Chromium

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Abstract

Chemical species shape chromium toxicology. Total chromium is kept distinct from the trivalent and hexavalent forms.

This page draws on evidence from EFSA, together with 27 peer-reviewed studies and 5 other cited sources. The complete citation list is at the bottom of the page.

1 | Overview

Chromium (atomic number 24) in the food system is a split case. Trivalent chromium has an ambiguous history as a putative essential trace element and is the species in most dietary supplements. Hexavalent chromium is a carcinogen by inhalation and has documented toxicity by ingestion, including in drinking water; its relevance to food is principally via drinking-water used in food preparation, via meat processing with certain contact materials, and via supply-chain contamination. The wiki maintains the species distinction where the source permits, and flags ambiguity where a source reports total chromium without specifying.

This page covers chromium as element and the trivalent species by default, plus chromium speciation discipline. The hexavalent species has a dedicated page at chromium-hexavalent because hexavalent chromium is a priority heavy-metal analyte whose toxicology, occurrence, regulatory, and testing posture all differ sharply from trivalent chromium. Sources that report total chromium without speciating route here as total-chromium occurrence context and must not be silently substituted for hexavalent chromium.

A toxicology textbook chapter supports the trivalent/hexavalent chromium distinction at the toxicology level, including hexavalent chromium absorption through sulfate/phosphate transporters, corrosive injury, allergic contact dermatitis, acute renal injury after high-dose ingestion, and lung-cancer/genotoxicity framing for hexavalent chromium 2; see chromium-hexavalent for the species-specific synthesis.

EFSA does not regard an essential role for chromium as established. The EFSA nutrition panel has concluded that an essential function of trivalent chromium in metabolism has not been substantiated, that no average requirement or population reference intake can be defined, and that, with no evidence of benefit in healthy

people, setting an adequate intake was not appropriate 1. The Food Safety Commission of Japan treats chromium in food as trivalent, on the reasoning that any hexavalent chromium in food would be reduced by the food's chemical reactivity, and therefore estimated hexavalent chromium intake from mineral water and tap water only 3. EFSA likewise describes food as generally a reducing medium in which oxidation of trivalent to hexavalent chromium is not expected 1.

2 | Toxicology

Hexavalent chromium by mouth

The Food Safety Commission of Japan identified damage to the small intestine and anemia as the major toxicities of hexavalent chromium in experimental animals, with diffuse hyperplasia of the duodenal mucosal epithelium in mice as the finding at the lowest LOAEL 3. Hexavalent chromium in drinking water significantly increased small-intestine tumors in mice and oral mucosa and tongue tumors in rats, and the commission considered it carcinogenic 3. Results were positive in many in vitro genotoxicity tests and in vivo after parenteral dosing, but not clearly positive after oral dosing; transgenic rodent mutation assays found no significant rise in mutant frequency in target tissues after 28 days (rats) or 90 days (mice) of drinking-water exposure, and the commission judged that the carcinogenic mechanism by drinking water was hardly attributable to genotoxicity 3. Absorption after oral dosing is low: swallowed hexavalent chromium is reduced to trivalent chromium slightly by saliva and mainly by gastric juice 3.

In female B6C3F1 mice given about 180 ppm hexavalent chromium in drinking water for 28 days, all exposed animals showed villous enterocyte hypertrophy and mild crypt epithelial hyperplasia in the duodenum, and after a further 28 days without exposure the duodenum was generally indistinguishable from that of unexposed mice 4. That study was funded by an industry chemistry council panel on hexavalent chromium, and it tested a single high dose 4.

In male rats given sodium dichromate dihydrate at 520 mg/L in drinking water (stated as 182 mg/L hexavalent chromium) for 3 months, serum urea and creatinine rose, chromium accumulated in blood and kidney, kidney malondialdehyde rose, and catalase activity and glutathione fell, with widespread tubular and glomerular damage; co-treatment with Spirulina platensis reduced these changes 5.

Trivalent chromium

EFSA's contaminants panel derived a tolerable daily intake of 300 µg of trivalent chromium per kg body weight per day from the NOAEL of a two-year oral rat study in which no adverse effects were seen at the highest dose, applying an uncertainty factor of 1,000 that included an extra factor of 10 for missing reproductive and developmental data 1.

At very high intakes, trivalent chromium accumulates in tissues and interacts with other minerals. Female rats fed a chromium(III) propionate complex at 100 to 1,000 mg chromium per kg of diet (stated as 10 to 100 mg per kg body mass per day) for 4 weeks showed dose-dependent rises in liver chromium, from 2.96 to 17.88 µg/g dry mass, and kidney chromium, from 1.69 to 27.74 µg/g dry mass 6. The two highest doses lowered serum iron and liver and kidney iron, and high doses altered copper, zinc and calcium status 6.

Low chromium intake

In a rat model, a maternal diet with 65% less chromium (0.51 versus 1.56 mg per kg of diet) for 12 weeks before mating lowered dam plasma chromium from 1.18 to 0.648 µg/L, and offspring had higher body weight, body fat

and central adiposity from 12 months of age; moving the dams or pups to the control diet restored circulating lipids and adipocytokines but not adiposity 7. This is an animal deficiency model and does not establish a human requirement.

3 | Typical exposure routes

Food and drinking water

EFSA restates European chronic dietary exposure to trivalent chromium from its 2014 contaminants assessment as means of 0.6 to 5.9 µg/kg body weight per day and 95th percentiles of 1.1 to 7.9 µg/kg body weight per day, excluding infants and toddlers 1. For hexavalent chromium, the Food Safety Commission of Japan estimated intake from mineral water and tap water at a mean of about 0.04 and a high value of 0.290 µg/kg body weight per day 3.

Soil and crop uptake

Arzew industrial soils had chromium mean 51.17 mg/kg, median 45.36 mg/kg and range 11.33 to 193.36 mg/kg (N=14). The aqua-regia/ICP-AES method did not resolve oxidation state. Source risk calculations cannot convert these elemental results into hexavalent chromium measurements (Table 2; Methods 2.3) 8.

Rice seedlings exposed to trivalent chromium retained chromium in roots and surface iron plaques. Synchrotron speciation distinguished ferrihydrite-bound from organic-associated trivalent chromium, with different proportions in root tips and mature zones; the study concerns an upstream uptake mechanism rather than grain contamination. Supports chromium uptake and iron-plaque pathway evidence. Hotspot spectral fractions are not bulk rice-grain species fractions and cannot substitute for a hexavalent chromium food result. Release of plaque-bound chromium during dissolution qualifies any assumption of permanent sequestration 9.

Household dust near chromate waste

In 329 residents of homes next to chromate production waste sites in Hudson County, New Jersey, household dust had a median chromium concentration of 119.0 µg/g (146.5 µg/g in homes of children under 10), and spot urine had a median of 0.27 µg/L 10. Urinary chromium was significantly related to dust chromium concentration, but not to dust loading, and the relationship remained in the final models for the whole population and for children under 10 but not for residents over 10, which the authors read as young children's exposure to dust driving the overall association 10. The measurements were of total chromium, although hexavalent chromium was present at the waste sites 10.

Work and medical devices

Boys aged 10 to 14 working in surgical instrument workshops in Sialkot, Pakistan, had a geometric mean urinary chromium of 23.0 µg/L, about 35 times that of schoolboys from the same city (0.66 µg/L), and one raw instrument sampled from a workshop contained 12.5% chromium 11.

Fixed orthodontic appliances release chromium into saliva. In 30 patients aged 10 to 25 in Bengaluru, mean salivary chromium was 69.15 ppb before treatment, 102.68 ppb after initial alignment and 87.67 ppb after 10 to 12 months, with large variation between patients 12.

Orally taken medicinal liquids

Oral medicinal and vitamin liquids can carry measurable total chromium. Of 34 pediatric syrups made in Nigeria and sold in Awka in 2007 to 2008, 9 had detectable chromium, from 0.01 to 0.58 mg/L, while only 1 of 16 imported syrups did (0.01 mg/L) 13. Six thyme-herb liquid products from Polish pharmacies contained 2.0 to 6.0 µg/L total chromium, giving estimated intakes of 40.30 to 181.41 ng per day at labeled use; several reported values sat below the method's stated limit of quantitation 14.

4 | Food sources

Measured results in foods and orally taken products

STUDY / LOCATION	MATERIAL / DESIGN	METAL SPECIES	VALUE (UNITS AND BASIS)	N	INTERPRETATION / LIMITATION
15 Ottawa, Canada	Retail chicken breast, control homogenates, fresh or stored 24 h	Cr(III); Cr(VI)	Cr(III) 2.76 to 3.38 ng/g; Cr(VI) 11.5 to 14.3 ng/g (ground meat, range of control means)	triplicate homogenates of one purchase	No LOD, CRM or recovery reported; abstract prints the same values in µg/g
2 EU assessment, Polish applicant	Chromium-enriched Yarrowia lipolytica biomass for food supplements	Total Cr, speciated as Cr(III)	19.3 to 22.8 µg/g across production lots; specification maximum 23 µg/g	5 lots	Applicant data; no Cr(VI) peak on HPLC/ICP-MS
13 Awka, Nigeria	Pediatric syrups and suspensions, market survey	Total Cr	Nigerian-made: not detected to 0.58 mg/L; imported: not detected except 0.01 mg/L	34 + 16	AAS; detection limit unit not stated; single analysis per product
14 Poland	Thyme-herb oral liquids, pharmacy survey	Total Cr	2.0 to 6.0 µg/L	6	ETAAS; LOQ 4.95 µg/L, so several values are between LOD and LOQ

Meat

Chromium species were measured by HPLC-ICP-MS in chicken breast bought at an Ottawa grocery store. In control meat, trivalent chromium was 2.76 to 3.38 ng/g and hexavalent chromium 11.5 to 14.3 ng/g, and adding oat protein hydrolysates lowered hexavalent chromium and raised trivalent chromium 15. The paper prints the same figures in µg/g in its abstract, reports no detection limits or reference material for the chromium species, and its finding that the hexavalent form predominated in raw chicken contrasts with the regulatory assumption that food chromium is trivalent 15 3.

Supplements and enriched ingredients

A chromium-enriched yeast biomass proposed for dietary supplements contained 19.3 to 22.8 µg of chromium per gram in five production lots, identified as trivalent chromium, with about half of it water-soluble (50.2%),

43.9% polysaccharide-bound and 4.3% protein-bound 1. At the proposed use of 2 g per day for children aged 3 to 9 and 4 g per day thereafter, it would supply 46 and 92 µg of chromium per day; added to high background dietary intake, EFSA estimated totals of 9.9, 6.9 and 3.9 µg/kg body weight per day for children, adolescents and adults, which are 3.3%, 2.3% and 1.3% of the trivalent chromium tolerable daily intake 1.

Crops, vegetables and botanicals

A Nahavand Plain farm study measured total chromium by ICP-AES in environmental and whole-biomass samples. Chromium was not speciated, so subsequent risk-model inputs cannot turn the occurrence measurements into hexavalent chromium data. Whole aerial biomass also cannot substitute for isolated edible grain or root tissue (Methods pp4 to 5; Tables 6 to 9) 16.

Abubakar and colleagues measured seven metals in sewage water, soil, spinach and cauliflower at two peri-urban sites in Faisalabad, Pakistan. The paper reports substantial differences between the two crop/site combinations, but its design does not separate plant-species effects from location. Concentrations are retained with the source's measurement and tissue limitations. These are localized paired environmental and crop m easurements, with plant results routed as leafy-tissue evidence. They do not establish a cauliflower-head c oncentration, a fresh-weight concentration, or a causal reduction in biomass from metal exposure. Industrial s ource attribution is proposed by the authors, rather than measured by a source-apportionment experiment 17.

Joseph and colleagues measured seven metals in kenaf, chili pepper, tomato and spinach plant parts, with associated soil and irrigation water from Gobbiya Dam in Nigeria. The paper separates edible leaves or fruits from roots and stems. Its concentration tables are preserved independently of several inconsistent safety comparisons and a soil-index calculation that uses water standards. The organ-resolved dry-weight values support local occurrence and irrigation-pathway analysis. Roots, stems and non-edible leaves are retained as pathway context rather than assigned to edible-product distributions. Broad leafy-vegetable and herb/spice ingredient routes retain kenaf and chili identity in the structured record without substituting a named cultivar 18.

This Sri Lankan study compares elemental concentrations and simulated digestive release in two leafy vegetables across five growing areas. Raw, coconut-milk-cooked and coconut-oil-stir-fried portions were tested separately; lower in-vitro release does not establish lower human absorption or safe consumption. Supports region-specific leafy-vegetable occurrence and cooking/bioaccessibility comparisons. Processing effects are not uniform: for example Wellampitiya A. sessilis gastric lead is 15.3% raw and 20.7% cooked. Coconut additions can change the matrix; an in-vitro endpoint is not in-vivo absorption 19. These studies bear on leafy vegetables.

Dyakova compares nine elements in medicinal plant materials collected in disturbed and control environments in Russia's Voronezh region during 2015 to 2020. The reported ranges preserve tissue and environmental setting; t he paper also proposes regional background means across species. Supports geographic and tissue-specific c ontamination evidence for botanical raw materials and environmental attribution hypotheses. It does not measure f inished supplements or isolate an individual polluter's causal contribution 20. This evidence relates to herbal bo tanicals.

Chocolate

Two anonymous chocolate products from Bwari market contained measurable nickel, iron, copper, chromium and lead. Their reported sample concentrations are preserved independently of inconsistent dispersion, intake means and safety comparisons in the paper. Provides a small local occurrence observation with anonymous products. It cannot establish market prevalence, source attribution, or a no-risk conclusion. Total chromium is not hexavalent chromium 21. See chocolate.

Fish and river water

Maurya et al. measured unspeciated chromium in Ganga water and freshwater-fish tissues. River-water means were 0.32 mg/L at Kanpur, 0.85 at Allahabad, 0.36 at Mirzapur and 0.45 at Varanasi (Table 3). Fish-table basis and exposure-model units are internally inconsistent. None of these measurements identifies hexavalent chromium or validates a species-specific health-risk estimate 22. See freshwater fish.

In the Biała Przemsza River in industrial Upper Silesia, Poland, monthly sampling at five points in 2014 found trivalent chromium medians of 1.74 to 2.51 µg/L and hexavalent chromium maxima of 0.93 to 1.19 µg/L, with hexavalent medians below the 0.37 µg/L detection limit at three points; on average trivalent chromium was two to three times the hexavalent form 23. This is surface water, not treated drinking water.

Animal feed and pet food

Texas mineral feed products had unspeciated chromium mean 40.43 mg/kg, SD 87.48 and median 9.3 (N=124; Table 3). Beef-cattle feed had mean 4.91 mg/kg and SD 3.92 (N=160). These heterogeneous feed categories and zero-substituted summaries do not measure hexavalent chromium, human-food concentrations or clinical outcomes 24.

A 2024 preprint reports chromium in all 93 pet-food products, mean 3.47 mg/kg and range 0.48 to 15.47 mg/kg (Table 3). The assay did not speciate chromium. Source-modeled hazard indices cannot turn those results into measured hexavalent chromium, and the later publication represents the same sample cohort 25.

5 | Regulatory limits

Regulatory limits track the species split. The enforceable thresholds that name hexavalent chromium specifically are California's drinking-water Maximum Contaminant Level of 10 µg/L (ca-swrcb-hexavalent-chromium-mcl) and California's Proposition 65 listing and safe-harbor levels (oehha-chromium-vi-prop65); both are covered on the chromium-hexavalent page. Total-chromium drinking-water MCLs (US EPA 100 µg/L, California 50 µg/L) apply to chromium as element and do not separate the hexavalent fraction.

Health-based guidance values

STUDY / LOCATION	MATERIAL / DESIGN	METAL SPECIES	VALUE (UNITS AND BASIS)	N	INTERPRETATION / LIMITATION
3 Japan	Tolerable daily intake, from two-year mouse drinking-water study	Cr(VI)	1.1 µg/kg bw/day (BMDL10 0.11 mg/kg bw/day, uncertainty factor 100)	not applicable	Based on diffuse duodenal epithelial hyperplasia in male mice

2 EU	Tolerable daily intake, from two-year rat study	Cr(III)	300 µg/kg bw/day (uncertainty factor 1,000)	not applicable	Restated from the 2014 EFSA contaminants assessment

The Food Safety Commission of Japan set its tolerable daily intake for hexavalent chromium in connection with an amendment of beverage standards by the Ministry of Health, Labour and Welfare, and concluded that the risk of health effects from current exposure through mineral water and tap water is extremely low because estimated intakes were below that value 3. EFSA has not set dietary reference values for chromium 1.

For oral medicinal products, one pharmacy survey compared estimated daily chromium intake with the ICH Q3D oral permitted daily exposure for chromium, which the paper prints inconsistently as 10,700 µg/day in the text and 10,700 mg/day in the abstract 14. For occupational biomonitoring, the Sialkot study compared children's urinary chromium with an adult occupational biological exposure index of 25 µg/L 11.

The papers cited on this page do not establish maximum levels for chromium in specific foods.

6 | Testing

Speciation matters because total chromium results cannot be read as hexavalent chromium. HPLC coupled to ICP-MS separated trivalent and hexavalent chromium in river water with detection limits of 0.19 and 0.37 µg/L and validation recoveries of 99% and 102% 23. Size-exclusion HPLC/ICP-MS of a water extract and a simulated digestate identified the chromium in an enriched yeast ingredient as trivalent, with no hexavalent peak 1. In chicken meat, an ion-pair HPLC-ICP-MS method detected both species at mass 52 after enzymatic extraction, but the paper gives no detection limit or recovery for chromium 15. Hexavalent chromium dosing solutions in a mouse study were verified by EPA method SW-846 7196A with a detection limit of 0.04 ppm 4.

Total-chromium methods in the cited papers include electrothermal atomic absorption spectrometry with a certified lichen reference material (recovery 97.81%, LOD 1.65 µg/L, LOQ 4.95 µg/L) for herbal liquids 14; atomic absorption for syrups, rat tissues (graphite furnace, with a tobacco-leaf reference material) and urine (standard additions) 13 6 10; ICP-MS for urine and saliva 11 12; and ICP emission spectrometry (ICP-OES) for serum and bone 26 27. Several clinical papers report no detection limit or reference material for chromium, which limits comparison between them. Method detail for chromium is collected at chromium methods.

7 | Microbiome effects

None of the human, animal or food studies cited on this page measured gut microbiome outcomes. The only microbial evidence here concerns soil bacteria and crop uptake:

Bashkin and Galiulina review vegetable-associated metal exposure assessment and microbial/agronomic risk-management approaches. Chinese and Russian case-study values are secondary reports; they remain traceable to the cited studies and are not counted as new independent occurrence samples. Supports exposure-method and remediation literature discovery. Bacterial effects can increase as well as decrease uptake depending on organism, metal and plant; the review does not establish a universal inoculant intervention. Secondary model outputs are not contemporary health or certification thresholds 28.

A separate wiki synthesis on chromium and the gut is at chromium gut axis; it is not built from the papers cited here.

8 | Vulnerable populations

Children

Child workers in surgical instrument manufacturing in Sialkot had urinary chromium about 35 times that of schoolchildren, above the adult occupational biological exposure index the authors cite 11. Near chromate waste sites in New Jersey, the association between household dust chromium and urinary chromium held for children under 10 but not for older residents 10. Pediatric syrups made in Nigeria contained detectable chromium more often than imported ones 13.

Clinical chromium status data in children are sparse and methodologically weak. In 30 Bulgarian children under 3 with iron-deficiency anaemia, mean serum chromium was 0.83 µmol/L by a spectrophotometric method, and 73% were below the cited reference range; healthy controls were not tested for chromium 29. In Ugandan children aged 2 to 10, with and without HIV, mean plasma chromium was 1 µg/L and the authors judged it sufficient, in a conference abstract with incomplete statistics 30.

Pregnancy

Pregnant women with gestational diabetes in Chennai had lower serum chromium (1.59 ng/mL, n = 30) than matched pregnant controls (4.58 ng/mL, n = 60) 26. This is an association in a small case-control study, not evidence of cause. In rats, maternal chromium restriction increased offspring adiposity 7.

Kidney disease and implants

In 37 hip-surgery patients in north-western Poland, mean chromium was 0.45 mg/kg dry mass in cartilage and 0.66 mg/kg in cortical and spongy bone, and bone chromium was lower in the five patients with kidney disease (0.28 versus 0.46 mg/kg) 27. The same paper's statements on implants and game meat conflict between its abstract and its results 27. Patients with fixed orthodontic appliances had higher salivary chromium during treatment than before it 12.

9 | Mitigation

Soil and sludge remediation

One Nilore, Islamabad soil sample characterization reported bulk chromium of 28.15 µg/g, with wet/dry basis unstated (Table 2). The source subsequently included that native total-chromium value in a calculation labelled hexavalent chromium removal; its oxidation state was not established 31.

A chromium special-issue editorial provides secondary environmental and remediation context. Its crustal-background comparator is not a measured site concentration or legal limit, and its summarized fish values require the underlying study before primary occurrence reuse (p1780) 32.

Column washing of Bangalore-area industrial sludge removed substantially more metals with hydrochloric acid plus EDTA than with distilled water. This is a remediation experiment relevant to sludge contamination pathways, with no measurements in food or a demonstrated safe land-application endpoint. Supports laboratory washing and contaminant-transport comparisons. Metal-rich leachate still requires management; the study does not establish agricultural reuse or field-scale safety 33.

Food processing

In a laboratory test, adding oat protein hydrolysates to ground chicken breast lowered hexavalent chromium and raised trivalent chromium, both immediately and after 24 hours of storage at 4 or -20 degrees C, an effect the authors attribute partly to thiol groups 15. This was not tested as a commercial process. Cooking effects on metal release from leafy vegetables are discussed under Food sources.

The cited papers do not establish a validated processing step that lowers total chromium in food.

10 | Open questions

- The papers cited on this page provide no maximum levels for chromium in specific foods, and no speciated survey of hexavalent chromium across a national food supply.
- Whether hexavalent chromium can persist in raw meat, as one chicken-breast analysis reported, needs confirmation with validated speciation methods, detection limits and recovery data.
- Current drinking-water intake estimates for hexavalent chromium come from Japan only; the cited papers give no comparable estimates for other countries.
- Human relevance of rodent intestinal findings at high drinking-water doses, and whether those lesions reverse after long exposure, remain open; the recovery evidence covers 28 days of exposure.
- Clinical chromium status studies in children and pregnancy rely on small samples and methods without reported quality control; a validated biomarker and reference range are not established by the cited papers.
- No cited paper measured chromium effects on the human gut microbiome.
- Validated processing or cooking steps that lower chromium in foods are not established.
- Chromium in orally taken medicines and supplements is documented only for small product sets in Nigeria (2007 to 2008) and Poland.

11 | Frequently asked questions

What is the difference between trivalent and hexavalent chromium in food?

Chromium in the food system is a split case between two species. Trivalent chromium (Cr3+) has an ambiguous history as a putative essential trace element and is the form found in most dietary supplements. Hexavalent chromium (Cr6+) is a carcinogen by inhalation and has documented toxicity by ingestion, including in drinking water, so the two species differ sharply and are tracked separately.

How does hexavalent chromium get into food?

According to the page, hexavalent chromium's relevance to food is principally through drinking water used in food preparation, through meat processing with certain contact materials, and through supply-chain contamination. Because of these distinct pathways, Cr6+ is handled on its own dedicated page separate from trivalent chromium.

What health effects are linked to hexavalent chromium exposure?

Drawing on Ufelle & Barchowsky 2021, hexavalent chromium is absorbed through sulfate and phosphate transporters and is associated with corrosive injury, allergic contact dermatitis, and acute renal injury after high-dose ingestion. That source also frames Cr(VI) in terms of lung cancer and genotoxicity. These effects are specific to the hexavalent species.

Is trivalent chromium (the kind in supplements) considered safe or essential?

The page describes trivalent chromium as having an ambiguous history as a putative essential trace element, and notes it is the species present in most dietary supplements. It does not resolve the essentiality question; the page is a sourced stub and states that Cr-III-specific expansion, including the essentiality debate and supplement context, awaits dedicated corpus ingest.

Why does it matter whether a study reports 'total chromium' instead of the specific species?

The wiki maintains the Cr3+ versus Cr6+ distinction wherever the source permits, and flags ambiguity when a study reports total chromium without specifying the species. Sources that report total chromium without speciating are treated only as total-chromium occurrence context and must not be silently substituted for hexavalent chromium, because Cr-VI's toxicology, occurrence, regulatory, and testing posture all differ sharply from Cr-III.

12 | What remains uncertain

Most of the measurements on this page are of total chromium. Only three cited studies separate trivalent from hexavalent chromium, and they cover one retail chicken purchase, one enriched yeast ingredient and one Polish river. Regulatory bodies assume that chromium in food is trivalent, but the cited speciation evidence in food is too thin to test that assumption.

The toxicology rests largely on rodent studies at high drinking-water doses, plus two health-based guidance values that differ by species: a tolerable daily intake for hexavalent chromium from Japan and one for trivalent chromium from EFSA. Several clinical and product studies have internal inconsistencies in units or group results, noted in their source records, so their numbers should be read as indicative rather than definitive.

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