Olive Oil

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Abstract

Olive oil in the HMI library has 610 reported results for lead, cadmium, total arsenic, inorganic arsenic, total mercury, methylmercury, nickel, chromium, aluminum, tin, antimony, uranium, Co, Cu, Fe, Mn, Zn, V, Se, As, As(III) and Ba from 26 sources. WHO GEMS/Food submissions reported lead in olive oil from 810 results in 3 reporting regions, with subgroup medians below 90 µg/kg, mostly non-detects. In the US Total Diet Study, olive oil had a median lead result below 5 µg/kg across 3 composites from 2018-2020.

1 | Olive oil overview

Across 12 other studies of ordinary farms and markets, reported lead means and medians on an as-sold or fresh-weight basis ranged from 1.52 µg/kg (S-T et al. 2024) to 1,250 µg/kg (Luka et al. 2019).[7,8] For cadmium, 8 studies on an as-sold or fresh-weight basis reported means and medians from 0.9 µg/kg (Pehlivan et al. 2008) to 90 µg/kg (Luka et al. 2019).[8,9] Higher results came from contaminated or exposed settings rather than ordinary supply. Refined olive oil had nickel higher at 14.1 µg/kg, against 0.721 µg/kg for unrefined in the same study.[7]

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

2 | What counts as olive oil

This page covers olive oil in 2 forms kept separate in every comparison: olive oil (600 results) and olive oil as sold (10 results).[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 olive oil

The evidence on how metals reach olive oil comes from studies that compared exposed and ordinary settings. Refined olive oil had nickel higher at 14.1 µg/kg, against 0.721 µg/kg for unrefined in the same study.[7] In another study, olive oil from industrial had total arsenic higher at 113 µg/kg, against 60 µg/kg for traditional (local shop/farmer's market) in the same study.[25] A third study found that olive oil from stored 12 months had cadmium higher at 4,990 µg/kg, against 3,360 µg/kg for Iranian olive oil, all flavoured and non-flavoured samples in the same study.[13]

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

The HMI reference for lead in olive oil pools 55 subgroup units from 5 sampling families, with a median of below 10 µg/kg and a middle half spanning below 5 (lower quartile) and below 20 µg/kg (upper quartile).[1,2,4,14,15] for lead in olive oil as sold, the reference median was below 10 µg/kg, with a middle half from below 7.5 to below 25 µg/kg across 4 units.[1] for cadmium in olive oil, the reference median was below 2 µg/kg, with a middle half from below 2 to below 10 µg/kg across 50 units.[1,2,11,14,15]

In one study, lead across 15 groups of olive oil ranged from 150 µg/kg (harvested from the ground; sample Kal10) to 1,480 µg/kg (harvested directly from the plantation tree; sample Kal7); the lowest is the lowest observed in that study, not an established sourcing preference.[8] In another study, lead across 9 groups of olive oil ranged from 10 µg/kg (glass bottle, 2021/2022 campaign (sample EVOO-P1)) to 100 µg/kg (porcelain (ceramic) container, 2021/2022 campaign (sample EVPR1)); the lowest is the lowest observed in that study, not an established sourcing preference.[6]

5 | Processing, cooking and preparation

Gouvinhas et al. (2015) compared 11 small-scale cold-extracted monovarietal Portuguese olive oils with 12 commercial mechanically extracted blends and found that commercial oils had higher aluminum and lead and lower cadmium than the monovarietal oils. Lead in commercial samples ranged from 0.141 to 0.327 µg/g, while monovarietal samples ranged from 0.030 to 0.116 µg/g, with no overlap between the two groups (Table 3). The difference could not be attributed to a single processing step because cultivar, origin, and blending also differed between the groups.[19]

A review by Nasr et al. (2022) summarized how the extraction process, centrifugation, filtration, and storage containers can alter trace element concentrations in olive oil. Olives in direct contact with metallic surfaces during extraction can generate contamination in the final product; non-centrifuged-to-centrifuged ratios showed discrepancies of up to three orders of magnitude for some elements. Filtration to remove pomace residues and leftover water "can significantly alter the trace element content." The review notes that no certified reference material for trace elements in olive oil exists, which limits inter-study comparability.[20]

Kheirati Rounizi et al. (2021) measured arsenic, lead, cadmium, zinc, and copper in sesame oil prepared by three methods (traditional Ardeh, cold-pressed virgin, and refined). This study was conducted in sesame oil, not olive oil; findings may not transfer directly to olive oil processing.[21]

6 | Mitigation for olive oil

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

No study in the library reports a deliberate intervention that reduced metals in olive oil. Three studies document associations between growing conditions and the trace element profile of the oil, without measuring a controlled reduction treatment.

Benincasa et al. (2012) compared olive oils from trees irrigated with treated wastewater (TWW, continuous and alternate regimes), conventional water, and non-irrigated controls in Sfax, Tunisia. Oils from non-irrigated control trees had a lower concentration of trace elements and minerals than oils from TWW-irrigated trees. Oils from olives that fell and contacted TWW-irrigated soil had higher Na, K, Ni, La, Sr, B, and Mo than oils from tree-picked olives. Cadmium and lead were not reported in the oil samples (Table 4 reports 19 elements; Cd and Pb appear in the method validation table but not in the results).[22]

Nasr et al. (2021) measured 17 elements in 42 EVOOs from Tunisia, Spain, and France with paired soil analysis. Four elements (Mn, Sr, Mg, Ni) showed significant Pearson correlations between the bioavailable soil fraction and the oil. Lead in Tunisian oils ranged from 0.57 to 2.16 µg/kg, with the highest value from oil sampled near a lead-zinc mining deposit in Jendouba. European oils did not exceed 1.35 µg/kg for lead. Cadmium was below the limit of detection in all 42 oil samples. The study supports orchard soil and nearby mining as sources of some elements in oil but does not report a reduction intervention.[23]

A review by Nasr et al. (2022) summarized that cultivar, irrigation, fertilizer use, fluctuations in annual climatic parameters, and the extraction process can each modify the elemental profile of olive oil. Agricultural amendments such as the Bordo Mix (copper sulfate and quicklime) can add Cd, Cu, and K. Elements such as As, Pb, Cu, Cr, and Ni can be sourced from discharges of industrial activities. None of the reviewed studies demonstrated a deliberate reduction treatment for any metal in olive oil.[20]

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 olive oil for metals

Results depend on the method and its reporting limit. Reporting limits for lead ranged from 0.85 µg/kg (authors 2009) to 4,000 µg/kg (WHO GEMS/Food), so a non-detect from a less sensitive method says much less.[1,5] Reporting limits for cadmium ranged from 0.06 µg/kg (authors 2009) to 1,200 µg/kg (WHO GEMS/Food), so a non-detect from a less sensitive method says much less.[1,5] Reporting limits for total arsenic ranged from 4 µg/kg (FDA Total Diet Study) to 160 µg/kg (WHO GEMS/Food), so a non-detect from a less sensitive method says much less.[1,2]

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

9 | Buying and verifying olive oil

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

10 | Exposure from olive oil

Two studies converted olive oil metal concentrations into dietary exposure estimates for defined populations in Iran.

Tayeb and Movassaghghazani (2025) assessed lead and cadmium exposure through olive and corn oil consumption in Gonbad-Kavus, northern Iran (n = 30 olive oil samples: 12 commercial, 18 traditional). Hazard Index values for lead plus cadmium combined were below 1 for all oils, indicating no non-carcinogenic risk at the assumed daily intake (0.328 g olive oil/day for a 70 kg adult). The Margin of Exposure (MOE) for lead in traditional olive oil was 7,875, below the 10,000 threshold, signaling a concern for potential carcinogenic risk in that product type; all other oils had MOE above 10,000. EFSA BMDL10 values used: lead 0.63 µg/kg bw/day, cadmium 0.36 µg/kg bw/day. The paper's Table 2 caption states a daily consumption of 40.2 g, which conflicts with the methods text (0.328 g); the source page preserves this inconsistency.[24]

Mehri et al. (2024) measured five potentially toxic elements (total arsenic, cadmium, lead, iron, zinc) in traditional and industrial edible vegetable oils from Hamadan, western Iran (n = 40, including olive oil), using a probabilistic Monte Carlo health risk assessment (50,000 iterations). Non-carcinogenic TTHQ values were below 1 for both adults and children across traditional (0.201 / 0.133) and industrial (0.408 / 0.285) oils. The cancer risk estimate for inorganic arsenic exceeded 1×10^{-6} for both traditional and industrial oils, but the calculation applies the inorganic arsenic cancer slope factor to total arsenic concentrations without speciation, which may overstate the risk if organic arsenic fractions are substantial. Assumed oil ingestion: 100 g/day adults, 20 g/day children.[25]

Both studies are from Iran and use regional consumption assumptions that differ substantially from Mediterranean or North American olive oil intake patterns. Neither study measures inorganic arsenic directly.

11 | Evidence review and remaining gaps

Every source record that names olive oil was decided on its content: 26 occurrence extracted, 26 records in all. The occurrence table renders every extracted result; held values remain visible with their reason.

No open-access peer-reviewed or agency study has reported a measured hexavalent chromium (Cr-VI) value in olive oil or in edible vegetable oils. The EFSA CONTAM Panel's 2014 Scientific Opinion on the risks to public health related to the presence of chromium in food and drinking water (EFSA Journal 2014;12(3):3595) found no occurrence data on Cr(VI) in food and assumed all chromium in food to be Cr(III).[26] That gap is why the HMTc olive-oil standard requires Cr-VI testing rather than treating total chromium as the hexavalent form.

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 | Olive oil FAQs

The library reports lead, cadmium, total arsenic, inorganic arsenic, total mercury, methylmercury, nickel, chromium, aluminum, tin, antimony, uranium, Co, Cu, Fe, Mn, Zn, V, Se, As, As(III) and Ba in olive oil, most often

lead, cadmium and total arsenic.[1,2,3,4] WHO GEMS/Food submissions reported lead in olive oil from 810 results in 3 reporting regions, with subgroup medians below 90 µg/kg, mostly non-detects.[1]

In the studies available, olive oil from contaminated or exposed settings carried more metal than olive oil from the same study's control.[7] refined olive oil had lead higher at 3.34 µg/kg, against 1.52 µg/kg for unrefined in the same study.[7]

In one study, lead across 15 groups of olive oil ranged from 150 µg/kg (harvested from the ground; sample Kal10) to 1,480 µg/kg (harvested directly from the plantation tree; sample Kal7); the lowest is the lowest observed in that study, not an established sourcing preference.[8] In another study, lead across 9 groups of olive oil ranged from 10 µg/kg (glass bottle, 2021/2022 campaign (sample EVOO-P1)) to 100 µg/kg (porcelain (ceramic) container, 2021/2022 campaign (sample EVPR1)); the lowest is the lowest observed in that study, not an established sourcing preference.[6]

Inorganic arsenic, the more toxic form, was measured in 10 results from 4 sources, far fewer than total arsenic.[1,16,17,18] Marín et al. 2018 reported inorganic arsenic at 1.5 µg/kg (mean) in olive oil from vegetable oils group, Region of Valencia TDS 2010-2011.[17]

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STATUS AND LICENCE

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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.

DATA AVAILABILITY

Every source behind this ingredient profile is listed with its own source record at https://heavymetalindex.com/ingredients/olive-oil#sources.

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