HEAVY METAL CERTIFIED · RESEARCH ANALYSIS

Why Tin in Canned Food Comes From the Can, Not the Crop

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

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Abstract

Inorganic tin in food is not an agricultural or geogenic contaminant like lead, cadmium, arsenic and mercury; it is a packaging contaminant. It dissolves from the bare tinplate wall of unlacquered (plain) cans into the acidic food they hold — canned tomato, canned fruit, citrus juice — and it is essentially absent from the fresh commodity, which carries around 0.03 mg/kg. Its adverse effect is acute gastrointestinal irritation from direct contact with the gut wall, not chronic systemic toxicity, and symptoms appear only in the hundreds to low thousands of mg/kg, three to four orders of magnitude above the parts-per-billion maximum levels that govern lead and cadmium. For certification, the consequence is that tin is a Tier-2 metal whose risk lives in one packaging format and one matrix chemistry, so a standard should scope it to unlacquered-can acidic products rather than treat it like the soil-borne toxics. The full anchor-source evidence base lives on the Heavy Metal Index, the independent literature reference this analysis cites one way.

A Contaminant of the Can, Not the Crop

Inorganic tin enters food almost entirely at the packaging interface. A narrative review by Blunden and Wallace, compiled for the tin industry's own research body and best read with that sponsorship in mind, nonetheless assembles the primary dissolution literature: fresh food carries roughly 0.03 mg/kg tin, food in lacquered cans about 3.2 mg/kg, and food in unlacquered (plain) tinplate cans about 76.6 mg/kg — a difference of some two thousand-fold between the fresh commodity and the same food left in a bare-metal can [1]. Roughly a fifth of European food cans still have a plain internal tin surface, while European beverage cans are internally lacquered as a rule, which largely removes canned drinks from the high-migration regime [1].

The rate is governed by chemistry and time, not by the field the fruit grew in. Migration rises with the acidity of the contents, with storage temperature, and with months on the shelf. A Romanian storage experiment tracked canned tomato paste climbing from at or below the limit of quantitation to roughly 9 to 23 mg/kg over about 36 months of ambient storage, while near-neutral matrices in the same cabinet — peas, pork, pâté — stayed below about 1.2 mg/kg; the acidic matrix accumulated tin about an order of magnitude faster [2]. Because the fresh tomato, pear or pineapple carries essentially no tin, single-ingredient surveillance of the raw commodity records tin as a non-issue and misses it entirely — the metal materialises only once an acidic food is sealed in an unlacquered can and stored.

An Acute Endpoint, Orders of Magnitude Higher

What tin does in the body is also unlike the soil-borne toxics. The foundational controlled-dose study, by Benoy, Hooper and Schneider at the University of Birmingham, fed authenticated food-poisoning juices and tin-spiked solutions to animals and to five human volunteers after a 1967 Kuwait outbreak traced to canned orange and apple juice at 250 to 385 ppm tin [3]. Volunteers who drank 240 ml of orange juice at 498, 540 or 730 mg/kg tin showed no adverse effect; at 1,370 mg/kg all five developed nausea and

diarrhoea. The mechanism is local irritation of the alimentary mucous membrane rather than systemic uptake: about 99 percent of an ingested dose left in the faeces, none in the urine, and only minute amounts reached tissues beyond the gut [3].

This is the decisive contrast for anyone used to lead and cadmium. Those metals are regulated against chronic systemic endpoints at single-digit-to-low-hundreds parts-per-billion; tin is regulated against an acute contact endpoint measured in hundreds to low thousands of mg/kg. The concentration that made healthy adults ill in Benoy's study is three to four orders of magnitude above the corresponding lead and cadmium maximum levels — the dose that matters for tin is the amount in the single serving touching the gut wall that day, not a body burden accumulated over years.

How the Limits Were Set

The European limits rest on that acute endpoint. The Scientific Committee on Food's 2002 opinion on acute risks from tin in canned foods concluded that gastrointestinal effects can appear above roughly 200 mg/kg in liquid foods and 250 mg/kg in solid foods, with lower no-effect levels for infants and young children [4]. From that it derived three maximum levels — 200 mg/kg for general canned food, 100 mg/kg for canned beverages, and 50 mg/kg for canned baby food and infant formula — which carry forward unchanged into Regulation (EU) 2023/915 [5]. The roughly five-to-seven-fold gap between the 1,000 to 1,400 mg/kg human symptomatic range and the 200 mg/kg general limit is the built-in margin of safety.

The 200 mg/kg general canned-food limit is about two thousand times the 100 ppb infant-food lead benchmark, and that gap is a feature, not a laxity: the two metals act through different mechanisms at different potencies. One live discrepancy is worth flagging rather than smoothing over. The EU general canned-food limit is 200 mg/kg, whereas the Codex Alimentarius recommended maximum for canned solid foods is 250 mg/kg [6], so the same canned-fruit unit can be compliant under one instrument and over the limit under the other. A certification assessment has to state which instrument it is applying rather than defaulting to one silently.

What Retail Cans Actually Carry

Occurrence data confirm that acidic canned fruit is where the tin sits. A Polish national monitoring survey by Mania and colleagues measured tin in the 69 metal-packaged samples out of about 600 fruit products — tin was assayed only where migration from packaging is the relevant route, a design choice that itself encodes the packaging thesis [7]. The mean was near 70 mg/kg wet weight, the 90th percentile 140 mg/kg, and the maximum 206 mg/kg in canned pears from China; the minimum, 2.39 mg/kg, was a domestically produced sliced tomato [7].

The shape of that distribution is the operational point. Typical product sits well under the 200 to 250 mg/kg limits, but the upper tail approaches — and in the single highest unit exceeds — the 200 mg/kg EU ceiling. A surveillance scheme built on the mean would miss exactly the units that matter. Modeled dietary intakes in the Polish cohort still stayed below EFSA and JECFA tolerable doses for adults and children, so the finding is not that canned fruit is dangerous [7]. It is that the high-tin units are real, they cluster in unlacquered cans of acidic contents late in shelf life, and they are the ones a testing programme has to be designed to catch.

What this means for certification

For a certification programme, tin is a Tier-2 metal, and the way it is handled should reflect that its risk lives in one packaging format and one matrix chemistry rather than across the food supply. 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; for the four Tier-1 toxics — lead, cadmium, inorganic arsenic and methylmercury — the ceiling may be set to the stricter of that government limit and the cleaner end of the occurrence evidence, but tin, like nickel, aluminium and hexavalent chromium, adopts the government limit directly. For canned acidic products that anchor is the EU 200/100/50 mg/kg structure, and where a canned solid food is instead assessed against the Codex 250 mg/kg figure, the standard should say which one it applied.

The sharper consequence is one of scope. Because tin migration is a property of the food-plus-package-plus-time system, a standard should apply a tin limit where the mechanism operates — unlacquered tinplate cans holding acidic contents such as tomato, fruit and citrus juice — and not spend an analyte line on fresh commodities or on matrices where it cannot arise. Near-neutral canned products mark the boundary: a canned-seafood standard can treat tin as peripheral, because modern lacquered cans and a low-acidity matrix keep migration low, even though the historical outbreak record contains an isolated high-tin canned-fish episode. Scoping tin to the format and matrix that actually generate it — rather than treating it like a soil-borne toxic present everywhere — is what keeps the limit meaningful and the testing effort pointed where the metal is.

Frequently asked questions

Where does the tin in canned food come from?

Almost entirely from the can, not the crop. Inorganic tin dissolves out of the bare tinplate wall of unlacquered (plain) cans into acidic contents such as tomato, fruit and citrus juice. Fresh food carries around 0.03 mg/kg, while food in an unlacquered can can carry 70 mg/kg or more, and the amount rises with acidity, storage time and temperature.

How much tin does it take to make someone sick?

A lot, by the standards of other food metals. In the controlled human study behind the EU limits, five volunteers had no adverse effect at up to 730 mg/kg tin in a 240 ml drink and all developed nausea and diarrhoea at 1,370 mg/kg. The effect is acute gastrointestinal irritation from direct contact with the gut lining, not chronic poisoning, so it is a single high-tin serving that matters rather than long-term low-level intake.

Why is the tin limit so much higher than the lead or cadmium limit?

Because tin acts through a different mechanism at a far lower potency. The EU limit for general canned food is 200 mg/kg — about two thousand times a 100 ppb infant-food lead benchmark — because tin causes acute gut irritation at high concentrations rather than accumulating in the body over years the way lead and cadmium do. The larger number reflects the different endpoint, not a weaker standard.

Which foods should be tested for tin?

Acidic products in unlacquered cans, sampled late in shelf life: canned tomato and tomato paste, canned fruit, and canned or bottled acidic juices. Testing a fresh commodity for tin is nearly uninformative because the fresh ingredient carries almost none. Near-neutral canned foods and lacquered-can products, including most canned seafood, carry low tin and sit at the periphery of the risk.

References

[1] Tin in Canned Food: Occurrence and Effect. Blunden & Wallace, 2003. Industry-sponsored review compiling the dissolution literature: fresh food near 0.03 mg/kg tin versus about 76.6 mg/kg in unlacquered cans, with roughly 20% of European food cans internally unlacquered.

[2] Tin and Iron Migration From Metallic Cans Into Foodstuffs During Storage. Buculei et al., 2012. Romanian storage experiment; canned tomato paste rose to roughly 9 to 23 mg/kg tin over about 36 months while near-neutral matrices stayed below 1.2 mg/kg.

[3] The Toxicity of Tin in Canned Fruit Juices and Solid Foods. Benoy, Hooper & Schneider, 1971. Controlled human and animal dose study; five volunteers showed nausea and diarrhoea only at 1,370 mg/kg tin, with no effect at 730 mg/kg and below, via local gut-mucosa irritation rather than systemic uptake.

[4] Opinion on Acute Risks Posed by Tin in Canned Foods. European Commission Scientific Committee on Food, 2002. Derived the 200 mg/kg general, 100 mg/kg beverage and 50 mg/kg infant maximum levels from the acute gastrointestinal endpoint.

[5] Maximum Levels for Inorganic Tin in Canned Food. European Union. Commission Regulation (EU) 2023/915. Carries forward 200 mg/kg for general canned food, 100 mg/kg for canned beverages and 50 mg/kg for canned infant and young-child food.

[6] Recommended Maximum Level for Tin in Canned Solid Foods. Codex Alimentarius. General Standard for Contaminants and Toxins in Food and Feed (CXS 193-1995). Recommends 250 mg/kg for canned solid foods, higher than the EU 200 mg/kg general limit.

[7] Lead, Cadmium, Arsenic, Mercury and Tin in Fruit and Fruit Products: Exposure Assessment. Mania et al., 2021. Polish national survey of 69 canned fruit products: mean near 70 mg/kg tin, 90th percentile 140 mg/kg, maximum 206 mg/kg in canned pears.

[8] Heavy Metal Index — tin as a can-format-and-acidity contaminant (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