Germanium

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CORRESPONDENCE

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Abstract

This page draws on 4 peer-reviewed studies. The complete citation list is at the bottom of the page.

1 | Overview

The cited evidence for germanium is small: four papers covering one population blood survey, one analytical method applied to purchased foods, one livestock feed experiment, and one plant genetics study. Together they show that germanium is detectable in human blood and in common foods, that rice plants take it up through silicon transport, and that a germanium-containing mineral has been tested as a feed additive 1 2 3 4.

The blood survey describes germanium as an essential trace element with a range of claimed health properties, but that description is background drawn from other work and the paper presents no data on essentiality 1. The cited evidence does not establish whether germanium is essential, beneficial or harmful at the levels people encounter.

2 | Toxicology

The cited papers do not measure toxicity in people or report a dose-response relationship for germanium in humans or food animals.

Two papers state toxicity concerns as background drawn from other studies. The analytical methods paper states that intake of germanium dioxide has been associated with serious adverse effects, including organ failure and possibly fatal outcomes 2. The blood survey states that excessive germanium can damage the kidneys, nervous system and lungs 1. Neither paper tested these effects.

In plants, germanium is directly toxic. Rice seedlings exposed hydroponically to germanic acid developed brown leaf lesions; the sensitive cultivar Bala showed lesions at 1.5 µM, while Azucena showed none at 1.5 or 5 µM, and lesion cover reached 97 percent at 500 µM after one week 4. Across 19 cultivars, leaf germanium accumulation explained only 22.8 percent of the variation in lesion severity, which the authors read as evidence of genetic differences in tissue sensitivity as well as uptake 4.

In a feeding study, mice and pigs given a germanium-containing aluminosilicate mineral showed immune and antiviral changes, and no toxicity endpoints were reported; the mineral is mostly silicon and aluminum oxides with germanium stated at 36 ppm, so the results cannot be attributed to germanium 3.

3 | Typical exposure routes

The blood survey names water, food and drugs as intake routes and notes that germanium is used in many drugs, but it measured none of these sources 1. In that survey of 1,302 residents of Shandong Province, China, the geometric mean whole-blood germanium was 19.9 µg/L, and blood germanium was higher among people reporting daily fried food consumption, among drinkers, and in the 16 to 20 year age group, while hair dye users had lower values 1. These are unadjusted associations and the authors state that their causes need further study.

A second route in the cited evidence is through animal feed: a germanium-containing mineral was proposed as a feed supplement for pigs 3. The study did not measure germanium in pork tissues, so it does not show whether this route reaches food.

Measured results

STUDY / LOCATION	MATERIAL / DESIGN	METAL SPECIES	VALUE (UNITS AND BASIS)	N	INTERPRETATION / LIMITATION
1 Shandong, China, 2009 to 2010	Whole blood, population sample aged 6 to 60 years	Total Ge	Geometric mean 19.9 µg/L (95% CI 19.3 to 20.6); median 18.3; P5 to P95 5.10 to 45.2 µg/L	1,302	General population; no foods analyzed; LOD 0.18 µg/L
1 Shandong, China	Whole blood, fried food every day vs 1 to 2 times per month	Total Ge	Geometric mean 28.5 vs 18.7 µg/L	80 vs 842	Univariate association from a questionnaire item; cause not established
1 Shandong, China	Whole blood, ages 16 to 20 years	Total Ge	Geometric mean 29.3 µg/L	168	Highest age group; explanation offered by authors is not tested

4 | Food sources

One paper measured germanium in purchased foods. A colorimetric sensor, checked against ICP-AES, gave germanium values from 11.2 ng/g in rice to 71.3 ng/g in beans for ten foods bought in supermarkets in Benha

City, Egypt 2. Since 1 ng/g equals 1 µg/kg, the same figures apply in µg/kg. The paper does not say how many samples of each food were bought, does not give dates or brands, and does not state whether results are on a fresh or dry basis, so these values show that germanium is measurable in these foods rather than how much they typically contain.

STUDY / LOCATION	MATERIAL / DESIGN	METAL SPECIES	VALUE (UNITS AND BASIS)	N	INTERPRETATION / LIMITATION
2 Benha City, Egypt	Beans, purchased	Ge(IV) after digestion	71.3 ± 0.16 ng/g (basis not stated)	6 determinations	Sample count per food not reported; ICP-AES 70.9 ng/g
2 Benha City, Egypt	Egg, purchased	Ge(IV) after digestion	53.5 ± 0.09 ng/g	6 determinations	As above; ICP-AES 53.8 ng/g
2 Benha City, Egypt	Sunflower oil, purchased	Ge(IV) after digestion	43.3 ± 0.25 ng/g	6 determinations	As above; ICP-AES 43.7 ng/g
2 Benha City, Egypt	Chicken, purchased	Ge(IV) after digestion	25.6 ± 0.13 ng/g	6 determinations	As above; ICP-AES 26.0 ng/g
2 Benha City, Egypt	Butter, purchased	Ge(IV) after digestion	21.7 ± 0.11 ng/g	6 determinations	As above; ICP-AES 21.5 ng/g
2 Benha City, Egypt	Peach, purchased	Ge(IV) after digestion	21.6 ± 0.42 ng/g	6 determinations	As above; ICP-AES 21.5 ng/g
2 Benha City, Egypt	Cornmeal (corn), purchased	Ge(IV) after digestion	16.0 ± 0.24 ng/g	6 determinations	As above; ICP-AES 15.7 ng/g
2 Benha City, Egypt	Tea, purchased	Ge(IV) after digestion	14.1 ± 0.26 ng/g	6 determinations	As above; ICP-AES 14.0 ng/g; product form (leaf or infusion) not stated
2 Benha City, Egypt	Apple, purchased	Ge(IV) after digestion	13.2 ± 0.39 ng/g	6 determinations	As above; ICP-AES 13.5 ng/g
2 Benha City, Egypt	Rice, purchased	Ge(IV) after digestion	11.2 ± 0.31 ng/g	6 determinations	As above; ICP-AES 11.0 ng/g

Rice plants take up germanium from solution through the same transporters they use for silicon, and cultivars differed about twofold in leaf germanium after experimental dosing 4. That study used seedlings in hydroponic culture and did not measure grain, so it does not establish germanium levels in rice as eaten.

5 | Regulatory limits

The cited evidence does not establish any food, water, feed or supplement limit for germanium, and none of the four papers cites one.

6 | Testing

Three analytical approaches appear in the cited papers. Whole blood was analyzed by ICP-MS after tenfold dilution, with a stated detection limit of 0.18 µg/L and spike recoveries of 90.0 to 112.4 percent across the three elements measured; no certified reference material was reported 1. Rice shoot tissue was analyzed by ICP-MS after microwave digestion, with certified reference material and blank digests for quality control 4.

For foods, a colorimetric optode read at 545 nm had detection and quantification limits of 1.75 and 5.75 ng/mL in solution, and its results agreed with ICP-AES within 0.4 ng/g for all ten foods 2. The authors used a reflux digestion because, they state, conventional dry ashing and wet digestion may lose germanium. The paper reports spike recoveries but no certified reference material.

7 | Microbiome effects

The cited evidence does not establish any effect of germanium on gut or other microbial communities. The feeding study measured immune cell and virus endpoints, not microbiota 3.

8 | Vulnerable populations

The cited evidence does not identify populations at higher risk from germanium. The blood survey found the highest geometric mean in people aged 16 to 20 years and a lower mean in children aged 6 to 12 years, but it did not link these values to any health outcome 1.

9 | Mitigation

The cited evidence does not establish any removal, processing or remediation method for germanium in food or water. The rice study found genetic variation in germanium accumulation and sensitivity among cultivars, but it was designed to map silicon and arsenite transport loci and did not test cultivar choice as a way to lower germanium in grain 4.

10 | Open questions

- Typical germanium concentrations in foods: the only food data are values for ten purchased foods from one Egyptian city, with sample counts, dates and moisture basis not reported.
- Dietary intake: no cited paper estimates germanium intake from food, water or supplements.
- Toxicology: no cited paper measures human or animal toxicity; toxicity statements are background drawn from other studies.

- Essentiality: the claim that germanium is an essential trace element is stated but not tested in the cited evidence.
- Regulatory limits: none are established or cited.
- Microbiome effects: not studied in the cited evidence.
- Vulnerable populations: not established.
- Mitigation: no removal or processing data.
- Whether germanium from germanium-containing feed additives reaches pork or other animal foods.
- Germanium levels in rice grain under field conditions, and whether cultivar differences seen in seedlings carry through to grain.
- Units for the water and soil values in the optode study, which are printed under a ng/mL column header after a 200-fold concentration step.

11 | What remains uncertain

The cited evidence is thin and uneven. It contains one large blood survey with no linked food data, one methods paper whose food values come from an unspecified number of purchased samples, and two experimental studies in which germanium was either a minor component of a test mineral or a tracer for silicon transport in plants. None of these designs can show how much germanium people take in from food, which foods matter most, or what level of intake is harmful.

The blood survey's associations with fried food, alcohol, age and hair dye are unadjusted and unexplained, and the text and table of that paper disagree on which alcohol group had the higher value. The toxicity statements on this page are reported as background from the papers, not as findings, and should not be read as established thresholds.

References

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STATUS AND LICENCE

COMPETING INTERESTS

Editorially reviewed in-house; no external peer review has been completed on this reference. Published as an institutional technical report with its review state tracked on the article page. Released under CC BY 4.0.

DATA AVAILABILITY

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

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