Yttrium

HEAVY METAL INDEX · REFERENCE November 2026

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CITE AS

Pendergrass, K. (2026). Yttrium. Heavy Metal Index. https://heavymetalindex.com/metals/yttrium

CORRESPONDENCE

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KEYWORDS

heavy metals, food safety, dietary exposure

PUBLICATION HISTORY

This revision 2026-11-03.

Abstract

This page draws on 6 peer-reviewed studies. The complete citation list is at the bottom of the page.

1 | Overview

Yttrium is grouped with scandium and the lanthanides as a rare earth element 1. The authors of a soil study note that ion-adsorption rare earth ores in southern China are enriched in medium and heavy rare earths such as yttrium, and that decades of leaching extraction have released ammonium salts and rare earths into surrounding ecosystems 1. Yttrium oxide nanoparticles are described as used in several industries, which raises questions about their entry into plants and animals 2 3. The radioactive isotope yttrium-90 is used in medicine as a beta-emitting radiation source 4.

The cited evidence on yttrium is thin and experimental. It contains no measurement of yttrium in any food as eaten, no dietary intake estimate and no regulatory value.

2 | Toxicology

Animal studies

Two companion studies from one research group gave mice oral yttrium oxide nanoparticles at 50 mg/kg body weight three times a week for two weeks, after a single 2,000 mg/kg dose caused no signs of toxicity over 14 days 5 2. In liver, yttrium oxide alone did not change comet assay DNA damage or reactive oxygen species compared with controls 5. In brain, the authors report no remarkable changes, although their own table shows a higher share of DNA in comet tails after yttrium oxide (32.72%) than in controls (18.15%) with a different significance letter 2. Both studies used five mice per group and one dose, and neither measured yttrium in tissues.

In mice injected with radioactive yttrium, the metal bound strongly to bone, and the authors note that unchelated yttrium tends to accumulate in the liver and reticuloendothelial system through colloid or transferrin complexes 4. With the bone-seeking chelator EDTMP, the biological half-life was about 24 hours in liver and kidney and well over 72 hours in bone 4. This describes injected yttrium, not dietary exposure.

Plant effects

Rice seedlings exposed to yttrium oxide nanoparticles at 5 to 100 mg/L for 30 days showed no visible growth changes, but roots showed more lipid peroxidation and suppressed peroxidase and catalase under some conditions 6. Cabbage roots in water with yttrium oxide nanoparticles accumulated particles at the junction of primary and lateral roots, which the authors suggest could block roots 3.

3 | Typical exposure routes

The cited evidence does not measure human exposure to yttrium by any route. It points to two environmental sources. The first is soil contamination around rare earth mining in southern China, as described by the authors of a pot study who spiked soil to 250 mg/kg yttrium to mimic it 1. The second is release of engineered yttrium oxide nanoparticles, which the authors of the mouse studies say could reach people through air, water and food 5.

4 | Food sources

No cited study reports yttrium in a food as sold or harvested. The plant evidence comes from spiked hydroponic or pot experiments on crop seedlings.

In lettuce grown in soil spiked to 250 mg/kg yttrium, a bacterial inoculant lowered root yttrium by 47% and rhizosphere soil-solution yttrium by 56% 1. In cabbage seedlings, imaging detected yttrium oxide nanoparticles in roots but none in shoots 3. Rice seedling roots reached 5,014 to 11,255 mg/kg dry weight under nanoparticle exposure, with limited movement to shoots 6. No rice grain was analyzed.

STUDY / LOCATION	MATERIAL / DESIGN	METAL SPECIES	VALUE (UNITS AND BASIS)	N	INTERPRETATION / LIMITATION
6 Laboratory, China	Rice seedling roots, hydroponics with 5 to 100 mg/L Y2O3 nanoparticles, 30 days	Total Y	5,014.12 to 11,255.05 mg/kg dry weight (about 50.6 to 113.5 times control)	4 bottles per treatment	Spiked exposure; roots only; no grain analyzed
1 Laboratory, China	Lettuce roots, soil spiked to 250 mg/kg Y, with bacterial inoculant	Total Y	47% lower than uninoculated control	5 pots per treatment	Percentage change only; absolute values in figures

3 Laboratory, USA	Cabbage seedlings, 0.120 g Y2O3 nanoparticles in 0.38 L water, 22 days	Y2O3 particles	Detected in roots; none detected in shoots	10 plants per jar	Imaging, not chemical analysis; distilled water stressed all plants

5 | Regulatory limits

The cited evidence states no regulatory limit, guidance value or tolerable intake for yttrium in food, water or food contact materials. The only reference-type figure is an acute oral LD50 for yttrium oxide nanoparticles in mice taken as above 2,000 mg/kg, from a screening test with no deaths 5.

6 | Testing

Plant studies measured yttrium by ICP-MS after nitric acid and hydrogen peroxide digestion of dried tissue 6 and in digested plant tissue and pore water collected with soil solution samplers 1. Neither paper reports detection limits or reference materials. Synchrotron X-ray micro-tomography with subtraction imaging at the yttrium absorption edge was used to locate nanoparticles inside cabbage roots, but its concentration estimates were reported in inconsistent units 3.

7 | Microbiome effects

The cited evidence does not address yttrium and the human gut microbiome. In soil, microbial consortia isolated from rare earth tailings shifted yttrium behavior in the root zone: a bacterial mix reduced lettuce uptake, while a fungal mix raised soluble yttrium around the hyperaccumulator Solanum nigrum by 89% 1.

8 | Vulnerable populations

The cited evidence does not establish any group with higher exposure or susceptibility to yttrium.

9 | Mitigation

The cited evidence does not establish any food processing method that removes yttrium. In spiked soil, inoculating lettuce with a bacterial consortium lowered root yttrium by 47% while raising shoot dry weight by 33%, which the authors present as a way to protect crops on contaminated land 1. For the hyperaccumulator Solanum nigrum, a fungal consortium raised yttrium availability without a matching rise in plant tissue, so its value for phytoextraction is not yet shown 1.

10 | Open questions

- No cited study measures yttrium in any food as sold or harvested, including crops grown near rare earth mining.
- The cited evidence gives no dietary intake estimate for yttrium.
- No regulatory limit or health-based guidance value appears in the cited evidence.
- Human toxicology and chronic oral animal toxicology are not covered; the only animal data are two-week nanoparticle studies at one dose.

- Toxicity of dissolved yttrium salts, as opposed to oxide nanoparticles, is not addressed.
- Vulnerable populations are not addressed.
- Effects on the human gut microbiome are not addressed.
- Analytical quality control for yttrium in plant tissue (detection limits, reference materials) is not reported.

11 | What remains uncertain

Everything known here about yttrium in crops comes from short, heavily spiked experiments on seedlings. They consistently show retention in roots, but none measured edible parts at harvest, and the experimenters set exposures high (5 to 100 mg/L of nanoparticles, or 250 mg/kg in soil). The lettuce study reports only percentage changes, so it cannot anchor any concentration.

The mammalian data are limited to two small studies of one oxide nanoparticle at one dose, which may share animals, plus older work on injected radioactive yttrium. They are not a basis for judging dietary risk.

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PUBLICATION HISTORY

This revision 2026-11-03. The full dated record is maintained at https://heavymetalindex.com/metals/yttrium.