Rice

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Abstract

Use this review to compare a rice result with the available occurrence evidence, investigate sourcing differences and select controls to verify. The profile covers inorganic and total arsenic, cadmium, lead, nickel, chromium and mercury where measurements are available. Cooked grain rice and derived foods retain their own measurement bases.

1 | Rice overview

The most consequential control decision is often the joint response of arsenic and cadmium: a water regime that lowers one can raise the other, while some field settings show lower arsenic without a statistically detected cadmium increase[4,5]. The evidence below identifies where that distinction changes a sourcing or processing decision.

2 | Rice identity and scope

This page covers edible brown, white and cooked rice. Brown rice retains the bran and germ; polishing removes outer tissues[8]. Flour, bran, syrup, protein ingredients and drinks have separate processing and composition evidence[9]. Uncooked grain describes a food form; dry weight describes an analytical moisture basis[8].

3 | Sources and contamination pathways

Rice contamination depends on both the metals present in the growing environment and the conditions that make them available to the plant[4,5,17]. Soil chemistry and water management help explain why grain concentrations do not simply track total soil concentrations[4,17]. Changes in flooding can alter arsenic and cadmium in different directions, so an improvement for one contaminant does not establish an improvement for the other[4,5,17].

Biological processes add another layer of variation. Microbial activity can change arsenic species around the roots, while binding and transport within plants influence uptake and retention[18,20,21]. The evidence connects these processes with differences in contamination, but a microbial association or laboratory mechanism does not by itself establish a treatment that will reliably reduce contaminants in harvested grain[18,19,20,21].

These findings make source attribution a separate task from measuring the food. A grain result establishes the concentration in the tested material; it does not identify the responsible field process or distinguish among possible inputs[1,16,22]. Investigating a source requires evidence linking the growing environment to the crop, with the sampling conditions and alternative explanations retained[1,16]. This distinction matters when deciding which control to investigate and what its effects would need to demonstrate.

The pathway is not simply “more soil metal means proportionally more grain metal.” Mineral binding, pH, redox, microbial transformations and plant transport affect availability[16]. A soil screening result identifies an environmental question; a grain measurement answers the food-composition question[1,16]. Market observations alone cannot identify whether a particular lot’s metal came from geology, irrigation, fertilizer or atmospheric d eposition[1,16].

A contaminated grain or retail sample does not identify where the metal entered the crop[1,16]. Testing a proposed pathway needs measurements along that route, such as irrigation water, soil, plant and grain, while considering other inputs and collection timing[16]. Purifying an analytical extract improves measurement; it does not demonstrate decontamination of the food[22].

Flooding changes the soil chemistry that controls plant exposure[4,17]. Reducing conditions can dissolve iron phases that retain arsenic and favor more mobile arsenic species in porewater[4,17]. Drying can increase cadmium availability, so water-management changes need to be evaluated for both analytes[4,17]. The response varies across growing conditions[4,5,17]. In the Arkansas production-field study, multiple aerations were associated with a 31% lower median grain inorganic arsenic than conventional flooding, while cadmium did not show a statistically significant water-management effect[5]. This observational comparison is a regional counterexample to an inevitable cadmium increase[5]. It does not establish equivalence or a universal reduction factor[5]. The paper’s field-year denominator differs between Methods and Table 1; its summary concentrations remain o utside the comparison tables pending reconciliation[5].

Dai and colleagues combine field observations, soil chronosequences, incubations and a global metagenomic survey to examine the balance between arsenic methylation and demethylation, linking microbial functions with grain speciation and straighthead disease[18]. A larger methylated fraction is not automatically nutritionally preferable[18]. Cheng and colleagues compare two rice cultivars and their root-associated microbiomes under soil amendments[19]. The lower-accumulating cultivar also had distinctive microbial and soil features[19]. Such coupled findings make biological mechanisms plausible, but a microbial association or predictive model is not by itself proof that adding one organism will lower harvested-grain cadmium under another field’s conditions[19].

Mishra’s arsenic work examines species transformation and thiol binding in exposed rice plants[20]. Inoue’s Nramp5 e ngineering study uses a yeast assay to examine cadmium and manganese uptake selectivity[21]. These studies help explain transport and retention; their experimental systems do not provide a market-rice concentration distribution or a demonstrated reduction in dietary exposure[20,21].

4 | Variation by origin, variety and growing conditions

Rice contamination varies both between and within sampled growing regions, so an origin label provides context rather than a concentration for every supplier or lot[1,2]. Geographic comparisons also depend on what was sampled: a growing location and a retail collection market describe different parts of the supply chain[1,2,3]. Useful comparisons retain the rice form, measurement basis and sampling scope alongside the location[1,2,3].

The surveys identify useful lower-contamination candidates: Carey's polished-rice survey reported the lowest i norganic-arsenic median in Malawi, 5 µg/kg (19 samples), followed by Tanzania, 9 µg/kg (88 samples), on f reeze-dried grain[1]. Shi's cadmium survey placed both countries among the lowest reported medians at 4.9 µg/kg, b ut that number substitutes half the 9.8 µg/kg detection limit rather than measuring an exact low concentration[2]. These historical market samples suggest origins to investigate for both analytes; they do not guarantee current lots or establish the lowest source for nickel, lead or mercury.

Variety and growing conditions need to be considered together[23]. A low result in one setting does not establish stable performance across soils, water regimes and seasons; climate and soil-arsenic experiments likewise describe responses under particular tested conditions[23,24]. These findings support evaluating a variety in the conditions where it will be grown, without turning a greenhouse result into a universal forecast for future crops[23,24].

Collection-year differences need similar care because the sampled foods and collection coverage can change-[3]. Matched historical comparisons can describe differences within the available samples, but they do not automatically establish a national trend or a change at a particular supplier[3]. For a sourcing decision, the survey evidence provides context for investigating harvest and lot histories rather than replacing measurements of the material being purchased[3].

Origin helps identify sourcing options to investigate[1,2]. International rice surveys show variation between and within sampled countries, but cultivar, milling, water management and harvest conditions also contribute[1,2]. Confirm whether a location means growing origin or collection market: FDA collection regions describe where foods were purchased, not where the rice was grown[3].

Select a cultivar for the conditions in which it will be grown. Liu's contrasting-environment study and Tran's pa ired brown/white grain study show that genetic and grain-fraction differences matter, but a low result in one se tting does not establish stable performance across soils, irrigation regimes and seasons[8,23]. A useful supplier comparison retains these conditions alongside grain measurements.

Muehe's greenhouse experiment examines climate and soil arsenic together and finds that their combined effects c an alter rice yield and grain arsenic[24]. It is a treatment-specific experiment, not a prediction that every future crop will show the same percentage change[24]. It strengthens the case for testing cultivar performance under the growing conditions in which it will actually be used.

Collection year can matter when growing conditions, sourcing or processing change. Compare periods with a compatible sampling design. In five shared winter-region groups, FDA cooked white-rice cadmium medians changed from 4.3 to 5.0 µg/kg and brown-rice medians from 5.5 to 9.8 µg/kg between FY2018 and FY2020[3]. The comparison uses six earlier and five later composites; it describes these matched samples, not a national trend[3]. Use the year and region controls to inspect the available matched comparisons. For a purchasing decision, request the supplier's own harvest and lot history as well: a change in historical survey samples does not identify a change at that supplier[3].

5 | Processing effects and derivatives

Processing changes which rice material is consumed and how its contaminant concentration should be interpreted[8]. Polishing can lower arsenic and many other elements, but the paired brown-and-white grain evidence does not support a universal cadmium reduction[8]. The retained grain and removed fractions therefore need their own interpretation, especially when both enter the food or feed chain[8].

Cooking and pretreatment effects depend on the chemical species, water conditions and process used[25,28]. Some tested methods lower residual inorganic arsenic, while rinsing alone has limited benefit and nutrient losses can accompany treatment[25,26]. Experimental chemical soaking differs from ordinary household rinsing; neither its results nor a cooking-study percentage supplies a universal reduction factor[25,28].

A lower concentration in a rice-derived ingredient does not by itself demonstrate removal of contaminant mass[25,27]. Milling can redistribute contaminants, water can dilute a product, and changes in chemical species can affect interpretation[6,8,25]. Verification needs measurements in the final material alongside moisture, yield and outgoing streams, rather than a general conversion from grain results or an assumption that processing leaves every species unchanged[6,10,25,27].

Polishing can lower arsenic and many other elements, but it is not a reliable universal cadmium control[8]. Tran's s tudy measured brown and white grain from the same plants: most measured elements were higher in brown g rain, while cadmium and molybdenum were exceptions[8]. That paired design is more informative about milling than comparing unrelated retail products[8]. Test the retained grain and the removed bran if both enter the food or feed chain.

Rinsing alone has limited arsenic benefit; FDA guidance also notes possible nutrient losses from rinsing or excess-water cooking of enriched rice[26]. Cooking methods need their own evidence. Carey's cooking e xperiments distinguish excess-water cooking from percolation[25]. At a 12:1 water:rice ratio, the study reports 57 ± 5% lower residual-grain inorganic arsenic across the tested materials; the meaning of the reported uncertainty term remains unresolved here[25]. That result concerns the tested method and endpoint, not a common reduction factor for cadmium, methylmercury or all household cooking[25].

Pogoson's process is substantially different: sequential chemical soaks, each lasting 12 hours, followed by c ooking[28]. The primary manuscript reports reductions in Cd, inorganic As and DMA, but the starting-species quantities in the stored extraction need arm and basis reconciliation[28]. The process belongs in the evidence on potential preprocessing; it should not be presented as ordinary rinsing or a validated household instruction[28].

Removal into discarded water differs from dilution by water retained in cooked food[25]. A process comparison should retain the starting and residual food concentration, food yield, water quality, drainage and waste destination. FDA guidance also notes that some excess-water methods reduce nutrients[26]. Reusing contaminated water or ignoring the discarded stream can change the exposure or environmental consequence-[25,26].

Derivative evidence confirms the need to measure the final material. Hosojima's protein-powder study includes a contaminant composition table, while Zhao tests microbial immobilization to remove cadmium from contaminated r ice flour[10,27]. One describes a specific ingredient used in a nutrition trial; the other evaluates a processing method[10,27]. Neither supplies a universal grain-to-protein or grain-to-flour conversion, and laboratory removal requires separate process-safety and residual-food validation[10,27].

Jackson's rice-syrup-containing foods and D'Amato's Italian-market beverages show why formulation and material identity travel with the result[9,29]. The beverage study separately measures arsenic species, rather than estimating inorganic arsenic from a generic total-arsenic fraction[29]. Its liquid-food concentrations cannot

be compared directly with dry grain without accounting for rice inclusion and water[29]. The rice-based-drink regulatory scope is a distinct category with a selected EU provision shown in the requirements table[30].

EFSA's organoarsenic assessment describes thiolated species and evidence of transformation during processing, s torage and acidic extraction[6]. Its processed-commodity scenarios partly assume no DMA loss[6]. These models cannot establish what actually happens in a particular puffed, stored or hydrolysed product[6]. Species-preserving measurements and the relevant original processing studies are needed to resolve that question[6].

A useful process calculation measures metal mass in the incoming rice and in each outgoing food, bran, water or sorbent stream, alongside moisture and yield[25,27]. A lower concentration in a wetter product can occur without the same reduction in total metal mass[25,27]. A process that transfers metal to waste also requires a disposal assessment; testing only the final concentration leaves that question unanswered[25,27].

6 | Heavy metal mitigation and remediation for rice

Rice controls act at different stages, and their effects depend on the contaminant, material and growing conditions[8,17,31]. Field water management can lower grain inorganic arsenic while increasing cadmium, while soil treatments and cultivar selection address other influences on grain accumulation[8,17,31]. These findings support matching a control to the grain and conditions being evaluated rather than treating a reduction in one metal as a general reduction in contamination[17,31].

Additional mitigation studies reinforce the breadth of approaches under investigation. Runkle et al. (2025) reviewed agronomic solutions for decreasing arsenic concentrations in rice, concluding that sprinkler irrigation reduced total grain arsenic by 69 to 98% compared to continuous flooding without raising grain cadmium beyond FAO limits.[48] Li et al. (2026) found that fulvic acid and humic acid amendments reduced grain cadmium by 30.95 to 87.68% in a pot experiment with co-contaminated paddy soil, but grain arsenic responses were dose-dependent and sometimes increased under humic acid treatments.[49] Mlangeni et al. (2022) showed that zero-valent iron amendments at 6.20 g Fe per kg or above reduced grain lead by 39 to 55% in two rice cultivars.[50] Roy et al. (2025) reported that laterite biochar composites decreased arsenic in rice seeds by up to 99.5% in a pot experiment with heavily contaminated soil (106 mg arsenic per kg), though these extreme conditions limit direct extrapolation to typical paddy soils.[51] Peña et al. (2023) demonstrated in a multi-year field experiment in Spain that sprinkler irrigation saved 55% of water and reduced grain arsenic compared to flooding, but favored cadmium uptake, which compost application partially offset.[52]

Cultivar selection is another lever. Shan et al. (2024) screened five rice genotypes under dry cultivation and identified Yunjing37 as a low cadmium-accumulating variety, with root morphology and iron plaque formation as mechanistic determinants of genotypic differences.[53] Addison et al. (2021) used genome-wide association to identify QTLs associated with grain arsenic concentration and straighthead resistance in US rice.[54] Naeem et al. (2025) found that combined salt, cadmium, and arsenic stresses differentially affected grain quality across rice varieties, with head rice yield reduced to 40 to 45% under combined stress in some cultivars.[55]

Two reviews provide broader context. Wang et al. (2025) synthesized mechanistic insights into cadmium contamination in Asian rice, noting that grain cadmium typically ranges from 0.1 to 0.3 mg/kg but can exceed 0.4 mg/kg in high-accumulating varieties or heavily contaminated environments.[56] Nawaz et al. (2026) reviewed integrated phytoremediation and microbial mitigation strategies, reporting that nanoenabled amendments and biochar composites can reduce bioavailable cadmium fractions by up to 75%.[57] Nackley et al. (2024) investigated tectonite dust as a soil amendment for dryland crops (wheat, not rice) in Oregon, noting that careful

sourcing and testing of mineral amendments are necessary to address potential heavy metal contamination risks.[58]

After harvest, source qualification, milling and preparation address different parts of the problem[8,12,26]. Polishing changes contaminant concentrations across grain fractions, with responses that differ by element[8]. Some cooking methods reduce residual inorganic arsenic, while rinsing alone has limited benefit and nutrient losses can accompany treatment[25,26]. A preparation result therefore applies to the tested method and food rather than providing a common reduction factor for every process[25].

Control performance depends on the chemical species, food material, starting condition and endpoint being compared[17,31]. A large relative decrease can leave an important residual concentration, so verification needs the remaining concentration, uncertainty, linked contaminant changes, nutrients and operating conditions[17,26,31]. Historical market contrasts and agency recommendations can inform control selection, but they do not establish an experimental treatment effect or demonstrate commercial performance[1,26].

7 | Trade-offs and failure modes

A control needs to be judged across the outcomes it changes, because a reduction in one contaminant does not establish a net benefit[8,17]. The rice evidence shows that arsenic and cadmium can respond differently to water management, with the cadmium response varying between studies[4,5,17]. A lower concentration in retained grain also does not by itself establish removal from every food or feed stream, particularly when other grain fractions are reused[8].

Nutritional composition and production outcomes can change independently of contaminant concentrations[26,33,34]. Greater yield or nutrient enrichment therefore needs to be distinguished from evidence of reduced grain contamination[33,34]. Some cooking processes can lower inorganic arsenic while reducing nutrients in enriched rice, making the composition of the remaining food part of the control decision[25,26].

Whether a treatment can be transferred to another setting depends on its operating requirements as well as what remains in the food and outgoing streams[27,28]. Chemical soaking has different operating and disposal requirements from ordinary cooking[28]. Complete mass balances and comparable commercial costs remain unavailable across the selected controls, so the evidence does not support a universal cost-effectiveness ranking[27,28].

8 | Sampling and testing rice for heavy metals

A rice test is only as informative as the material it represents[2,3]. Analytical repeats can describe precision within a composite without establishing variation across the shipment; lot identity and sampling coverage therefore matter alongside the numerical result[2,3]. A precise measurement of one submitted sample does not establish the composition of every untested bag or lot[2,3].

Chemical species and sample preparation can change the meaning of a test result[6,35,36,37]. Total arsenic is not a measured inorganic-arsenic result, and extraction or storage can affect species recovery[6,35,36,37]. Method validation and species stability therefore need to match the rice material and the decision being made[35,36,37].

Screening can help select samples for confirmatory analysis when its performance in rice is established[22]. A non-detect remains bounded by the method's stated analytical limit rather than demonstrating zero c ontamination[3,37]. A statistically nonsignificant treatment comparison is a different result again and does not, by itself, establish that a treatment has no effect[33].

A useful laboratory report connects the measured sample to the lot being purchased. Check how increments were taken and combined, which rice form was tested, and whether the sampling covers the shipment[2,3]. Repeated analyses of one composite assess analytical precision; they do not measure variation between untested bags or lots[2,3].

The record should also describe sample reduction and identify any retained samples available for repeat testing[2,3].

Request the species needed for the decision, with matrix validation, recovery, reporting limits and uncertainty-[35,36]. A total-arsenic result does not supply measured inorganic arsenic[35,36]. The ICP-MS methods overview explains how elemental measurement differs from chromatographic speciation.

Song's Cr(VI) method found no detectable Cr(VI) in its small food sample, including rice flour, but recovery d ependended on extraction and holding time[37]. EFSA also describes conversion of thiolated arsenic species to DMA during acidic extraction[6]. Ask whether the method preserves the species being reported and whether the reporting limit answers the purchasing question.

The method report should document extraction recovery, species stability, blanks and reference materials; calibration correlation alone is insufficient[35,36].

Portable screening can help select samples for confirmatory testing when its performance in rice is established-[22]. Tian's magnetic-purification assay removes analytical interference before measuring cadmium and lead; i t does not decontaminate the food[22]. Check bias and false acceptance or rejection near the intended decision boundary before using screening for lot release[22].

A non-detect means the result is below a stated analytical limit under that method[3,37]. It is not a measured zero, and an unspecified limit cannot establish a useful upper bound[3,37]. A nonsignificant treatment comparison answers a different question again: it may reflect little effect or imprecision[33].

9 | Procurement and process control

Historical origin patterns can guide a sourcing investigation, but the evidence for a purchase needs to describe the rice actually being delivered[1,2]. Cultivar, growing conditions, harvest and processing affect whether an earlier qualification still applies; a country label alone does not establish the lot's contaminant composition[1,2,4,23].

A useful specification connects the intended food use with the measured species, material basis and testing decision[12,35]. Incoming-rice results and a generic certificate of analysis do not automatically establish the composition of the prepared finished food[12,35]. Sampling fitness and measurement uncertainty remain relevant when interpreting a result for acceptance[12,35].

A control claim needs a traceable relationship between its reported effect, starting and residual measurements, actual sampling and operating conditions[31,34,38]. Program reach does not establish how many farms were independently sampled, and a historical reduction percentage is not a guarantee for a later purchase[4,31,34,38]. Changes in source, cultivation or processing therefore need to be checked against evidence for the material to be supplied[4,23,38].

Malawi and Tanzania are candidates to investigate for lower inorganic arsenic and cadmium in the cited polished-rice surveys[1,2]. Shortlisting those origins is different from approving a shipment: compare current lots, verify growing origin and grain form, and measure the relevant analytes on a compatible basis. A low-arsenic origin cannot be assumed to have the lowest nickel or mercury without corresponding comparative results.

Request evidence for the rice being delivered: lot identity, growing origin, harvest, cultivar, grain form, milling and water management where known[1,2]. Use historical country evidence to investigate alternatives, then compare actual supplier lots on a compatible basis[1,2]. A country label alone does not establish their arsenic, cadmium or mercury composition[1,2].

A downloadable supplier and testing brief provides a reusable evidence-request sequence. Record the material, intended use and destination market before choosing a numerical comparator. The testing section explains the analytical report requirements.

Specifications should name the intended food use, chemical species, material basis and analytical decision rule[12,35]. Incoming-rice results need a documented relationship to the final recipe and preparation[12]. Rejection or acceptance near a limit should address measurement uncertainty and sampling fitness; a generic certificate of analysis or a total-arsenic value cannot silently replace a species-specific requirement[12,35].

For a claimed control, request its starting and residual grain measurements, sampled farms and lots, duration, yield and operating cost. Li's regional program and Sun's and Jiang's multiyear field observations provide imp lementation context, but program reach is not the number of independently sampled farms[31,34,38]. Use these details to judge whether the reported benefit transfers to the purchase.

Where a supplier changes cultivar, farm, water regime, amendment, milling or processing, the previous qualification may no longer describe the delivered material[4,23,38]. The field evidence makes these changes plausible effect modifiers[4,23,38]. Verify them with relevant grain and finished-food results rather than assuming a historical reduction percentage will persist.

10 | Finished-product and exposure implications

Grain measurements do not transfer directly to rice drinks, specialized rice-based infant formulas or dry rice-based infant cereal[11,29,39]. These foods differ in composition, intended use and preparation, so their concentrations need direct product evidence or a verified formulation model[9,11,29,39]. Rice drinks and infant formulas also require separate interpretation: sharing a rice-derived ingredient does not make them interchangeable materials[11,29].

Estimating exposure adds another step. Ingredient concentrations need to be connected to the finished recipe, processing yield, preparation water and the amount consumed[6,11]. A dilution assumption used for one formula or study cannot serve as a universal preparation factor[6,11]. Food concentrations, laboratory bioaccessibility and human biomarkers consequently describe different parts of the exposure pathway[6,40].

The human studies support investigating exposure, while diet, age, other foods, drinking water and metabolism complicate attribution to rice alone[41,42,43,44]. Observational associations do not establish that changing rice will change a health outcome, and calculated risk is distinct from measured illness[7,45,46]. These boundaries matter when interpreting infant and pregnancy biomarkers or using a finished-food result to estimate exposure[40].

Rice drinks and specialized rice-based infant formulas differ in formulation, intended use and preparation[11,29]. 'Amato's beverage findings and Meyer's hydrolysed-rice formula measurements describe separate products[11,29]. Retain each product's composition and preparation instructions when interpreting its result; their concentrations c annot be substituted for one another or transferred to other rice products using a common conversion factor[11,29].

EFSA's rice-formula DMA scenario reuses Meyer's measurements with explicit reconstitution and consumption as sumptions[6,11]. It is not an additional independent formula survey, and its assumed dilution is not a universal preparation factor[6,11]. Ingredient inclusion, moisture, processing yield, other ingredients and preparation water all need to be identified before estimating consumed dose[6,11].

The infant studies require careful study identity. The 2017 Belfast report includes 79 pre-weaning infants and an 11-infant paired subset[41]. The separate 2018 New Hampshire study follows 15 paired infants and reports higher urinary arsenic species during weaning, with associations involving rice cereal, fruit and vegetables[42]. These data support exposure investigation, but diet and age change together; the biomarker is not a rice-specific disease endpoint[41,42]. Du's clinic cohort provides a useful null comparison: among 56 infants with reflux or d ysphagia, total urinary arsenic did not differ statistically between thickener groups (p=0.086)[43]. The small, observational groups do not establish equivalence or justify changing prescribed feeding[43]. A null thickener comparison also does not negate the dietary associations in a different cohort with different exposures and sampling[41,42,43]. Pregnancy adds physiological and metabolic complexity to urinary arsenic interpretation[44]. Ashley-Martin's review explains why species, timing, metabolism and exposure sources matter[44]. A urine concentration should not be attributed to rice without considering drinking water and other foods, nor should urinary DMA automatically be equated with the amount of inorganic arsenic eaten[44].

Rothenberg's rural-China cohort links a prenatal exposure biomarker with child development, rather than m easuring an intervention on rice[7]. In adjusted models, doubling maternal hair total mercury corresponded to a 1.3-point lower mental-development score (95% CI −2.6 to −0.14); the psychomotor estimate's interval included n o association[7]. Follow-up declined from 391 enrolled mothers to 190 children assessed at 36 months[7]. Hair total mercury was the measured proxy, and attrition, caregiving and confounding limit a rice-specific causal interpretation[7].

Modeled risk and observed disease must also remain separate. Song's intake assessment multiplies food c oncentrations by consumption, while Huang's meta-analysis includes hazard calculations whose combined-metal re sult must be distinguished from individual-metal quotients[45,46]. These are exposure or risk models, not measured illness rates or a diagnosis for a reader[45,46]. No individual risk prediction is generated from the occurrence explorer.

11 | Evidence review, methods and research gaps

This selected-source review supports scoped comparisons of rice contamination and investigation of potential controls. Interpretation depends on the material, chemical species, measurement basis and study conditions; results do not automatically transfer to current lots, commercial processes or individual health outcomes.

Requirements and toxicological context

Requirements depend on species, rice form, intended use and jurisdiction[12,30]. The selected EU provisions below were checked on October 18, 2026 against the consolidation dated August 19, 2026 and the nickel amendment; FDA's final infant-rice-cereal guidance remains nonbinding and enforcement-relevant[12,30]. This is a dated selection, not a complete list of applicable analytes, jurisdictions or finished-food requirements.

EU maximum levels generally apply to the edible food as placed on the market, unless the entry specifies otherwise[30]. They are not automatically moisture-free dry-weight limits[30]. For processed or compound foods without a specific maximum, Article 3 requires justified concentration, dilution, processing and ingredient factors[30]. A cooked-rice literature value cannot be compared directly with an uncooked-grain requirement without a supported basis relationship[30]. Nickel rice entries apply from July 1, 2026; the regulation retains its transition for food lawfully placed on the market earlier[30]. Article 4 also prohibits deliberate chemical detoxification of covered food; a laboratory removal result is not authorization to use that process commercially-[30].

Toxicological reference points answer a different question from food-law limits[6,47]. EFSA's inorganic-arsenic and o rganoarsenic assessments evaluate different chemical species and uncertainties[6,47]. Their modeled exposure and margin-of-exposure scenarios should retain their assumptions and source datasets[6,47]. A legal maximum, health reference point and descriptive survey percentile cannot be substituted for one another[6,47].

12 | Rice FAQs

Rice measurements on this page include inorganic and total arsenic, cadmium, lead, nickel, chromium and mercury, with chemical species and rice preparations kept separate[3]. A measured result or non-detect belongs to its sampled food and reporting limit; it does not mean every rice lot contains each contaminant at the same level.

FDA identifies rice as a crop that absorbs arsenic more readily than other crops[26]. Rice irrigation studies show how flooded conditions can mobilize soil arsenic, while drying can change arsenic and cadmium availability in opposite directions[17]. This arsenic explanation should not be generalized to every metal or every rice-growing system.

No. Jackson's study measured arsenic in organic brown-rice syrup and foods containing it[9]. Those product measurements show that an organic label is not evidence of an arsenic-free food; they do not quantify a universal organic-versus-conventional rice difference. The chemistry term organic arsenic describes a chemical species, not an organic-farming label[6].

Arsenic is a group of chemically distinct measurements[6]. Total arsenic includes inorganic arsenic and organic species; inorganic arsenic usually combines arsenite and arsenate[1,6]. Dimethylarsinic acid (DMA) is often present in rice and can vary independently[1,6]. A total-arsenic result therefore cannot be converted into measured inorganic arsenic using a universal percentage[1,6]. The same separation is needed between total mercury and methylmercury, and between total chromium and Cr(VI)[15,37].

Tran's paired grain study found most measured elements higher in brown grain, but cadmium and molybdenum were e xceptions[8]. Polishing is therefore an element-specific choice, not a universal contaminant-removal guarantee; compare the actual retained grain and any bran being reused.

Malawi had the lowest median in Carey's sampled polished rice, with Tanzania also low; these are historical d ry-grain observations, not country-wide supplier guarantees[1]. The values and sample counts are explained in Variation.

Malawi and Tanzania were among the low-median groups in Shi's polished-rice survey, with both reported at the h alf-detection-limit substitution value[2]. That reporting convention prevents an exact ordering of the low groups; the survey supports a sourcing shortlist, not a promise about a new shipment.

Liu's contrasting-environment study and Tran's grain study show that genetic differences need interpretation al ongside the growing environment and grain fraction[8,23]. A useful variety choice needs results under the intended soils, water regime and seasons; one low result is a candidate for validation.

Water-management studies show that arsenic and cadmium can respond in opposite directions, so a single-metal improvement does not establish an overall advantage[17]. No common-origin ranking for nickel, lead and mercury has been established in the evidence assembled for this page. Ask for the analytes relevant to the purchased rice rather than treating a low-arsenic label as a complete panel.

Jackson's syrup-containing foods and Gu's infant-food categories concern distinct formulations and measured pr oducts[9,39]. Use finished-product evidence or a verified formulation model; a drink, infant formula and dry rice cereal are not interchangeable matrices.

Long-term inorganic-arsenic exposure is associated with adverse effects including cancer; EFSA's 2024 a ssessment used skin cancer as the critical endpoint[47]. FDA also identifies neurodevelopmental concerns in its infant-rice-cereal guidance[12]. These hazard assessments are not a diagnosis or a risk estimate for one rice meal: interpretation needs the measured species, concentration, amount eaten and other exposure sources.

FDA recommends grain variety rather than relying only on infant rice cereal; iron-fortified oat, barley and multigrain cereals are other options[26]. Its infant-rice-cereal action level addresses inorganic-arsenic exposure, including neurodevelopmental concerns[12]. These complementary-food choices do not authorize substituting rice drinks for infant formula or changing a formula's preparation instructions.

Yes, requirements depend on the market, analyte and rice form: the selected EU provisions in this page's Review d istinguish rice and rice-derived categories[30]. In the United States, FDA's infant-rice-cereal guidance sets a 100 µ g/kg inorganic-arsenic action level; it is nonbinding guidance relevant to enforcement, not a universal legal limit f or every rice product[12]. The EU table retains its stated October 18, 2026 verification date; this FAQ does not claim a fresh complete legal review.

The evidence here does not establish one weekly serving allowance for everyone. FDA advises a varied diet and allows rice as part of a balanced diet rather than supplying a universal weekly rice limit in its cited consumer guidance[26]. Any individual calculation would need the rice's contaminant concentrations, preparation, portions, b ody weight and other dietary exposure; a survey average alone cannot supply it.

FDA describes cooking rice in 6-10 parts water per part rice, then draining it, as an approach that can lower inorganic arsenic[26]. It also warns of losses of added nutrients in enriched rice and describes rinsing alone as having little arsenic benefit[26]. The result depends on rice type and method and is not one removal factor for every contaminant.

No. The cited cooking study reports less inorganic arsenic remaining in rice after specified excess-water or percolating methods; this is a reduction in the grain result, not destruction of the element[25]. It does not establish one removal percentage for cadmium, methylmercury or every household recipe.

Limmer's irrigation study reports this trade-off under the tested conditions[17]. Evaluate both residual concentrations and the local growing conditions before adopting the method; a percentage reduction in arsenic alone leaves the cadmium question unanswered.

FDA's advice supports including rice in a varied, balanced diet rather than excluding it entirely[26]. Grain variety and the preparation choices discussed here address exposure without treating every rice product or consumer as equivalent. A person with a specific medical or dietary requirement needs guidance suited to that situation; this occurrence review does not prescribe elimination.

The FDA dataset identifies the food preparation, analyte, collection and reporting limits for each result[3]. Apply that same traceability to a supplier report: identify the lot and sampled grain form, confirm the required species, and retain units, basis and reporting sensitivity. Repeated tests of one composite do not establish variation across untested lots.

FDA's rice measurements describe particular prepared-food composites rather than an individual's total diet[3]. A comparison also needs the amount eaten, preparation and other dietary sources; a concentration ranking alone is not a personal exposure estimate.

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DATA AVAILABILITY

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