Cobalt

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Abstract

Essential to vitamin B12, cobalt also has compound- and route-dependent toxicity. This page now carries occurrence data for cobalt in cosmetic personal care products from Saudi Arabia.

1 | Toxicology

Cobalt is an essential trace metal serving as the central metal atom in vitamin B12 (cobalamin). It is therefore a required dietary nutrient at the microgram level, with a WHO provisional tolerable intake derived from requirements for cobalamin synthesis rather than from independent cobalt toxicology. At elevated exposures, cobalt toxicity is strongly route- and compound-dependent 1.

Cobalt-containing dusts and hard-metal (tungsten carbide with cobalt binder) aerosols are the most toxicologically characterized forms. Inhalation of cobalt-containing dusts is associated with respiratory sensitization, interstitial lung disease ("hard metal lung disease"), occupational asthma, and lung cancer in occupational settings. The carcinogenicity classification under the International Agency for Research on Cancer places cobalt metal with tungsten carbide as Group 2A (probably carcinogenic to humans). Allergic contact dermatitis is documented from cobalt in consumer products including alloys, cosmetics, and pigments; the threshold for eliciting dermatitis in sensitized individuals is debated, with a literature-proposed limit of 5 µg/g for cosmetic matrices and an abundantly cautious limit of 1 µg/g cited in dermatological literature 2. Cardiomyopathy from cobalt ingestion has been documented following ingestion of cobalt-contaminated beverages. The clinical significance of dietary cobalt as a free ionic species (Co2+) distinct from vitamin B12-cobalt is not well characterized in the food-safety literature loaded on this wiki.

2 | Exposure routes

The principal routes of cobalt exposure documented in the loaded corpus are dietary intake of vitamin B12 and cobalt-containing foods; dermal contact with cobalt in cosmetics, alloys, and pigmented products; and inhalation of cobalt-containing dusts in occupational settings. The loaded corpus does not carry a cobalt total diet study or a food survey with representative cobalt occurrence data for a national or regional market. Soil-to-plant transfer

is documented in the agricultural and soil literature (see the soil evidence section below), but transfer factors to edible tissues have not been characterized from the loaded sources.

3 | Food sources

The loaded corpus does not currently contain a peer-reviewed food occurrence dataset establishing typical or upper-tail cobalt concentrations in dietary staples. The evidence on this wiki for cobalt in food matrices is limited to incidental reporting in multi-element surveys of botanical and agricultural materials. This gap limits the ability to characterize dietary cobalt intake or to compare dietary cobalt exposure with the reference doses and tolerable intakes established by EFSA and WHO.

4 | Cobalt in cosmetic personal care products

Ahmed and colleagues measured cobalt and lead by flame atomic absorption spectroscopy in 41 cosmetic samples from four product types (henna, foundation cream, kajal/kohl, and skin-whitening cream) collected from local markets in Northern Province, Saudi Arabia 2. All 41 samples had cobalt concentrations exceeding 5 µg/g, the threshold proposed by Iwegbue et al. (2016) as a cosmetic limit below which contact-dermatitis risk is considered low.

STUDY / LOCATION	MATERIAL / DESIGN	METAL SPECIES	VALUE (UNITS AND BASIS)	N	INTERPRETATION / LIMITATION
2, Al-Ahsa, Saudi Arabia	Henna (non-brand), FAAS, as-purchased	cobalt	mean 141,710 µg/kg (141.71 µg/g), range 138,220 to 144,910 µg/kg	9	Exceeds 5 µg/g dermatitis threshold; local market only; collection year not stated
2, Al-Ahsa, Saudi Arabia	Foundation cream (non-brand), FAAS, as-purchased	cobalt	mean 59,330 µg/kg (59.33 µg/g), range 57,190 to 62,050 µg/kg	9	Exceeds 5 µg/g threshold; local market only
2, Al-Ahsa, Saudi Arabia	Kajal/kohl (non-brand), FAAS, as-purchased	cobalt	mean 39,020 µg/kg (39.02 µg/g), range 36,710 to 41,330 µg/kg	6	Exceeds 5 µg/g threshold; kohl is a traditional eye cosmetic
2, Al-Ahsa, Saudi Arabia	Skin-whitening cream (non-brand), FAAS, as-purchased	cobalt	mean 55,620 µg/kg (55.62 µg/g), range 42,970 to 68,260 µg/kg	6	Exceeds 5 µg/g threshold; highest inter-sample variability

The dataset reflects a single provincial Saudi Arabian market at an unspecified collection date and cannot characterize the broader Gulf, Middle East, or global cosmetics market distribution for cobalt. The slight positive bias in SRM recovery (115%) introduces a minor upward bias in the reported values. These are relevant to the traditional-eye-cosmetics product page for kohl/kajal.

5 | Soil and environmental occurrence

The loaded sources carry two soil datasets reporting cobalt. Boudia et al. (2019) reported cobalt mean 12.41 mg/kg in beach-zone soils and 7.38 mg/kg in industrial-zone soils around Arzew, Algeria, as air-dried surface samples 4. One Nilore, Islamabad soil characterization reported cobalt of 0.76 µg/g by bulk elemental analysis 3; that source does not state a wet/dry basis or replicated uncertainty. Rueda-Saa et al. (2025) provide soil statistics for agricultural watersheds in Valle del Cauca, Colombia 5. These soil values do not establish edible-crop concentrations or transfer factors and are not food occurrence data.

6 | Regulatory limits

There is currently no binding international maximum level for cobalt in food matrices from any of the regulatory bodies tracked by this wiki (EU, Codex Alimentarius, FDA, Health Canada, FSANZ, WHO/JECFA). The literature-proposed cosmetic limit of 5 µg/g (Iwegbue et al. 2016) cited in 2 is not a government regulatory instrument; it is a peer-reviewed recommendation. EFSA published a tolerable daily intake for cobalt of 0.6 µg/kg body weight per day for inorganic cobalt in 2009, but this is an intake guidance for free ionic cobalt, distinct from the cobalamin/vitamin B12 intake requirement.

7 | Testing

Flame atomic absorption spectroscopy (FAAS) is the standard method used in the cosmetics occurrence literature for cobalt quantification, as demonstrated by 2 (wavelength 240.7 nm, air-acetylene flame). Inductively coupled plasma mass spectrometry (ICP-MS) is more sensitive and is used in multi-element food surveys. The principal analytical challenge for cobalt in food matrices is the low concentrations relative to competing matrix elements; speciation (Co2+ versus vitamin B12-cobalt) is analytically demanding and not routinely performed in occurrence surveys.

8 | Microbiome effects

The loaded corpus does not carry a mechanistic study of cobalt effects on gut microbiota. Cobalt's essential r ole in vitamin B12 is distinct from direct cobalt-microbiome interactions. Microbiome content should be drafted w hen peer-reviewed mechanistic evidence is ingested.

9 | Vulnerable populations

Sensitized individuals with cobalt contact allergy are the principal vulnerable population identified in the loaded corpus for dermal exposure from cosmetics. The threshold for eliciting dermatitis in sensitized individuals is below 10 µg/g and may be below 1 µg/g based on dermatological literature cited in 2. For dietary cobalt, the loaded corpus does not characterize a vulnerable subpopulation with a cobalt-specific intake concern separate from vitamin B12 deficiency.

10 | Mitigation

The Ahmed 2021 source does not report intervention or processing approaches for cobalt reduction in cosmetic matrices. The paper recommends regulatory monitoring of cobalt in cosmetic products and careful selection of raw materials free from elevated cobalt. Mitigation options for dietary cobalt are not characterized in the loaded corpus.

11 | What remains uncertain

The most significant gaps in the cobalt evidence base loaded on this wiki are, in priority order:

Cobalt concentration in dietary food matrices. The loaded corpus contains no food occurrence dataset for cobalt in dietary staples. The absence of a cobalt total diet study means dietary cobalt intake cannot be estimated from this wiki's evidence base.

Cobalt in food versus cobalt in personal care products as exposure pathways. The only direct cobalt occurrence data in the loaded corpus are for cosmetic personal care products, not for food. The relationship between dermal exposure from cosmetics and dietary intake as competing exposure pathways is not characterized.

Generalizability of the Ahmed 2021 Saudi Arabia cosmetics data. The single-province, single-country cosmetics dataset cannot characterize the global or even Gulf regional cosmetics market. Cobalt concentrations in henna, kohl, and cosmetic creams in other markets may differ substantially.

The 5 µg/g proposed cosmetic limit. This threshold is a literature recommendation, not a regulatory instrument. No government body has adopted a binding cobalt-in-cosmetics maximum. The practical significance of exceedances cannot be assessed relative to a regulatory standard.

Cobalt speciation in food and personal care matrices. Total cobalt reported by FAAS or ICP-MS does not distinguish ionic Co2+ (the form associated with contact allergy and systemic toxicity) from cobalt complexes or cobalamin. Speciation data are absent from the loaded corpus.

12 | Frequently asked questions

What is cobalt and why does the body need it?

Cobalt is an essential trace metal, meaning the body requires small amounts of it. Its essential role comes from being the central metal atom in vitamin B12, according to Ufelle & Barchowsky 2021.

What health effects can cobalt cause?

The attached toxicology source notes that cobalt-containing dusts and hard-metal materials can produce respiratory toxicity, allergic dermatitis, cardiomyopathy, and carcinogenicity concerns Ufelle & Barchowsky 2021. The page does not quantify these effects or tie them to specific dietary exposures.

Which forms of cobalt are associated with toxicity?

The page attributes cobalt's toxic effects specifically to cobalt-containing dusts and hard-metal (hard-metal/-tungsten-carbide) materials rather than to cobalt in general Ufelle & Barchowsky 2021. It does not describe toxicity thresholds or food-specific exposure levels.

How much does this page currently tell me about cobalt in food?

Very little. This is a source-map stub created during the re-ingest of Ufelle & Barchowsky 2021, and it states that substantive, cobalt-specific expansion awaits a dedicated cobalt ingest. At present it carries only a general characterization of cobalt and a single attached toxicology source.

References

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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/cobalt#sources.

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