Platinum

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Karen Pendergrass · Heavy Metal Index, Institute of Contaminant Standards

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Abstract

Platinum enters food primarily from catalytic converter particulate deposition in roadside soils; concentrations in potatoes near industrial areas reach tens of micrograms per kilogram dry weight. Speciation determines bioavailability and toxicological significance.

Platinum (Pt) is a platinum group element (PGE) that enters the food chain primarily through catalytic converter particulate deposition onto roadsides and from industrial and refinery emissions. Concentrations in foods are generally very low but vary by proximity to emission sources: potatoes grown in most agricultural settings approach or fall below the analytical detection limit, while samples from areas near Sicilian industrial and refinery zones reached 109 micrograms per kilogram dry weight in one Italian dataset 1. Wild mushrooms near heavily trafficked roads have been reported at multi-milligram-per-kilogram concentrations in referenced literature 4. The average adult dietary platinum intake has been estimated at 1.44 micrograms per day based on Australian market basket data 2.

Speciation is the central analytical gap across the current evidence base. Total elemental platinum measured by ICP-MS cannot distinguish ionic platinum, which is bioavailable and pharmacologically active, from platinum nanoparticles, which have different toxicokinetics and are largely immobile in soils 5. This limitation applies to all food and soil platinum measurements reviewed here.

This page draws on 5 peer-reviewed papers from a dedicated evidence deposit. The existing textbook source (Ufelle & Barchowsky 2021) is retained from the prior stub.

1 | Toxicology

Non-therapeutic environmental and dietary exposure

No regulatory body has established a maximum level for platinum in food. The European Medicines Agency Permitted Daily Exposure for platinum as a pharmaceutical elemental impurity is 100 micrograms per day, a threshold intended for drug products rather than dietary exposure 1. The Food and Nutrition Board tolerable higher intake figure is 0.3 micrograms per day per kilogram body weight, equivalent to approximately 15

micrograms per day for a 50 kilogram adult 1. Dietary intake estimates from Australian market basket data suggest an average of 1.44 micrograms per day for adults in Sydney 2, well below both benchmarks.

The biomonitoring evidence from paediatric scalp hair in Spain confirms that at typical urban environmental exposure levels in 2001, platinum was undetectable in both children and adolescents by standard multi-element ICP-MS (limits of detection 0.005-0.0063 micrograms per gram), consistent with the Swedish general-population hair median of 0.00008 micrograms per gram 3. The gap between standard ICP-MS detection limits and actual population-baseline hair platinum is 60-80-fold, meaning that characterizing background dietary exposure through hair biomonitoring requires dedicated higher-sensitivity methods.

Therapeutic platinum: pharmacology and toxicology

Platinum-based chemotherapeutics (cisplatin, carboplatin, oxaliplatin, nedaplatin, lobaplatin) are the dominant context in which platinum toxicology has been characterized in humans. The mechanisms, doses, and clinical endpoints described in this section are specific to pharmacological doses and are not applicable to dietary or environmental platinum exposure 2.

Cisplatin binds human serum albumin covalently with greater than 90% plasma protein binding; it is eliminated renally (23-50% excreted) and has a terminal half-life of approximately 5.4 days 2. Long-term accumulation is well documented: a 20-year follow-up of 458 testicular cancer survivors found serum platinum significantly elevated versus surgery-only controls even two decades after treatment, with dose-dependent correlation to cumulative cisplatin dose 2. Among 45 patients assessed 8-75 months post-treatment, 24% of plasma platinum was present as an ultrafilterable biologically active free form retaining binding activity toward biomacromolecules 2.

Nephrotoxicity affects 20-30% of cisplatin-treated patients through OCT2- and CTR1-mediated accumulation in proximal tubular cells, mitochondrial oxidative stress, and programmed cell death leading to renal interstitial fibrosis; 40-100% develop hypomagnesemia 2. Ototoxicity occurs in 75-100% of patients: hearing loss is dose-dependent, bilaterally symmetric, and irreversible; platinum accumulates in the stria vascularis for months to years, disrupting blood-labyrinth barrier integrity and endolymphatic potassium homeostasis 2. Each 100 milligrams per square meter increase in cumulative cisplatin dose raises hearing impairment risk by 5-7%. Oxaliplatin causes sensory neuropathy in 70% of patients, with platinum residues detectable in dermal collagen fibers 5-60 months after treatment withdrawal 2.

Carcinogenicity: a cohort of 5,625 testicular cancer survivors showed a 1.6-2.1-fold higher risk of a second primary neoplasm in those receiving two or more cycles of platinum chemotherapy versus chemotherapy-naive controls 2.

Hypersensitivity and platinosis (occupational allergic sensitization to platinum salts) are reported by Ufelle & Barchowsky 2021 as the principal industrial health concern for workers in platinum refining operations.

2 | Food occurrence

Potatoes

The most direct food-matrix platinum measurement in the current deposit is from 38 peeled potato samples analyzed by differential pulse voltammetry in Italy, France, Belgium, and Australia 1. Platinum concentrations ranged from 0.007 to 109 micrograms per kilogram dry weight (LOQ 0.007 micrograms per kilogram dw). The mean across all samples was approximately 12 micrograms per kilogram dry weight, but that figure is dominated

by four high-outlier samples from areas near industrial and refinery facilities in Sicily (109, 65, 56 micrograms per kilogram dw) and Veneto (69 micrograms per kilogram dw). Most samples were near or at the LOQ 1.

Geoaccumulation index analysis found approximately 80% of samples practically uncontaminated, with 5 moderately contaminated and 3 moderately-to-heavily contaminated, the latter all from areas with documented industrial or refinery activity. Enrichment factors below 1 for most samples indicate natural-origin platinum without anthropogenic dominance 1.

Dietary intake estimates at a 100 g dry potato per day assumption ranged from 0.0007 to 11 micrograms per person per day, the upper end driven entirely by the industrial-proximate Sicilian samples 1. All estimated intakes fall below the EMA PDE of 100 micrograms per day, though the highest samples approach the FNB tolerable higher intake benchmark.

Rhodium concentrations in the same potato samples were 0.0008-0.030 micrograms per kilogram dry weight. The platinum-to-rhodium ratio in potatoes averaged approximately 14,500, far above the crustal ratio of approximately 100, indicating selective platinum enrichment in potato tissue relative to crustal background 1.

For comparison, an Australian market basket study (Vaughan & Florence 1992, cited in 1 and 2) reported platinum concentrations of 8.1 micrograms per kilogram in liver, 5.8 in eggs and offal, 3.2 in grain, 1.8 in fish, 0.82 in fruit and vegetables, 0.27 in milk products, and 0.13 in full-cream milk.

Wild mushrooms

Referenced literature cited by 4 (Mleczek et al., Poland, wild species near trafficked road) reported substantially higher platinum concentrations: Agaricus arvensis 5.72 mg/kg dry weight, Boletus edulis 3.61 mg/kg dry weight, and Laeticutis cristata 2.90 mg/kg dry weight. A separate survey of commercially cultivated Lentinula edodes (shiitake) found a mean of 0.90 mg/kg dry weight for platinum 4. These values are orders of magnitude above the potato data and reflect the known capacity of certain fungi to bioaccumulate platinum group elements, particularly in proximity to road traffic PGE emissions. No primary measurement data for mushrooms were generated in the current Leicester study; the values are reported from cited comparative literature.

3 | Environmental pathways to food

Soil mobility and speciation

Platinum enters roadside and periurban soils primarily as metallic nanoparticles (up to 99% of catalytic converter emissions) and to a lesser extent as soluble platinum forms (reported at up to 10% of total city-traffic emission in some studies) 5. Laboratory incubation of ionic platinum and 5 nm and 50 nm platinum nanoparticles in four soil types for 60 days showed that soil organic matter is the dominant control on platinum mobility 5.

In sandy and low-organic roadside soils, approximately 10% of ionic platinum mobilized into the acetic acid-extractable (plant-available) fraction, while only 0.8-1.2% of 5 nm nanoparticle platinum mobilized, and 50 nm nanoparticles were essentially immobile below 0.22% 5. In peat and high-organic soils, even ionic platinum was strongly immobilized below 1% extraction. Citrate (simulating rhizosphere root exudate conditions) modestly increased total Pt mobility in ICP-MS measurements but did not transform nanoparticles to ionic form, as confirmed by parallel adsorptive stripping voltammetry measuring ionic Pt only 5.

After 60 days of incubation, approximately 30-50% of mobile platinum in the nanoparticulate-spiked Zabrze roadside soil fraction was present as ionic Pt, rising to 75-80% under oxidizing sequential extraction conditions 5. This transformation from nanoparticulate to ionic forms over time in low-organic soils increases the bioavailable

fraction available for plant uptake or groundwater migration and provides a plausible mechanism for the elevated potato platinum concentrations observed near Sicilian industrial facilities.

Biomonitoring context

Paediatric scalp hair platinum was undetectable in all 120 children and all 97 adolescents measured in Alcala de Henares, Spain in 2001 (ICP-MS LODs 0.005-0.0063 micrograms per gram), confirming that standard urban environmental background exposure in the late 20th century did not produce measurable platinum accumulation in hair at the sensitivity of routine multi-element methods 3. By contrast, Sicilian adolescents near petrochemical sites showed measurable hair platinum at medians of 0.00008-0.00156 micrograms per gram in referenced comparative data 3. Palladium (another PGE from catalytic converters) was detected in 10% of the Spanish children and 7% of adolescents at concentrations near analytical limits, consistent with low but non-zero traffic-related PGE deposition in the urban environment 3.

4 | Analytical considerations

Accurate platinum measurement in food matrices requires several technical considerations not present in routine multi-element panels. Standard ICP-MS multi-element methods have limits of detection 60-80-fold above the population-baseline hair platinum concentration documented in European cohorts 3. For soil and food matrices, combined ICP-MS (total Pt) and adsorptive stripping voltammetry (ionic Pt only) are required to characterize speciation-dependent bioavailability, since ICP-MS alone cannot distinguish ionic from nanoparticulate platinum 5. In mushroom matrices, isobaric correction for 192Pt interference is required when measuring 192Os, and vice versa 4. The voltammetric method applied to potatoes (LOQ 0.007 micrograms per kilogram dw) demonstrated adequate sensitivity for food analysis but required matrix-matched calibration and careful ash-dissolution protocol 1.

5 | What remains uncertain

No regulatory maximum level for platinum in food exists in any cited jurisdiction. The food occurrence dataset is sparse: one primary potato study with 38 samples, and wild mushroom values drawn from comparative literature rather than from studies in this deposit. The Australian market basket data (Vaughan & Florence 1992) predates widespread catalytic converter adoption and may not reflect current dietary platinum loading in regions with high traffic density. No bioavailability data for ionic versus nanoparticulate platinum ingested through food are available in the current evidence set. The relationship between soil platinum mobility (measured in controlled laboratory incubations) and actual plant uptake or food-chain transfer has not been established by any source in this deposit. Speciation-resolved food measurements, updated market basket surveys, and crop-uptake experiments across soil organic matter gradients would substantially strengthen the evidence base.

6 | Frequently asked questions

Where does platinum exposure come from?

According to the page, platinum is relevant through industrial exposure, jewelry, catalysts, and platinum coordination complexes used as antitumor agents. The single source on the page, Ufelle & Barchowsky 2021, connects platinum to the wiki through these routes. The page does not provide food-specific occurrence or exposure data.

What health effects are associated with platinum?

The page cites Ufelle & Barchowsky 2021 for concerns including hypersensitivity/platinosis, cisplatin-related nephrotoxicity (kidney toxicity), neurotoxicity, ototoxicity (hearing effects), marrow suppression, and carcinogenicity. Several of these effects are tied specifically to platinum coordination complexes such as cisplatin, which are used as antitumor (chemotherapy) agents. The page does not quantify doses at which these effects occur.

Is there good coverage of platinum in food on this page?

No. The page is explicitly a source-map stub created during the re-ingest of Ufelle & Barchowsky 2021, and it states that substantive platinum-specific expansion awaits a dedicated ingest. It currently draws on a single source and provides no food-specific concentration or exposure figures.

What are the platinum compounds mentioned as relevant?

The page identifies platinum coordination complexes used as antitumor agents, naming cisplatin, carboplatin, and oxaliplatin in its species list. These are chemotherapy drugs, and the page connects cisplatin in particular to nephrotoxicity and related toxic effects. The page does not describe dietary sources of these compounds.

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