Broccoli

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Abstract

Broccoli in the HMI library has 167 reported results for lead, cadmium, total arsenic, inorganic arsenic, total mercury, nickel, chromium, aluminum, tin, antimony, uranium, Co, Cu, Fe, Mn, Zn, V, Ca, K, Mg, Mo, P, Sr and Ti from 16 sources. WHO gems/food submissions reported lead in broccoli as sold from 1,155 results in 3 reporting regions, with subgroup medians from 6.15 to 8.84 µg/kg. In the US Total Diet Study, cooked broccoli had a median lead result below 4 µg/kg across 27 composites from 2017-2020.

1 | Broccoli overview

Across 3 other studies of ordinary farms and markets, reported lead means and medians on an as-sold or fresh-weight basis ranged from 4.3 µg/kg (Norton et al. 2015) to 930 µg/kg (Guerra et al. 2012).[4,6] For cadmium, 4 studies on an as-sold or fresh-weight basis reported means and medians from 5.1 µg/kg (Norton et al. 2015) to 80 µg/kg (Guerra et al. 2012).[4,6]

For a buyer the practical points are the form bought, the basis a result is reported on, where the broccoli came from and the laboratory's reporting limit. Testing finds contamination but does not remove it.

2 | What counts as broccoli

This page covers broccoli in 2 forms kept separate in every comparison: broccoli as sold (158 results) cooked and broccoli (9 results).[1,2,3,4,5,6] Foods made from broccoli that have their own pages, such as broccoli cheese soup, are covered there.

Results stay on the basis each source reports: as sold or fresh weight, dry weight, or unstated. Dry-weight, as-sold and unstated results are never pooled, and no moisture conversion is applied.

3 | How metals reach broccoli

Root uptake from soil is the primary documented pathway for cadmium in broccoli. A controlled greenhouse experiment in turkey grew broccoli (*Brassica oleracea* var. *italica*) alongside cress, watercress, and white cabbage in soil spiked with cadmium at five levels (0 to 50 mg per kg soil as CdCl2) and found that broccoli showed the strongest growth inhibition of the four species (shoot dry weight reduced up to 66.4% at 50 mg per kg Cd) while simultaneously accumulating substantial cadmium in both root and shoot tissues on a dry weight basis.11 At low to moderate soil cadmium (5 to 20 mg per kg), broccoli retained most cadmium in roots (more than 85% to 97% of total plant cadmium), limiting shoot translocation. At the highest treatment level (50 mg per kg), root retention capacity was exceeded and shoot cadmium rose 185-fold relative to the control, reaching 172 mg per kg dry weight on the shoot.11 Crucially, the study noted that plants that maintained relatively stable growth under moderate cadmium exposure still accumulated substantial cadmium concentrations in shoots, illustrating a disconnect between agronomic performance and food safety that is specific to Brassicaceae.11

These values are from a greenhouse spiked-soil experiment on a dry weight basis at cadmium concentrations substantially above typical agricultural background levels (background 0.1 to 0.5 mg per kg soil; slightly contaminated soils approximately 1 to 3 mg per kg). They characterize the uptake pathway but are not transferable directly to fresh-weight retail broccoli concentrations.

Organic soil amendments and wastewater irrigation are a separate documented pathway. A field trial in Zomba, Malawi applied bio-slurry (derived from municipal wastewater treatment) to plots growing rape (*Brassica napus*) and Chinese cabbage (*Brassica pekinensis*) and measured no detectable lead or mercury in any crop sample across all amendment treatments; cadmium in crops remained below FAO/WHO permissible limits in all treatments, though bio-slurry application increased soil chromium concentrations relative to the unamended control.12

Wastewater irrigation in a peri-urban Malawian setting produced lead exceedances above FAO/WHO permissible limits in all Brassica species sampled, with the highest concentrations in Brassica rapa stems (lead 4.09 mg per kg dry weight, against a permissible limit of 0.3 mg per kg). Cadmium concentrations in Brassica rapa and other Brassica species from the same wastewater-irrigated plots partially exceeded the FAO/WHO limit of 0.2 mg per kg, and 64% of vegetable samples exceeded the total chromium permissible limit of 2.3 mg per kg.13 Those measurements were on a dry weight basis from a single-season snapshot at a wastewater treatment plant irrigation site and do not characterize commercial broccoli supply chains.

4 | Which forms and regions measured lower

For cadmium, the HMI reference median was lowest for broccoli as sold (5.1 µg/kg) cooked and highest for broccoli (11 µg/kg); forms differ in water content, so this compares foods as sold or eaten, not uptake.[1,2,6] The cooked hmi reference for lead in broccoli pools 28 subgroup units from 2 sampling families, with a median of below 4 µg/kg and a middle half spanning below 4 (lower quartile) and below 4 µg/kg (upper quartile).[2,8] for lead in broccoli as sold, the reference median was below 9 µg/kg, with a middle half from below 7 to between 5.24 and 20 µg/kg across 68 units.[1] for cadmium in broccoli as sold, the reference median was 5.1 µg/kg, with a middle half from 5.1 to between 5.5 and 7.25 µg/kg across 60 units.[1,6]

Among GEMS/Food reporting regions, broccoli as sold had the lowest lead subgroup median in PAHO (6.15 µg/kg) and the highest in EURO (8.84 µg/kg); reporting regions are markets, not growing areas.[1] For cadmium, the lowest regional median was in EURO (4.94 µg/kg) and the highest in WPRO (10 µg/kg).[1] For total arsenic, the lowest regional median was in WPRO (1.3 µg/kg) and the highest in EURO (1.85 µg/kg).[1]

In one study, lead across 6 groups of broccoli ranged from 10 µg/kg (locality IV (green markets, Novi Sad)) to 6,690 µg/kg (locality III (green markets, Novi Sad)); the lowest is the lowest observed in that study, not an established sourcing preference.[9]

5 | Processing, cooking and preparation

No processing study for metals in this food is in the library yet.

6 | Mitigation for broccoli

Lot testing against the applicable limit is the check that can be verified.

7 | Trade-offs and limits of controls

Metals do not move together, so a lot that passes a lead limit says little about cadmium, arsenic or nickel unless those are tested as well.

8 | Testing broccoli for metals

Results depend on the method and its reporting limit. Reporting limits for lead ranged from 0.5 µg/kg (WHO GEMS/Food) to 3,000 µg/kg (WHO GEMS/Food), so a non-detect from a less sensitive method says much less.[1] Reporting limits for cadmium ranged from 0.08 µg/kg (WHO GEMS/Food) to 1,000 µg/kg (WHO GEMS/Food), so a non-detect from a less sensitive method says much less.[1] Reporting limits for total arsenic ranged from 0.667 µg/kg (WHO GEMS/Food) to 300 µg/kg (WHO GEMS/Food), so a non-detect from a less sensitive method says much less.[1]

A useful lot result names the form, the basis and a quantification limit well below the limit that applies.

9 | Buying and verifying broccoli

No maximum level for metals in broccoli was verified from primary text for this page; buyers should confirm the limit that applies in the destination market.

10 | Exposure from broccoli

No source in the library converted broccoli concentrations into a verified estimate of intake for a defined population. Concentrations describe the food, not individual risk.

11 | Evidence review and remaining gaps

Every source record that names broccoli was decided on its content: 16 occurrence extracted, 16 records in all. The occurrence table renders every extracted result; held values remain visible with their reason.

References identify the sources used in these answers. The Sources index preserves additional discovery links; inclusion there does not mean a source has been reviewed for this assessment. Corrections, completed searches, new direct evidence and changes in requirements should reopen the relevant answer.

12 | Broccoli FAQs

The library reports lead, cadmium, total arsenic, inorganic arsenic, total mercury, nickel, chromium, aluminum, tin, antimony, uranium, Co, Cu, Fe, Mn, Zn, V, Ca, K, Mg, Mo, P, Sr and Ti in broccoli, most often lead, cadmium and total arsenic.[1,2,3,4] WHO gems/food submissions reported lead in broccoli as sold from 1,155 results in 3 reporting regions, with subgroup medians from 6.15 to 8.84 µg/kg.[1]

For cadmium, the HMI reference median was lowest for broccoli as sold (5.1 µg/kg) cooked and highest for broccoli (11 µg/kg); forms differ in water content, so this compares foods as sold or eaten, not uptake.[1,2,6]

Among GEMS/Food reporting regions, broccoli as sold had the lowest lead subgroup median in PAHO (6.15 µg/kg) and the highest in EURO (8.84 µg/kg); reporting regions are markets, not growing areas.[1] For cadmium, the lowest regional median was in EURO (4.94 µg/kg) and the highest in WPRO (10 µg/kg).[1]

Inorganic arsenic, the more toxic form, was measured in 3 results from 2 sources, far fewer than total arsenic.[1,10] WHO GEMS/Food submissions reported inorganic arsenic in broccoli as sold from 19 results in 2 reporting regions, with subgroup medians below 8 µg/kg, mostly non-detects.[1]

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GOVERNMENT

STATUS AND LICENCE

Editorially reviewed in-house; no external peer review has been completed on this ingredient profile. 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 ingredient profile is listed with its own source record at https://heavymetalindex.com/ingredients/broccoli#sources.

COMPETING INTERESTS

The Heavy Metal Index reports what the peer-reviewed and regulatory literature supports. It is operated separately from any certification program, does not evaluate or endorse brands, and does not use certification thresholds as evidence for the statements made here.

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