocoa, a legume, an oat or whole-grain cereal product, or a nut is the commodity's natural distribution, not a contamination signal to be traced and removed. A single across-the-board ceiling set at a contamination-control level would fall below the natural content of cocoa, soy, or cashews and operate as a prohibition of those foods rather than a limit — which is why the EFSA opinion recorded that no European maximum level for nickel in food existed and declined to propose one [1].

The program handles this by class. For the four Tier-1 toxics — lead, cadmium, inorganic arsenic, and methylmercury — a standard may set the stricter of the strictest maximum level from a credible government regulator and the cleaner end of the occurrence evidence. Nickel is not in that group: as a Tier-2 metal it adopts the strictest maximum level set by a credible government regulator directly, converted to the product's own basis, without pulling the number down toward the cleaner tail of an

intrinsic distribution. The practical consequences follow. Screening is targeted by ingredient composition — cocoa, soy and other legumes, peanuts and tree nuts, and whole-grain or bran cereal fractions weighted high, refined grains and animal muscle weighted low — rather than run as a uniform contamination screen across grain products. And a nickel result is read against the crop's reference distribution: on its own it is evidence of what the commodity is, not evidence that anything went wrong.

Frequently asked questions

Does a high nickel level in food mean it is contaminated?

Not by itself. Nickel concentrates in a specific set of plant staples — cocoa and chocolate, soybeans and other legumes, peanuts and tree nuts, and oats and whole-grain cereals — because those plants take nickel up from soil and store it as ordinary physiology. The same food ranking recurs across four decades and five jurisdictions, which is the signature of an intrinsic crop trait rather than a pollution source. An elevated nickel value in these commodities is the botanical baseline, not evidence of contamination.

Which foods are highest in nickel?

Cocoa and dark chocolate are the highest, with solid cocoa products averaging around 9,528 µg/kg in the European data. Soybeans and other legumes, peanuts and tree nuts (cashews average about 6.434 mg/kg wet weight), and oats and whole-grain cereals follow. Meat, fish, dairy, fruit, and refined grains are minor contributors, typically well below a few tenths of a milligram per kilogram.

Can a normal diet exceed the nickel tolerable intake?

Under the 2015 EFSA tolerable daily intake of 2.8 µg/kg body weight per day, yes — background European diets met or exceeded it for young age classes with no pollution involved. EFSA later revised the tolerable intake upward to 13 µg/kg in 2020, roughly 4.6 times higher. Under the 2020 value most mean intakes fall below the reference point, with modeled exceedances mainly for young children eating high-nickel staples at high frequency.

Why is refined flour lower in nickel than whole grain?

Nickel concentrates in the bran and germ fractions of the grain, and refining physically removes those fractions. In a Polish cereal survey, whole-grain flour ran up to 2.12 mg/kg while refined wheat flour fell below the limit of quantification, and whole-grain pasta reached 1.79 mg/kg against 0.03 to 0.08 for regular pasta. The gradient is a milling-physics effect, not a contamination difference.

References

[1] Scientific opinion on dietary nickel exposure in the European population. EFSA CONTAM Panel, 2015. Integrated 44,585 occurrence records from fifteen Member States; cocoa, soy, legumes, nuts and grains dominate nickel occurrence, and background exposure met or exceeded the 2.8 µg/kg bw/day tolerable daily intake for young age classes with no pollution source.

[2] Nickel content of food and estimation of the dietary intake in the Danish diet. Flyvholm et al., 1984. Compiled 2,221 food samples and modeled the Danish average diet, producing the same commodity ranking (cocoa, soy, walnuts, peanuts, oats) four decades before EFSA, with oatmeal the standout per-gram contributor.

[3] Nickel in cereal grains and cereal-based products on the Polish market. Mania et al., 2020. Measured 56 Polish cereal products; whole and less-refined fractions carried the nickel (grains mean 1.16 mg/kg) while refined flour fell below the limit of quantification, and cereal grains supplied about 13 percent of the 2020 tolerable intake for adults.

[4] Cadmium, lead, chromium and nickel in nuts on the Polish market. gv–VÁ g-Drabek et al., 2025. Measured 69 nut samples; nickel was the most abundant of the four toxic elements, averaging 6.434 mg/kg in cashews and about 4 in peanuts, with a single peanut sample at 11.20 mg/kg.

[5] Nickel in muscle meat from official controls in Italy. Manfredi et al., 2025. Measured 809 muscle-meat samples; means of 0.016 mg/kg (poultry), 0.010 (beef), and 0.009 (pork), with meat supplying under 1 percent of the nickel tolerable daily intake across all age groups.

[6] Nickel in a total-diet study of Zhejiang Province, China. Han et al., 2024. Measured 2,628 food samples; beans were the clear outlier (mean 3.094 mg/kg, n=5), and children aged 0 to 6 were the only segment modeling an exceedance (21.57 µg/kg bw/day) under a high-concentration, high-consumption scenario.

[7] National food safety standard: maximum levels of contaminants in food (GB 2762-2022). China. Sets a 1 mg/kg nickel limit that all five bean samples in the Zhejiang total-diet study exceeded, illustrating a ceiling set below an intrinsic plant content.

[8] Heavy Metal Index — dietary nickel as an intrinsic plant-staple trait (synthesis with full anchor-source records). The independent literature synthesis this analysis reframes, carrying every anchor source and its per-record page. · heavymetalindex.com

Cite this analysis