Strawberries

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Abstract

Strawberries in the HMI library has 225 reported results for lead, cadmium, total arsenic, inorganic arsenic, total mercury, nickel, chromium, aluminum, tin, antimony, uranium, Co, Cu, Zn, As and Ba from 20 sources. WHO gems/food submissions reported lead in strawberries as sold from 2,335 results in 4 reporting regions, with subgroup medians from 2.3 to 1,120 µg/kg. In the US Total Diet Study, frozen strawberries had a median lead result below 4 µg/kg across 27 composites from 2017-2020.

1 | Strawberries overview

Across 7 other studies of ordinary farms and markets, reported lead means and medians on an as-sold or fresh-weight basis ranged from 3.1 µg/kg (Marín et al. 2018) to 400 µg/kg (Guerra et al. 2012).[4,6] For cadmium, 6 studies on an as-sold or fresh-weight basis reported means and medians from 2.4 µg/kg (Norton et al. 2015) to 40 µg/kg (Sembratowicz et al. 2010).[8,9] Higher results came from contaminated or exposed settings rather than ordinary supply. Strawberries as sold from frozen product, Poland retail/official control had lead higher at 11 µg/kg, against 9 µg/kg for fresh product, Poland retail/official control in the same study.[7]

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

2 | What counts as strawberries

This page covers strawberries in 5 forms kept separate in every comparison: strawberries as sold (213 results), frozen strawberries (8 results), strawberries juice (2 results), canned strawberries (1 result) dried and strawberries (1 result).[1,2,3,4,5,6]

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 strawberries

The evidence on how metals reach strawberries comes from studies that compared exposed and ordinary settings. Strawberries as sold from frozen product, Poland retail/official control had lead higher at 11 µg/kg, against 9 µg/kg for fresh product, Poland retail/official control in the same study.[7]

These are observational comparisons from single studies; the size of the difference depends on the site, metal and distance.

4 | Which forms and regions measured lower

For cadmium, the HMI frozen reference median was lowest for strawberries (8.5 µg/kg) and highest for strawberries as sold (30 µg/kg); forms differ in water content, so this compares foods as sold or eaten, not uptake.[1,2] The hmi reference for lead in strawberries as sold pools 109 subgroup units from 2 sampling families, with a median of between 135 and 155 µg/kg and a middle half spanning below 5.5 (lower quartile) and 275 µg/kg (upper quartile).[1,9] frozen for lead in strawberries, the reference median was below 4 µg/kg, with a middle half from below 4 to below 4 µg/kg across 27 units.[2] for lead in strawberries as sold, the reference median was 1,090 µg/kg, with a middle half from 544 to 1,200 µg/kg across 4 units.[1]

Among GEMS/Food reporting regions, strawberries as sold had the lowest lead subgroup median in PAHO (2.3 µg/kg) and the highest in EURO (1,120 µg/kg); reporting regions are markets, not growing areas.[1] For cadmium, the lowest regional median was in PAHO (7 µg/kg) and the highest in EURO (50 µg/kg).[1] For inorganic arsenic, the lowest regional median was in PAHO (3.23 µg/kg) and the highest in EURO (32 µg/kg).[1]

Targeted strawberries as sold samples in EURO had aluminum lower at 516 µg/kg, against 905 µg/kg for EURO in the same study.[1]

In one study, Zn across 4 groups of strawberries ranged from 1,060 µg/kg (vegetable and fruit market; washed with 10% acetic acid vinegar) to 1,360 µg/kg (amateur farmers; washed with 10% acetic acid vinegar); the lowest is the lowest observed in that study, not an established sourcing preference.[3]

5 | Processing, cooking and preparation

Processed or prepared forms were compared only with unprocessed strawberries in the same study and group. Canned strawberries (Fruits, Riyadh city markets, May 2009) had lead higher at 30 µg/kg, against 17 µg/kg for the unprocessed form in the same group (strawberries as sold).[12] In another study, strawberries juice (PAHO) had cadmium lower at 3 µg/kg, against 16 µg/kg for the unprocessed form in the same group (strawberries as sold).[1]

Forms differ in water content, so a per-kilogram difference is not by itself a measured removal or gain of metal.

6 | Mitigation for strawberries

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

7 | Trade-offs and limits of controls

Avoiding exposed growing areas lowered the metal measured in the studies available, but no study measured the cost or supply effect of doing so.[7] 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 strawberries for metals

Results depend on the method and its reporting limit. Reporting limits for lead ranged from 1 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 1 µg/kg (WHO GEMS/Food) to 78.5 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 2.14 µg/kg (Lee et al. 2023) to 1,010 µg/kg (WHO GEMS/Food), so a non-detect from a less sensitive method says much less.[1,5]

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

9 | Buying and verifying strawberries

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

10 | Exposure from strawberries

No source in the library converted strawberries 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 strawberries was decided on its content: 20 occurrence extracted, 20 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 | Strawberries FAQs

The library reports lead, cadmium, total arsenic, inorganic arsenic, total mercury, nickel, chromium, aluminum, tin, antimony, uranium, Co, Cu, Zn, As and Ba in strawberries, most often lead, cadmium and total arsenic.[1,2,3,4] WHO gems/food submissions reported lead in strawberries as sold from 2,335 results in 4 reporting regions, with subgroup medians from 2.3 to 1,120 µg/kg.[1]

In the studies available, strawberries from contaminated or exposed settings carried more metal than strawberries from the same study's control.[7] strawberries as sold from frozen product, Poland retail/official control had lead higher at 11 µg/kg, against 9 µg/kg for fresh product, Poland retail/official control in the same study.[7]

For cadmium, the HMI frozen reference median was lowest for strawberries (8.5 µg/kg) and highest for strawberries as sold (30 µg/kg); forms differ in water content, so this compares foods as sold or eaten, not uptake.[1,2]

Among GEMS/Food reporting regions, strawberries as sold had the lowest lead subgroup median in PAHO (2.3 µg/kg) and the highest in EURO (1,120 µg/kg); reporting regions are markets, not growing areas.[1] For cadmium, the lowest regional median was in PAHO (7 µg/kg) and the highest in EURO (50 µg/kg).[1]

Only comparisons between forms in the same study are available, not before-and-after measurements of the same strawberries.[12] canned strawberries (Fruits, Riyadh city markets, May 2009) had lead higher at 30 µg/kg, against 17 µg/kg for the unprocessed form in the same group (strawberries as sold).[12]

Inorganic arsenic, the more toxic form, was measured in 12 results from 2 sources, far fewer than total arsenic.[1,6] Marín et al. 2018 reported inorganic arsenic at 2.8 µg/kg (mean) in strawberries as sold from Vegetables and fruits group, Region of Valencia TDS 2010-2011.[6]

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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/strawberries#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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