Vanadium

HEAVY METAL INDEX · REFERENCE

November 2026

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CITE AS

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

CORRESPONDENCE

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KEYWORDS

heavy metals, food safety, dietary exposure

PUBLICATION HISTORY

This revision 2026-11-03.

Abstract

A developing vanadium source map with limited toxicology context and elemental measurements in cosmetic clays.

This page draws on 3 peer-reviewed studies and 1 other cited source. The complete citation list is at the bottom of the page.

1 | Overview

Vanadium is listed among minor toxic metals for which toxicity has been described 1. The Essentials chapter does not provide a detailed vanadium subsection, so this node is source-map context only.

Vanadium is described as a naturally occurring transition metal found at high concentrations in the earth's crust, oceans, soil and fossil fuels, and widely used in corrosion-resistant alloys 2. Soluble vanadium salts in the micromolar to millimolar range have been reported to harm mainly the liver and kidney, and ammonium metavanadate mimics many actions of insulin in cells by inhibiting a tyrosine-specific phosphatase 2. These are background summaries of earlier work.

Laboratory interest in vanadium also comes from medicine: inorganic compounds such as ammonium metavanadate and sodium orthovanadate have shown insulin-like action in rats, and vanadium-binding proteins from sea cucumber and sea squirt have been studied for effects on fat cells 3.

2 | Toxicology

In male rats given ammonium metavanadate as their only drink for up to 90 days, kidney lipid peroxidation rose by about 117.5% at day 30 and the antioxidant enzymes superoxide dismutase, catalase and glutathione peroxidase rose by 74.5%, 31.5% and 82% 2. The kidney cortex showed damaged capsules, a smaller Bowman's space and swollen interstitial cells, while serum creatinine did not change, which the authors read as early, not yet severe, kidney damage 2. The authors attribute vanadium toxicity to production of reactive oxygen species 2.

In cultured human preadipocytes, a synthetic vanadium-protein complex had no adverse effect on viability at 5 to 20 µg/mL and reduced viability by up to 17.25% at 40 µg/mL after 14 days 3. That paper states, citing earlier work, that binding vanadium to organic ligands can improve absorption and reduce toxicity 3.

STUDY / LOCATION	MATERIAL / DESIGN	METAL SPECIES	VALUE (UNITS AND BASIS)	N	INTERPRETATION / LIMITATION
2, Sfax, Tunisia (laboratory)	Wistar rats, ammonium metavanadate as sole drink, 15 to 90 days	Ammonium metavanadate	1.185 mmol/L in drinking water (stated as 60 mg ammonium metavanadate/kg body weight); kidney lipid peroxidation about 117.5% above control at day 30	5 per group and time point	Single high dose; abstract gives a different dose (0.24 mmol/kg body weight); no tissue vanadium measured
3, Korea and China (laboratory)	Primary human preadipocytes, 14-day culture	Synthetic vanadium-protein complex	No viability loss at 5 to 20 µg/mL; up to 17.25% loss at 40 µg/mL	not stated	Concentration is of the complex, not vanadium alone; drug-candidate study

The cited evidence does not establish vanadium toxicity in people, target organs in humans or dose thresholds.

3 | Typical exposure routes

A Durban cosmetic-clay study reports elemental XRF results for red and white cosmetic clays bought in Durban 4. Measurements refer to dried and ground market material, with no dermal absorption or species-specific determination.

The rat study used drinking water only as a dosing vehicle at a high experimental dose 2. The cited evidence does not establish typical human exposure routes or intake levels for vanadium.

4 | Food sources

The cited evidence does not report vanadium concentrations in any food. The vanadium-binding proteins from sea cucumber and sea squirt mentioned in one study are research materials, not measured food occurrence 3.

5 | Regulatory limits

The cited evidence does not state any regulatory limit, guidance value or tolerable intake for vanadium in food, drinking water or cosmetics.

6 | Testing

The cosmetic-clay results were obtained by x-ray fluorescence on dried, ground clay, which gives total elemental content without chemical species 4; see x-ray fluorescence. The vanadium-protein complex was quantified for vanadium by ICP-OES 3. The rat study did not measure vanadium in any tissue 2.

7 | Microbiome effects

The cited evidence does not establish any effect of vanadium on the gut microbiome or other microbial communities.

8 | Vulnerable populations

The cited evidence does not identify human groups at higher risk from vanadium. The rat study notes that the kidney tends to accumulate metals, including vanadium, which the authors link to chronic kidney disease, citing earlier work 2.

9 | Mitigation

The cited evidence does not establish any removal, processing or remediation method for vanadium. In rats, a decoction of common mallow (Malva sylvestris) given with the vanadium dose kept kidney lipid peroxidation, antioxidant enzymes and kidney structure at control values 2. This is a single animal experiment and does not support any human dietary recommendation.

10 | Open questions

- The literature set behind this page was drawn only from open-access PubMed Central articles, so key subscription-journal studies and agency assessments on vanadium in food, water and human health are likely missing.
- No food or drinking-water concentrations of vanadium are cited.
- Typical human exposure routes and intake levels are not established.
- No regulatory limit or guidance value is cited.
- Human toxicity, target organs and dose-response data are absent; the animal evidence is one high-dose rat study.
- Speciation (for example vanadate versus vanadyl forms) in food, clays or the body is not addressed.
- No gut microbiome evidence is cited.
- Vulnerable groups and practical mitigation approaches are not established.

11 | What remains uncertain

The vanadium evidence here is thin and indirect. The rat kidney study used one high dose, gives two inconsistent descriptions of that dose, and did not measure vanadium in tissue. The cell study concerns a synthetic drug candidate, and the cosmetic-clay results report total element content only.

None of the cited sources measures vanadium in food or drinking water or in people, so the page cannot yet say how much vanadium people take in, from which sources, or at what level effects begin.

References

[1] Toxic Effects of Metals (Chapter 23), in Casarett & Doull's Essentials of Toxicology, Fourth Edition
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[3] Vanadium-protein complex inhibits human adipocyte differentiation through the activation of β-catenin and LKB1/AMPK signaling pathway
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PEER-REVIEWED

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STATUS AND LICENCE

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DATA AVAILABILITY

Every source behind this reference is listed with its own source record at https://heavymetalindex.com/metals/vanadium#sources.

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