Lanthanum

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Abstract

This page draws on evidence from EFSA, together with 16 peer-reviewed studies. The complete citation list is at the bottom of the page.

1 | Toxicology

Mammalian

In rats given lanthanum chloride in drinking water at 0.25%, 0.5% or 1% from gestation through 28 days after weaning, offspring showed impaired spatial learning in a water maze, dose-dependent accumulation in the hippocampus, neuronal damage and increased apoptosis; cell experiments pointed to a microRNA-124 and PI3K/Akt mechanism 2. Hippocampal concentrations were reported only in a figure, and water intake was not recorded, so the absorbed dose cannot be derived from these experiments. The concentrations used are far above any food exposure level described in the cited evidence.

A clinical trial in India randomized 75 patients with chronic kidney disease to lanthanum carbonate at 500 mg three times daily for six months and reported a fall in serum phosphate from 8.79 to 4.02 mg/dL; lanthanum itself was not measured in blood or tissues 3. The European Food Safety Authority panel found no genotoxicity, no systemic effects in a 90-day study, and some persistent lung effects in rats from inhalation; the additive was authorized for cats at up to 7.5 g/kg of complete cat feed, with an adverse event incidence of 0.0003% in post-market monitoring covering cats that already had kidney disease 1.

Aquatic

A seven-day study in Daphnia magna measured survival, feeding, growth and sexual maturation after exposure to dissolved lanthanum. The lethal concentration for 50% of test organisms was 403.67 µg/L; the more sensitive maturity endpoint responded at an effect concentration for 10% of organisms (EC10) of 0.26 µg/L and an effect concentration for 20% of organisms (EC20) of 0.79 µg/L 4. Measured lanthanum in test solutions fell to about one-third of the initial nominal concentration by day seven, complicating dose assignment. These are aquatic ecotoxicity data and do not apply to human dietary exposure.

In catfish fed mycotoxin-contaminated diets, adding 200 or 400 mg/kg lanthanum chloride improved growth and blood and serum enzyme profiles compared with the contaminated-diet-only group 5. No lanthanum residues were measured in fish tissue.

Plant stress

Rice seedlings exposed to lanthanum at 0.5 mM and above showed raised hydrogen peroxide, superoxide and lipid peroxidation in roots, while lower concentrations raised catalase and peroxidase activity, consistent with a low-dose stimulation and high-dose inhibition pattern 6. These hydroponic concentrations are far above normal agricultural soil-solution levels.

2 | Exposure routes

Soil to crop. Lanthanum is present at background levels in agricultural soils. Three Jiangsu rice field soils contained 46.93, 47.37 and 32.78 mg/kg dry weight of lanthanum 7. None of the cited studies measured lanthanum transfer from soil into crop grain.

Agricultural inputs applied to crops. Lanthanum chloride has been applied to aromatic rice at 12 kg/ha in field trials and at 20 to 120 mg/kg in pot experiments to raise yield and the aroma compound 2-acetyl-1-pyrroline, though grain lanthanum was not reported 8. Lanthanum chloride solutions at 20 to 80 mg/L raised glucomannan content in konjac corms 9, and a chelated lanthanum amino acid complex at 20 mg/L mitigated copper stress in rice seedlings 10. Tea plants treated with 1.20 mmol/L lanthanum accumulated more lanthanum in roots than leaves, with differences between cultivars 11. None of these studies measured lanthanum in the harvested food.

Deliberate oral use. Lanthanum carbonate is taken as a phosphate binder by people with chronic kidney disease, at 500 mg three times daily in one Indian trial 3. Lanthanum carbonate octahydrate is authorized as a feed additive for adult cats in the EU at 1.5 to 7.5 g/kg of complete feed 1. In aquaculture, lanthanum chloride was added to catfish feed at 200 to 400 mg/kg 5.

Water treatment materials. Lanthanum-based sorbents and catalysts studied for water treatment can release small amounts of lanthanum: about 3% of lanthanum leached from a lanthanum-modified coconut shell activated carbon during chromium removal tests 12, and carbon coating greatly reduced leakage from lanthanum nanorods 13. These are laboratory measurements, not drinking water occurrence data.

Plant root accumulation. Germinating rice seeds sequestered lanthanum into phytoliths, and sequestration was favored at pH 4.5 relative to pH 3.5 14. These phytolith-binding experiments document a plant storage mechanism at high treatment concentrations but do not give grain lanthanum values.

3 | Food sources

No cited study reports lanthanum in any food as sold or at harvest. The experimental studies described in the Exposure routes section apply lanthanum to crops but measure effects on yield or quality rather than lanthanum residues.

STUDY / LOCATION	MATERIAL / DESIGN	METAL SPECIES	VALUE (UNITS AND BASIS)	N	INTERPRETATION / LIMITATION
7 Jiangsu, China	Topsoils from three rice field sites (Yangzhou, Xuzhou, Yancheng), 0 to 20 cm	Total La	46.93, 47.37 and 32.78 mg/kg dry soil	1 per site	Background values for a microcosm study; no crop measurements

The table above covers the only quantitative field measurements in the cited evidence. Tea plant leaves, the harvested part of Camellia sinensis, accumulated lanthanum after treatment at 1.20 mmol/L, with cultivar-dependent differences between Tieguanyin and Shuixian, but values were reported only in figures and not in a table 11. No measurement of lanthanum in made tea is cited.

4 | Regulatory limits

The only regulatory value in the cited evidence is the EU feed authorization for lanthanum carbonate octahydrate as an additive for adult cats, at 1.5 to 7.5 g/kg of complete cat feed, confirmed by the European Food Safety Authority in 2019 1. The same opinion records additive impurity specifications: arsenic below 2, cadmium below 1, lead below 1 and mercury below 0.2 mg/kg. The panel explicitly excluded consumer and environmental safety from the scope of its assessment, and stated that uncertainty remained about the analytical limits of detection and quantification for the method used 1.

No food limit, oral reference dose, tolerable weekly intake or health-based guidance value for lanthanum in human food or drinking water appears in the cited evidence.

5 | Testing

Lanthanum was measured by ICP-MS in the soil and rice studies 7 14 and in rat hippocampus (values only in a figure) 2. In the aquatic ecotoxicity study, nominal and measured concentrations diverged substantially over seven days, indicating that lanthanum precipitated or adsorbed out of solution during exposure 4.

The European Food Safety Authority opinion noted analytical uncertainty about the limits of detection and quantification of the method used to characterize the lanthanum carbonate feed additive 1. An electrochemical sensor using a strontium-doped lanthanum sulfide electrode was developed to detect a herbicide in food and water matrices, with a detection limit of 2.4 nM for the herbicide; lanthanum was the electrode material, not the analyte 15.

For water treatment research, lanthanum-modified sorbents were characterized by X-ray photoelectron spectroscopy, confirming lanthanum in the La(III) oxidation state 15, and by BET surface area, FTIR and scanning electron microscopy 12 13 16 17.

6 | Microbiome effects

The cited evidence does not address the human gut microbiome. In rice paddy soil microcosms from Jiangsu, adding lanthanum chloride at 300 to 1200 mg/L inhibited methane consumption to a degree that depended on soil pH and origin, and methane-oxidizing microbial communities shifted toward Methylobacter, Methylosarcina and Methylocystis while maintaining function over time 7. This is soil ecology evidence and does not support statements about gut effects in people.

7 | Vulnerable populations

People with chronic kidney disease who take lanthanum carbonate as a phosphate binder receive sustained oral lanthanum doses (500 mg three times daily in one trial) that far exceed any dietary exposure described in the cited evidence 3. The cited trial did not measure lanthanum in blood or tissue, so body burden under this regimen is not established.

Developmental exposure during gestation and lactation impaired spatial learning in rat offspring at high drinking-water concentrations 2, but whether doses in this range are achievable from food is not addressed in the cited evidence.

The cited evidence does not address children, pregnant women, or any other population subgroup at dietary exposure levels.

8 | Mitigation

Agricultural practice. None of the cited field or pot studies measured lanthanum residues in the edible parts of crops treated with lanthanum inputs, so the effect of agronomic practice on food lanthanum levels cannot be derived from them.

Water treatment material design. Carbon coating of lanthanum nanorods greatly reduced lanthanum leakage into water relative to uncoated material, suggesting that material design can limit secondary exposure from water treatment equipment 13.

The cited evidence does not establish any food processing step that removes lanthanum.

9 | What remains uncertain

No cited study reports lanthanum in any food as sold or harvested. The gap between the extensive literature on lanthanum as an agricultural input, as a water treatment material and as a pharmaceutical, and the absence of residue data in edible crops means that ordinary dietary exposure cannot be estimated from the cited evidence. This includes rice, konjac and tea, all of which were treated with lanthanum in the cited experiments but whose edible parts were not analyzed.

Toxicological endpoints in mammals come from drinking-water exposure at concentrations far above food levels, and from a clinical trial that measured phosphate rather than lanthanum. The aquatic ecotoxicity data show that dissolved lanthanum is acutely toxic to invertebrates in the low microgram-per-liter range for sublethal reproductive endpoints, but this cannot be extrapolated to human oral exposure.

The EU feed authorization for cats provides the only regulated context, and even that assessment explicitly excluded human consumer safety and noted analytical uncertainty. No oral reference dose, health-based guidance value or food limit for lanthanum in people exists in the cited evidence.

The behavior of lanthanum species (chloride salt, carbonate, oxide, amino acid chelate) may differ substantially, as seen in plant studies where the chelated form outperformed the inorganic salt; applying findings for one species to another is not supported by the cited evidence.

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DATA AVAILABILITY

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