CODEX ALIMENTARIUS COMMISSION

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World Health Organization

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**JOINT FAO/WHO FOOD STANDARDS PROGRAMME**

**CODEX COMMITTEE ON CONTAMINANTS IN FOODS**

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**Bangkok, Thailand**

# CODE OF PRACTICE FOR THE PREVENTION AND REDUCTION OF CADMIUM CONTAMINATION IN FOODS

(Prepared by the Electronic Working Group chaired by the United States of America)

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| Codex members and observers wishing to submit comments at Step 3 on the proposed *Code of practice for the prevention and reduction of cadmium contamination in foods* should do so as instructed in CL 2025/10-CF, available on the Codex webpage[1] |

## BACKGROUND

1. The 17th Session of the Codex Committee on Contaminants in Foods (CCCF17, 2024) agreed to establish an Electronic Working Group (EWG) chaired by the United States of America (USA) to prepare a *Code of practice (CoP) for the prevention and reduction of cadmium contamination in foods* for consideration by the next session of the Committee.

2. The scope of the work would address measures, supported by scientific data, that prevent or reduce cadmium contamination as it relates to all aspects of food production from agricultural and aquacultural techniques, source-directed measures (reduction of cadmium in soil and water), drinking water, food ingredients and processing, and production and use of food packaging and storage products.

3. This work would build on previous work on cadmium, most recently the development of the *Code of practice for the prevention and reduction of cadmium contamination in cocoa beans* (CXC 81-2022).[2]

4. This work follows recommendations from the European Union (EU) and Japan in response to the circular letter CL 2022/85-CF[1] on the *Review of Codex Standards for Contaminants*[3] that a code of practice (CoP) should be considered before reviewing/revising cadmium maximum levels (MLs).

5. CCCF17 reviewed the discussion paper[4] and noted support for the development of a CoP as well as the following points:

   - There was enough information to start work on the CoP.
   - Considering the various factors affecting cadmium levels in seafood, regional or national-specific mitigation measures, such as consumer advice or regional standards, may also be appropriate.
   - The development of annexes containing commodity-specific recommendations would depend on the information provided to the EWG, i.e., whether they were detailed or specific enough to warrant commodity-specific annexes.
   - If commodity-specific annexes were developed, foods that contribute significantly to cadmium exposure,

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1 Codex webpage/Circular Letters: http://www.fao.org/fao-who-codexalimentarius/resources/circular-letters/en/.
Codex webpage/CCCF/Circular Letters: http://www.fao.org/fao-who-codexalimentarius/committees/committee/related-circular-letters/en/?committee=CCCF

2 CCCF working documents and reports of its sessions including other relevant documents can be downloaded from the Codex/CCCF webpage: https://www.fao.org/fao-who-codexalimentarius/committees/committee/en/?committee=CCCF

3 CX/CF 23/16/4

4 CX/CF 24/17/16

such as rice, cereal, cereal products, and fish and seafood, should be prioritized.

6. CCCF17 agreed to[5]:

- start new work on a CoP for the prevention and reduction of cadmium contamination in foods,
- forward the project document to CAC47 for approval, and
- establish an Electronic Working Group (EWG) chaired by the USA to develop a CoP for the prevention and reduction of cadmium contamination in foods, for comment and consideration by CCCF18 (2025), and to determine the need for developing annexes with commodity-specific recommendations.

7. The 47th Session of the Codex Alimentarius Commission (CAC47, 2024) approved the new work, which is expected to be completed in 2027.[6]

**WORK PROCESS**

8. The EWG received and reviewed comments and scientific information in response to CL 2024/26-CF[1] and to two drafts of the CoP, which were shared on the Codex online forum in 2024-2025.

9. For the second draft prepared for CCCF18, two commodity-specific annexes on seaweed and rice were presented. The EWG was asked for input on:

(i) whether there was sufficient information to warrant the development of commodity-specific recommendations in annexes, and

(ii) whether annexes should be stand-alone documents or only present unique information, similar to the approach used in the *Code of practice for the prevention and reduction of mycotoxin contamination in cereals* (CXC 51-2003).

Appendix II includes the references used in the annexes.

10. Comments in response to either the CL and/or the two drafts on the online forum were received from Australia, Brazil, Canada, Chile, Cuba, Ecuador, Egypt, EU, Institute of Food Technologists (IFT), Indonesia, Iraq, Ireland, Jamaica, Japan, Netherlands, New Zealand, Panama, Peru, Russia, Singapore, Thailand, United Arab Emirates (UAE), United Kingdom, and the USA. The list of members and observers registered to participate in the EWG is found in Appendix III.

**KEY POINTS OF DISCUSSION**

11. There was general consensus on the scope of mitigation measures addressed in the general part of the CoP, which covers source-directed measures, agriculture and aquaculture techniques, drinking water, food ingredients and processing, production and use of food packaging and storage products, and consumer practices.

12. In addition to comments received on the general provisions of the CoP, there was agreement that only unique information should be presented in the annexes.

13. There was less agreement on whether sufficient information was available to develop the annexes. Canada supported the annexes on seaweed and rice. Japan supported the rice annex, but stated that a seaweed annex was unnecessary, as there were few unique recommendations specific to seaweed. The other members/ observers did not comment on the sufficiency of the information for annex development.

14. The EWG was informed that the bioavailability of cadmium to humans consuming crops and terrestrial and aquaculture species is an active area of research, as differences in bioavailability could affect cadmium uptake, and that this should be considered in the development of a CoP. As JECFA did not consider bioavailability in its risk assessment (JECFA73[7], 2011; JECFA91[8], 2021), the EWG did not incorporate bioavailability considerations into the proposed CoP.

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5 REP24/CF17, paras. 130-133 and Appendix IX

6 REP24/CAC47, para. 154, Appendix V

7 https://openknowledge.fao.org/server/api/core/bitstreams/a3da64ef-146b-4818-9cdb-2a37e1fe59d9/content
https://www.who.int/publications/i/item/9789241209601
https://iris.who.int/handle/10665/44515

8 https://www.who.int/publications/i/item/9789240100152
https://cdn.who.int/media/docs/default-source/food-safety/jecfa/summary-and-conclusions/jecfa91-1to12march2021-summary-and-conclusions.pdf?sfvrsn=1d79351f_5

**CONCLUSIONS**

15. The EWG concluded as follows:

(i) Available information has been reviewed and incorporated into the CoP as appropriate. Additional risk management practices not yet considered in the current draft may be provided in response to the circular letter and in plenary.

(ii) There is support for developing annexes to address recommendations specific to given commodities and associated mitigation measures not addressed by the general provisions of the CoP.

(a) The development of annexes is contingent upon data availability on commodity-specific mitigation measures (i.e., whether information is detailed and specific enough).

(b) Rice and seaweed were proposed as possible annexes. There was support for the development of the rice annex. A member country noted that seaweed had only a few unique mitigation measures and thus may not warrant development of an annex.

(iii) The EWG supported the CoP for consideration by CCCF18, including annexes that contain unique information not addressed in the general part of the CoP. Further discussion is needed on the rice and seaweed annexes.

**RECOMMENDATIONS**

16. CCCF is invited to consider the proposed CoP in Appendix I as follows:

(i) To consider the overall structure and content of the CoP, including the availability of additional data and information on risk management practices to reduce or prevent cadmium contamination in foods.

(ii) To consider the annexes on seaweed (Annex I) and rice (Annex II) per the following:

(a) whether there is sufficient information to warrant their development;

(b) whether there is additional information on cadmium mitigation measures in seaweed and rice to develop the annexes further;

**Note**: Risk management measures for inclusion in Codex codes of practice should be readily available, applicable worldwide, and proven to be effective across different production scales, including small- and medium-sized businesses.

(c) whether there are any other commodities for which annexes would be appropriate (i.e., commodities that contribute significantly to exposure and for which there are detailed and specific mitigation measures not addressed in the general part of the COP).

(iii) To consider whether the *Code of practice for the prevention and reduction of cadmium contamination in cocoa beans* (CXC 81-2022) should be converted into an Annex, and, if so, whether it is timely to task the EWG with this work.

(iv) To consider re-establishing the EWG to continue working on the general and specific provisions of the CoP to support the prevention and reduction of cadmium contamination in foods, and to submit a revised document to CCCF18 (2026) for consideration.

**APPENDIX I**

**PROPOSED CODE OF PRACTICE FOR THE PREVENTION AND REDUCTION OF CADMIUM CONTAMINATION IN FOODS**

**(For comments at Step 3)**

**INTRODUCTION**

1. Cadmium is a toxic heavy metal that occurs in the environment both from natural and anthropogenic sources. Exposure to cadmium can occur through ingestion, inhalation, and dermal contact. Dietary cadmium exposure is primarily associated with adverse effects on kidneys and bones. Cadmium is relatively poorly absorbed into the body, but once absorbed it is slowly excreted, with a half-life of between 10 to 33 years.

2. Sources of cadmium exposure include food, water, atmospheric deposition (e.g. from burning of fuels, metal smelters), cigarette smoking, occupational exposures, and consumer products (e.g. batteries, paints, coatings, jewelry, and pigments used in pottery finishes, glassware, and on certain plastics). Food is the primary source of cadmium exposure for most people, with the exception of smokers, for whom tobacco is a significant cadmium source, or individuals with occupational exposures.

3. The Joint FAO/WHO Expert Committee on Food Additives (JECFA) completed evaluations (2010, 2013, 2021) of cadmium in foods, including vegetables, fruits, meat and poultry offal, shellfish/molluscs, grains, nuts and oilseeds, and spices. At its 73rd session (2010), JECFA established a provisional tolerable monthly intake (PTMI) of 25 µg/kg bw, reflecting the long half-life of cadmium in humans. JECFA conducted additional dietary exposure assessments on cadmium at its 77th session (2013) and 91st session (2021), focusing on the contribution of cocoa products to cadmium exposure. The most recent JECFA assessment concluded that the main sources of dietary cadmium exposure are cereals and cereal-based products, vegetables, and fish and seafood.

4. Cadmium is present at low levels in most foods, with higher mean concentration ranges reported by JECFA for vegetables (0.006-0.1 mg/kg); meat offal (0.03-0.5 mg/kg), poultry offal (0.006-0.5 mg/kg); shellfish/molluscs (0.01-4.8 mg/kg); nuts and oilseeds (0.02-0.1 mg/kg); coffee, tea, and cocoa (0.0001-1.8 mg/kg); and spices (0.006-0.2 mg/kg). Certain mushrooms, rice, and seaweed, grown in certain geographic regions with higher cadmium, may also contain elevated concentrations.

5. Cadmium in food arises from numerous sources including soil and air. Cadmium occurs naturally in soils, including from sedimentary and shale rocks. Soil cadmium also results from mining and smelting operations, sewage sludge, manure, and phosphate fertilizers containing elevated levels of cadmium. Agricultural crops can take up cadmium from the soil. Atmospheric particles of cadmium from soil dust and from industrial activities (e.g. burning of fuels, metal smelters) can deposit on plant surfaces (e.g. leafy greens, wheat). Cadmium-containing crops, native vegetation, and soil are also a potential source of contamination of livestock.

6. Cadmium can also enter the food chain from water. Agricultural crops can take up cadmium from irrigation water. Surface waters contaminated with runoff from industrial activities or atmospheric deposition can be a potential source of contamination for wild-harvested or aquaculture-grown seaweed and seafood. For drinking water and water used in food preparation, cadmium contamination can result from cadmium impurities in zinc used in galvanized steel pipes or cadmium-containing solders in metal fittings used in water distribution systems.

7. Cadmium uptake by crops or aquaculture can also be affected by the availability of cadmium depending on soil and water chemistry (e.g. pH, chlorinity). Different crops, livestock, and aquatic species have different propensities to uptake and accumulate cadmium.

8. Cadmium contamination can also result from food processing and food packaging. Galvanized steel for food preparation or for food grinding can contribute to cadmium in foods. Cadmium sulfide and cadmium selenide have been used as red, yellow, and orange colour pigments in plastics and various types of paints. Brightly coloured ceramicware, glassware, and plastic tableware for food preparation or food packaging, when not properly prepared, can be a potential source of cadmium in foods.

9. In summary, low levels of cadmium in foods may be unavoidable, because of the ubiquitous presence of cadmium in the modern industrial world. However, good agricultural, aquacultural, and manufacturing practices, awareness of recommended standards, and broader public health efforts can minimize cadmium contamination of foods.

10. The Codex Alimentarius Commission has recommended maximum levels (MLs) for cadmium in various foods (*General standard for contaminants and toxins in food and feed*, CXS 193-1995)[1]. National competent authorities have also recommended or established cadmium standards in foods.

11. The objective of this CoP is to provide guidance to countries and industry on the prevention and reduction of cadmium contamination in foods. This CoP compiles practical information on measures to prevent or reduce cadmium in foods including through source-directed measures, agriculture and aquaculture techniques, drinking water, food ingredients and processing, and production and use of food packaging and storage products. Because many useful interventions for reducing cadmium rely on actions by consumers, a section with suggestions on consumer practices is included as well. This CoP builds on measures identified in the *Code of practice for the prevention and reduction of cadmium contamination in cocoa beans* (CXC 81-2022).

**RECOMMENDED PRACTICES BASED ON GOOD AGRICULTURAL PRACTICES (GAP) AND GOOD MANUFACTURING PRACTICES (GMPs)**

**Source directed measures**

13. National or relevant food control authorities should consider implementation of source-directed measures in the *Code of practice concerning source directed measures to reduce contamination of foods with chemicals* (CXC 49-2001).

**Agricultural**

***Crops***

14. It is important to be aware of cadmium sources in agricultural soils. Cadmium levels can increase as a result of atmospheric deposition (e.g. burning of fuels, metal smelting), application of sewage sludge and manure, use of phosphate fertilizers not controlled for cadmium, and flooding with water contaminated with cadmium. Also, cadmium levels in cropland near rivers can be contaminated from mines or other industrial activities.

15. Because certain crops are more susceptible to cadmium uptake, before planting a new field, farmers may consider it helpful to consult with agricultural extension services or other relevant authorities to determine if selected crops are prone to cadmium uptake.

16. For crops prone to cadmium uptake, farmers should consider consulting with agricultural extension services to review soil survey maps to determine if a crop field is in an area with known elevated cadmium levels. If a field is in an area with known elevated cadmium, it may be necessary to evaluate cadmium levels directly through a soil testing program. Cadmium levels can vary within a field, so specific information on cadmium levels across a field and at varying depths may be useful.

17. Because cadmium uptake in crops is influenced by soil properties, including pH, organic carbon content, zinc content, chlorinity, cation exchange capacity, redox potential, clay content, and oxides of iron and manganese, farmers, when possible, should conduct testing of soil properties, with testing for pH, organic carbon, and zinc being most important. This testing should be conducted by accredited laboratories using internationally recognized validated methods.

18. When planning soil testing, agronomists and farmers should consider the appropriate soil depth for testing and the method for composite sampling. Where available, soil characterization analysis should be conducted by accredited laboratories, using validated methods that include the use of certified reference materials and standards and provide associated uncertainties. At least one composite soil sample (consisting of soil from at least 10 locations) per 4 hectare (10 acre) field should be collected. However, if the field is larger, collect at least one additional sample for approximately every additional 1 hectare (or 2 acres). If the field contains several distinct soil types, collect and analyze a composite sample for each soil type.

19. Establish agricultural crops away from urban areas or high-traffic areas, if possible, to reduce exposure of the crops to emissions from combustion engines (e.g. vehicles) because they may contain cadmium. Similarly, crops should be located in areas separate from mining areas, smelting areas, industrial wastes, and sewage because these could be sources of cadmium.

20. A greater amount of soil organic matter may improve retention of cadmium in the soil and thus may help to decrease cadmium uptake by crops. The use of organic fertilizers with low cadmium levels, such as treated manure or compost, can increase the organic matter content of the soil, while also improving its microbiological activity. Organic fertilizers should not contain pathogenic microorganisms (CXC 53-2003).

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[1] *General standard for contaminants and toxins in food and feed* (CXS 193-1995)

21. The application of soil amendments (e.g. magnesium, sulphate, humus, charcoal, dolomitic limestone, spent mushroom substrate, farmyard manure and zinc sulphate fertilizer) can decrease cadmium concentrations in crops by increasing pH or by binding directly to the cadmium. The suitability and effectiveness of amendments varies depending on the characteristics of the soil and the crops.

22. The most sensitive zone for cadmium uptake from the soil is at the root level. It is important to ensure that soil cadmium, pH, and zinc fertilizers are managed at the root level.

23. Phosphate fertilizers applied to agricultural fields should contain low cadmium levels. To decrease cadmium uptake, phosphate fertilizers used on agricultural crops should meet available standards set by competent authorities with respect to the ratio of cadmium to phosphorus (Cd:P or Cd:$P_2O_5$).

24. Manures, composts, biosolids, and irrigated wastewater may also contain cadmium. In agricultural areas with known high cadmium soil levels, ensure that fertilizers (including phosphate fertilizers), manures, and irrigated wastewater that are low in cadmium are used.

25. Cadmium phytoavailability to crops is strongly affected by pH of soil at the root depth. Cadmium is most mobile in acidic soils with a pH less than 5.5-6.0, while in more alkaline soil (pH greater than 6) cadmium is less mobile, binding to organic matter and soil minerals. When tilled to the root depth, liming has been effective in increasing pH and decreasing cadmium uptake. However, it is important to verify that the added lime does not contain cadmium. In addition, the soil pH should be tested to determine the need for liming, as liming can lead to elevated calcium levels in the soil, increasing cadmium availability.

26. Cadmium competes with zinc for uptake by plants, and cadmium is more likely to enter crops and accumulate in plants when zinc soil concentration is low. Thus, for crops, grown where there is a deficiency of zinc in the soil, zinc levels should be increased at the root depth with zinc fertilizer. Farmers should consult with extension services for guidance on zinc fertilizer application.

27. For rice, controlling flooding cycles can limit cadmium absorption into plants. Cadmium is less phytoavailable under flooded, anaerobic conditions. This is discussed in more detail in Annex II.

28. Measures to reduce cadmium levels in cocoa beans during cocoa cultivation include using cover crops to improve soil organic matter and to protect soil from erosion, removing pruned cocoa limbs and leaves from the ground, and applying liming products and zinc fertilizers. Additional recommendations are discussed in the *Code of practice for the prevention and reduction of cadmium contamination in cocoa beans* (CXC 81-2022).

29. Cadmium uptake in crops can also be affected by chloride content of irrigation water and soil, as higher chloride levels can increase cadmium phytoavailability. Monitoring chloride levels in irrigation water and soil may help with efforts to minimize cadmium uptake depending on soil conditions.

30. Given that certain crops are more susceptible to cadmium uptake and particular varieties (cultivars) uptake more cadmium, it may be preferable to plant crop varieties with a lower potential for cadmium uptake on soil known to contain high levels of cadmium, while considering the need for crop rotation. Low uptake crops or varieties have been developed through plant-breeding techniques and genetic engineering and are available in some countries. Examples include development of lower cadmium durum wheat cultivars in Canada and the United States and rice cultivars in Japan.

***Livestock***

31. Livestock may take up cadmium by ingesting soil or water during grazing, consuming crops with elevated cadmium, or consuming fertilizer directly. Grazing livestock on pasturelands near industrial sites or other areas containing elevated cadmium may increase the risk of cadmium exposure in those animals.

32. For cattle produced in areas with high cadmium soil levels, where there are no standards for cadmium in feed, and where kidney consumption is common, it may be prudent for kidneys of older cattle (e.g. > 2 years) to be excluded from the food chain.

33. Cadmium levels in offal should not exceed standards set by competent authorities, and where no levels exist, cadmium levels in offal should be as low as reasonably achievable.

34. Ingredients used in animal feed, including mineral additives such as phosphates, zinc sulphate, zinc oxide and seaweed and seaweed-derived products, may contain cadmium. Levels of cadmium in these feed ingredients should conform with standards set by competent authorities to ensure animals do not consume excess quantities of cadmium, and when no standards exist, cadmium levels should be as low as reasonably achievable.

35. Livestock should be prevented from grazing in areas with cadmium sources, including farm rubbish such as discarded metal (e.g., galvanized steel) that may be a source of cadmium.

36. Local and national competent authorities as well as agricultural extension services should make farmers aware of appropriate practices for reducing and preventing cadmium contamination of crops and livestock.

**Farmed and wild-harvested seafood and seaweed**

37. National or relevant competent authorities should consider measures to prevent or reduce cadmium contamination in seafood provided in the *Code of practice for fish and fishery products* (CXC 52-2003).

38. Cadmium tends to bioaccumulate in the viscera of seafood, in particular scallops and cephalopods. For scallops, removal of the viscera (i.e. kidneys and digestive glands) and for cephalopods, removal of the ink sac, is recommended by processors prior to consumption to reduce cadmium exposure.

39. "Brown crab meat" from the cephalothorax of crabs, which includes the hepatopancreas, is known to contain higher levels of cadmium. Consumer advice can be targeted to particular populations who consume brown crab meat to inform them of potential risks.

40. Agricultural runoff and other point sources containing elevated cadmium can lead to bioaccumulation of cadmium in marine or freshwater life (e.g. shrimp, crabs, mussels, and other shellfish) near coastal areas. Monitoring cadmium levels in water and in bioindicator species, such as bivalve molluscs, can provide information on the extent of contamination and inform water quality programs designed to reduce and prevent cadmium pollution.

41. Given the broad variety of factors affecting cadmium levels in different types of seafood and seaweed, including different uptake patterns, characteristics of the aquatic environment, and proximity to cadmium sources, regional-specific mitigation measures may be most appropriate. These could include consumer advice or standards set by competent authorities (e.g. regulatory limits). Regionally targeted measures also should consider the dietary patterns of local populations.

42. Feed management for aquaculture species should ensure that feed products contain low cadmium levels, including when possible, avoiding the use of marine organisms or seaweed byproducts with elevated cadmium and testing commercial aquaculture feed for cadmium.

43. Seaweed is known to bind and bioaccumulate cadmium from seawater. Growing seaweed in aquatic environments that have lower cadmium levels reduces the potential for elevated cadmium in the seaweed. This is discussed in more detail in Annex I.

**Drinking and processing water**

44. Drinking water from private wells or public water systems could contain cadmium. Cadmium in private wells may result from naturally occurring cadmium in rocks and soil that leaches into groundwater. Cadmium also may result from impurities in the zinc used in galvanized steel pipes or cadmium-containing solders in metal fittings. The corrosivity of the water (e.g. low pH), the amount of cadmium in the plumbing system components, and the amount of water drawn through the plumbing system affect cadmium levels in drinking water and water used for food processing.

45. Administrators of water systems with high cadmium levels should replace, where appropriate, problematic galvanized steel service lines, pipes, or components. The corrosivity of the water should be monitored.

46. National or local competent authorities should consider establishing allowable cadmium levels or appropriate treatment techniques for controlling cadmium levels in drinking water. The World Health Organization (WHO) has established a guideline value for a maximum level for cadmium in drinking water of 0.003 mg/L.

**Food ingredients and processing**

47. Food producers should limit cadmium in foods to levels below recommended MLs in the *General standard for contaminants and toxins in food and feed* (CXS 193-1995) or standards established by national or local competent authorities for foods and food additives; this is particularly important for foods intended for infants and young children.

48. Where standards are not established, national or regional competent authorities could consider establishing standards limiting the concentration of cadmium allowed in foods that contribute to the highest exposures and for which there is an identified or high potential for an unacceptable health risk to consumers. In the absence of standards, national or local competent authorities or industry can monitor selected foods, including dietary supplements, to ensure that cadmium levels do not rise above normal background levels or are as low as reasonably achievable.

49. Food processors should choose food and food ingredients, including ingredients used for dietary supplements, that are below recommended MLs or specifications, or where no MLs or specifications are available, that are as low as reasonably achievable. Where feasible, they should consider whether the production areas where crops, seaweed or shellfish are produced may contain elevated cadmium levels.

50. Food processors should consider having control measures in place to monitor incoming ingredients or verify that suppliers are providing ingredients that are below the recommended MLs or specifications, or where there are no MLs or specifications available, that levels are as low as reasonably achievable. Food processors should consider occasional testing of incoming raw materials and finished products for cadmium to verify that their control measures are functioning effectively.

51. More focused testing should be considered for ingredients or products known to contain high cadmium levels or that are intended for infants and children.

52. For foods for infants and children, consideration should be given to sourcing of raw materials and ingredients used in the manufacture of finished products to ensure levels of cadmium are as low as reasonably achievable.

53. During processing, removal of surface cadmium should be practiced, including by thoroughly washing vegetables, particularly leafy vegetables. Peeling root vegetables, where appropriate, can reduce cadmium levels. For example, for potatoes, higher levels of cadmium have been found in the skin versus the flesh.

54. Milling of grains can reduce cadmium concentrations, as the cadmium concentrations are generally higher in the outer layers of the grain compared to the inner parts. Milling durum wheat has been shown to decrease cadmium levels 29-37% in semolina in comparison to the whole grain.

55. Because filtration aids (specifically diatomaceous earth, bentonite, and charcoal filtration) used in processing fruit juices, wines, and beer can contain cadmium, selecting filtration aids, if available, with lower cadmium levels or washing filtration aids with solutions such as ethylenediamine tetraacetic acid (EDTA) or hydrochloric acid solution may reduce cadmium levels in the beverages. Alternative filtration methods also may be used, for example, ultrafiltration. The Codex Guidelines on Substances Used as Processing Aids (CXG 75-2010) provides guidance on filtration aids that can be used for processing beverages.

56. Food processors should ensure that the water supply for food processing complies with the MLs for cadmium established by the national or local competent authorities.

57. Food processors should use food-grade metals for all metal surfaces that come into contact with food and beverages. For example, galvanized steel that is used in food preparation and food conveyance applications should not be used with foods that have high acid content such as tomatoes, oranges, and limes because of the potential for cadmium leaching in acidic conditions.

58. Food processors engaged in milling should ensure that metal components used in grinding are not contributing cadmium to the final milled product.

59. National and local competent authorities could consider setting standards for cadmium migration and cadmium composition in food contact materials used in food processing or manufacturing.

**Production and use of packaging and storage products**

60. Packaging foods for sale in glazed ceramics containing cadmium should be avoided because these ceramics may leach significant quantities of cadmium into the foods when ceramics are not glazed at proper temperatures and for the required time.

61. Decorative ceramic ware or other food contact materials that can leach unacceptable quantities of cadmium (e.g. some pewter and decorative-coloured glass) should be clearly labelled as not for food use.

62. National and local competent authorities should consider setting standards limiting cadmium migration from cadmium-glazed ceramic ware and other cadmium-containing items, such as plastics and glassware, or metals and alloys that contain cadmium as an impurity, such as tin, that might potentially be used for food storage, food preparation, or tableware.

63. National and local competent authorities could consider implementing supply chain controls pertaining to the quality and composition of raw materials used in manufacture of food packaging and storage products for foods.

64. Data indicate that certain brightly coloured plastic tableware on the market can contain high levels of cadmium that can leach into food. Plastic tableware, including those intended for use specifically by children, should comply with standards to ensure cadmium levels are as low as reasonably achievable.

**Consumer practices and consideration of certain foods**

65. Consumers should wash vegetables and fruit thoroughly to remove dust and soil that may contain cadmium. Peeling root crops can reduce cadmium levels. Washing hands before preparing food will also help remove any cadmium-containing dust or soil from hands.

66. National or local competent authorities should educate consumers about the potential risks of consuming local specialty foods, (e.g. organs of fish and shellfish) or collected wild foods (e.g. mushrooms, kidneys from game meat) that could contain elevated cadmium levels.

67. Consumers should be educated about the risks of cadmium exposure from geophagia, the practice of consuming clay or soil.

## ANNEX I

## SEAWEED

### Introduction

1. In addition to mitigation approaches identified in the general part of the CoP, this annex addresses mitigation practices specific to seaweed.

2. Good Agricultural Practices and Good Manufacturing Practices include reducing cadmium in seaweed (macro-algae) through growing, harvesting, post-harvest, and processing practices. Seaweed is either harvested naturally (wild seaweed) or from cultivated (farmed) crops.

### Growing/harvesting practices

3. Refer to paragraphs 40-43 of the general part of the general part of the CoP

4. Testing water in growing areas is recommended to reduce potential for elevated cadmium in seaweed. This is particularly important in coastal areas identified as susceptible to human pollution.

5. Seaweed aquaculture (farming) may offer opportunities for greater standardization and control of cadmium levels as compared with wild harvesting.

6. When growing seaweed in land-based tanks, minimize the use of fertilizers that contain cadmium.

### Post-harvesting and processing

7. Refer to paragraphs 41, 48-50 of the general part of the general part of the CoP.

8. Processors should be aware that cadmium levels in seaweed vary significantly based on seaweed type, geographic origin, and proximity to human activity, as well as age, season, temperature, pH, amount of sunlight, and nutrient concentrations and oxygen. Therefore, repeat testing may be needed on batches harvested at different times and in different locations. As more information on growing and processing measures to reduce cadmium in seaweed becomes available, it may be possible to select seaweed species with lower cadmium levels for processing and consumption. For example, data suggest that green seaweed (e.g. sea lettuce) has lower cadmium than brown or red (e.g. nori and wakame), as brown and red seaweed tends to bind more strongly to cadmium leading to higher cadmium concentrations. However, it is recognized that the desired flavor and usage of seaweed varies by species, and flavour profile may influence ability to select alternate species.

9. Washing or soaking seaweed during processing can help reduce cadmium levels in the finished products, with increasing washing times resulting in reduced cadmium levels. Washing or soaking solutions (e.g. with sodium chloride) should be effective in reducing cadmium levels and should conform with appropriate standards developed by national or regional competent authorities.

10. The water used to wash seaweed (both seawater and fresh water) should be checked for cadmium levels. When washing seaweed during processing, ensure that the cadmium levels in the water are lower than in the seaweed and water is replaced as needed to reduce cadmium.

11. Fermenting, a seaweed processing step that follows washing or blanching, and is used to lower salt content, has been found to reduce cadmium levels.

12. When cleaning and processing seaweed, it is advisable to sort seaweed lots based on harvest location/seaweed farm to allow traceback if elevated cadmium levels are identified in finished product testing.

## ANNEX II

## RICE

### Introduction

1. In addition to mitigation approaches identified in the general part of the CoP, this annex addresses mitigation practices specific to rice.

2. Good Agricultural Practices and Good Manufacturing Practices include methods to reduce cadmium in rice through growing, harvesting, post-harvest, and processing practices.

Mitigation of cadmium in rice is most effective at the production stage, through management and cultivation of the rice, with primary mitigation methods including: 1) modifying the physicochemical properties of the rice paddy soil through addition of amendments to reduce cadmium availability, 2) use of irrigation management to alter the solubility of the cadmium, 3) use of low-cadmium cultivars that uptake less cadmium from the soil, or a combination of these methods.

### Source-directed measures

3. Refer to paragraphs 13 and 14 of the general part of the CoP.

### Agricultural measures (Growing/harvesting practices)

4. Refer to paragraphs 14, 16-18, 20-26, and 30 of the general part of the CoP .

5. Testing of soil for arsenic concentrations, together with other soil properties (para. 17) may be important given the challenge of mitigating both cadmium and arsenic.

6. For rice crops, adjusting soil pH may not be sufficient to reduce cadmium (see para. 25) and this may need to be combined with flooding management.

7. Irrigation or flooding management can significantly affect the mobility of cadmium in rice paddy soil by modifying soil redox potential. Cadmium concentrations in rice plants can be significantly reduced under flooded conditions, due to cadmium complexing with sulfide in the soil and becoming insoluble, reducing its phytoavailability to rice plants.

8. However, when applying irrigation management techniques such as flooding to reduce cadmium, consideration needs to be given to the soil properties and the effect of flooding on arsenic uptake. If arsenic concentrations in rice are of concern in a geographic region, risk managers should ensure that implementation of cadmium control measures would not increase arsenic concentrations in rice to unsafe levels

9. Likewise, risk managers should ensure that arsenic rice control measures (e.g. *Code of practice for the prevention and reduction of arsenic contamination in* rice (CXC 77-2017)) do not increase cadmium uptake. In regions with calcareous soils, when fields are drained during rice growing to reduce arsenic levels, cadmium levels are not increased. However, in other regions with non-calcareous soils, and when managed at acidic pH, draining the field to minimize arsenic uptake during rice growing can significantly increase cadmium uptake.

10. Therefore, when growing rice in non-calcareous soil conditions, controlling flooding cycles to increase time spent in flooded conditions (e.g. three weeks before and after the flowering period) can limit cadmium absorption into plants, as cadmium is less phytoavailable under flooded, anaerobic conditions.

11. If cadmium levels in soil and in irrigation water are low, the increase in cadmium in rice resulting from alternate-wet drying irrigation (where fields are drained and reflooded one or more times during a growing season) can maintain low cadmium levels in the rice.

12. Since low-cadmium rice varieties tend to produce low cadmium rice even under aerobic soil conditions such as intermittent irrigation, flooding management may not need to be implemented to suppress cadmium absorption.

13. In fields where there is a manganese deficiency (an essential element for plant growth) and the rice being grown is a low-cadmium rice variety with a defect in the OsNRAMP5 gene, additional manganese may need to be added, as these low-cadmium rice varieties have reduced uptake of manganese in comparison to conventional rice varieties.

14. When using low-cadmium rice varieties, it is important to introduce varieties that are suitable to the growing regions and to evaluate the yield and growth of the varieties planted.

15. When managing cadmium levels in rice, multiple mitigation measures may be needed including the use of amendments to increase pH (for example, calcium carbonate), combined with low cadmium accumulation cultivars, and use of delayed drainage of paddy water during late grain filling phase (i.e., when rice grains form) to reduce cadmium grain levels.

16. If growing rice under flooded conditions does not reduce cadmium, consider covering cadmium-contaminated farmland with lower cadmium-containing soil to remediate the soil. Because paddy rice roots are usually found within 20 cm of the soil surface, even if the soil is contaminated with cadmium, it is possible to reduce cadmium in the rice crop layer to uncontaminated levels by covering with 20 to 40 cm of uncontaminated soil. However, such measures are expensive and not practical on large fields.

17. For specific growing regions, farmers/extension services should consult available regional-specific cadmium mitigation guidance documents to provide advice on the local conditions for growing and harvesting lower cadmium rice.

**Post-harvesting and processing**

18. Refer to paragraphs 48-50 of the general part of the CoP .

19. Polishing of rice may reduce cadmium concentrations, as the cadmium concentrations may be higher in the outer layers of the grain compared to the inner parts. For example, polishing rice may reduce cadmium concentrations 20-40%.

20. Washing rice using clean water prior to cooking can be used to decrease cadmium concentrations in the rice. Where practical, cooking rice in excess water (6 to 10 parts water to 1 part rice), then draining the excess water prior to consumption, may reduce cadmium in rice by 10 to 15%.

**APPENDIX II**

**References for Seaweed and Rice Annexes**

**(For information)**


1. McHugh 2004. A guide to the seaweed industry. FAO Fisheries Technical Paper. 441. (See para. 2)
2. European Commission. 2018. Commission recommendation (2018/464) on the monitoring of metals and iodine in seaweed, halophytes and products based on seaweed.

   https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018H0464&from=EN; FAO/WHO 2022. Report of the Expert Meeting on Food Safety for Seaweed. Current Status and Future Perspectives. October 28-29, 2021 (Table 15). (See para. 4)
3. FAO/WHO 2022. (See para. 5)
4. Concepcion et al. 2020. Seaweed production and processing in Connecticut: A guide to understanding and controlling potential food safety hazards. Groton, Connecticut. uconn.edu/wp-content/uploads/sites/1985/2020/01/Seaweed-Hazards-Guide_Jan2020_accessible.pdf. (See para. 6)
5. Food Safety Authority of Ireland. 2020. Safety considerations of seaweed and seaweed-derived foods available on this Irish Market; FAO/WHO 2022. Report of the Expert Meeting on Food Safety for Seaweed. Current Status and Future Perspectives. October 28-29, 2021; FAO/WHO 2022. Report of the Expert Meeting on Food Safety for Seaweed. Current Status and Future Perspectives. October 28-29, 2021. (See para. 8)
6. Roleda et al. 2019. Variations in polyphenol and heavy metal contents of wild-harvested and cultivated seaweed bulk biomass: health risk assessment and implication for food applications. Food Control. 95: 121-124; Circuncisao et al. 2018. Minerals from macroalgae origin: health benefits and risks for consumers. Marine Drugs. 16: 400. (See para. 8)
7. Stevant, P. et al. 2018. Biomass soaking treatments to reduce potentially undesirable compounds in the edible seaweeds sugar kelp (*Saccharina latissimi*) and winged kelp (*Alaria esculenta*) and health risk estimation for human consumption. Journal of Applied Phycology. 30: 2047-2060. (See para. 9)
8. Banach et al. 2024. A case study on Norwegian commercial harvesting and production of Saccharina latissimi (Part 1): Effect of processing seaweed on chemical hazards, allergens, and microbiological hazards. Food Control. 162: 110461. (See para 11)
9. Hussain et al. 2020. Strategies for reducing cadmium accumulation in rice grains. Journal of Cleaner Production. 286: 12557. (See para. 7)
10. Japan Ministry of Agriculture, Forestry and Fisheries. 2018. Implementation guidelines for the reduction of cadmium in rice. (See para 12)
11. Japan Ministry of Agriculture, Forestry and Fisheries. 2018. Implementation guidelines for the reduction of cadmium in rice. (See para 13)
12. Japan Ministry of Agriculture, Forestry and Fisheries. 2018. Implementation guidelines for the reduction of cadmium in rice. (See para 14)
13. Chen et al. 2018. Effective methods to reduce cadmium accumulation in rice grain. Chemosphere. 207: 699-707. (See para 15)
14. MAFF, Japan. Implementation guidelines for reduction of cadmium in rice. (See para 17)
15. Meharg et al. 2013. Variation in rice cadmium related to human exposure. Environmental Science & Technology. 47: 5613-5618. (See para 19)
16. Gu et al. 2020. Chemical speciation and distribution of cadmium in rice grain and implications for bioavailability to humans. Environmental Science and Technology. 54: 12072-12080. (See para 19)
17. Gray et al. 2015 Cooking rice in excess water reduces both arsenic and enriched vitamins in the cooked grain. Food Additives & Contaminants: Part A. 33(1): 78-85. (See para 20)

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