CODEX ALIMENTARIUS COMMISSION

Food and Agriculture Organization of the United Nations

World Health Organization

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CODEX COMMITTEE ON CONTAMINANTS IN FOODS

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DISCUSSION PAPER ON THE DEVELOPMENT OF A CODE OF PRACTICE FOR THE PREVENTION AND REDUCTION OF CADMIUM CONTAMINATION IN FOODS

(Prepared by the United States of America)

Codex members and observers wishing to submit comments on the recommendations in Appendix I, paragraphs 7-10, of should do so as instructed in CL 2024/26-CF available on the Codex webpage[1]

Background

1. The 16th Session of the Codex Committee on Contaminants in Foods (CCCF16, 2023) agreed that the United States of America (USA) would prepare a discussion paper on a possible 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 development of this discussion paper follows from recommendations from the European Union (EU) and Japan in response to CL 2022/85-CF on the Review of Codex Standards for Contaminants[2], that a CoP should be considered prior to review/revision of cadmium maximum levels (MLs). This work also builds on previous work on cadmium, most recently development of the *Code of Practice for the Prevention and Reduction of Cadmium Contamination in Cocoa Beans* (CXC 81-2022).

3. Although no electronic working group (EWG) was established, the USA received input on cadmium sources and mitigation measures from the following member countries: Canada, Japan, New Zealand, and Peru, who led the development of the CoP to prevent and reduce cadmium contamination in cocoa beans.

4. The aim of this discussion paper is to present the issues and approaches to support the development of a code of practice for the prevention and reduction of cadmium contamination in foods (Appendix I). Much of the information presented was gathered from the available literature and from input provided by the above-mentioned countries. The information has been used to draft an initial code of practice to prevent and reduce cadmium contamination in foods (Appendix III). A project document to develop a CoP based on the information provided is presented in Appendix II.

[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] CX/CF 23/16/14

APPENDIX I
DISCUSSION PAPER

(For consideration by CCCF)

BACKGROUND

1. Cadmium levels in foods can vary widely depending on the characteristics of agricultural regions, including the levels of naturally occurring cadmium in the soil and varying contributions of cadmium in soil and water from human activities. Cadmium uptake by crops or aquaculture can also be affected by the bioavailability of cadmium depending on soil and water chemistry. Also, different crops and aquatic species have different propensities to uptake and accumulate cadmium. As a result, some mitigation methods are specific to particular crops, such as cocoa beans. A number of member countries and organizations have developed cadmium-specific guidance including for rice, soybeans, potatoes, and leafy greens. Because of the variation in mitigation methods as well as the cadmium distribution in foods, it may be beneficial to include annexes in a CoP with commodity-specific recommendations for cadmium reduction measures.[1]

LITERATURE REVIEW

2. The United States of America (USA) reviewed available literature on risk management practices to prevent or reduce cadmium contamination in foods as well as information provided by a limited number of Codex members and produced an initial code of practice (CoP) that can constitute the basis for further development in an Electronic Working Group (EWG) if new work is recommended by the Codex Committee on Contaminants in Foods (CCCF) for approval by the Codex Alimentarius Commission (CAC) in 2024.

3. The proposed CoP presents cadmium reduction measures for consideration by CCCF and is presented in Appendix III for information. Measures addressed include agricultural and aquacultural techniques, food processing modifications, and consumer practices which are based on a literature review of cadmium sources and mitigation measures. The references are indicated here below and are linked to the relevant sections/paragraphs in the CoP.

CONCLUSIONS

4. Based on risk management practices identified from the literature review and information provided by certain Codex members, there are sufficient data to support an initial CoP that addresses the prevention and reduction of cadmium contamination in foods.

5. More information from member countries would however be needed to further develop the CoP. Issuance of a circular letter (CL) requesting information from member countries on national cadmium reduction practices would be helpful following agreement of CCCF on the development of a CoP using the draft presented in Appendix III.

6. In addition, input on whether there is a need for development of annexes to this CoP that could contain commodity-specific recommendations that could be incorporated currently and in the future.

RECOMMENDATIONS

7. CCCF is invited to consider if there is sufficient information available on cadmium sources and mitigation measures, based on the information provided in Appendices I and III, to recommend development of a Code of Practice for the Prevention and Reduction of Cadmium Contamination in Foods.

8. If CCCF agrees to develop the CoP, to consider the need for development of annexes to a CoP that could contain commodity-specific recommendations, similar to the *Code of Practice for the Prevention and Reduction of Mycotoxin Contamination in Cereals* (CXC 51-2003).

9. If CCCF supports use of annexes:

9.1 to advise on whether the recently completed *Code of Practice for the Prevention and Reduction of Cadmium Contamination in Cocoa Beans* should be maintained as a separate document or adapted as an annex.

9.2 to indicate if there is any adjustment that would be needed to the approach outlined in Appendix III, in order to support the use of commodity-specific annexes

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[1] EFSA. 2014. Commission recommendation of 4 April 2014 on the reduction of the presence of cadmium in foodstuffs. Office Journal of the European Union. L 104/80. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014H0193.

10. Based on these recommendations, CCCF is invited to:

10.1 review the project document accordingly in order to forward it to the Executive Committee (CCEXEC) and the Commission for approval as new work for the Committee (see Appendix II); and

10.2 consider the issuance of a circular letter following CCCF17 to support the further development of the CoP by an electronic working group for consideration by CCCF18.

REFERENCES for
Proposed CoP – Appendix III

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2. World Health Organization. 2011. Safety evaluation of certain food additives and contaminants. Prepared by the Seventy-third meeting of the Joint FAO/WHO Expert Committee on Food Additives (JECFA). Cadmium (p.305-380). https://apps.who.int/food-additives-contaminants-jecfa-database/Home/Chemical/1376; WHO 2022. Evaluation of certain food additives and contaminants. Ninety-first report of the Joint FAO/WHO Expert Committee on Food Additives. https://www.who.int/publications/i/item/9789240054585. (See para. 3)

3. CXC 81-2022 (See para. 5)

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APPENDIX II

PROJECT DOCUMENT

Proposal for new work on a

Code of Practice for the Prevention and Reduction of Cadmium Contamination in Foods

(For consideration by CCCF)

1. Purpose and scope of the project

The purpose of the proposed new work is to develop a code of practice (CoP) to prevent or reduce cadmium contamination in foods. The scope of the work encompasses reduction of cadmium contamination during agricultural and aquacultural production and food processing, preparation, packaging, and transport.

2. Relevance and timeliness

The 73rd Meeting of the Joint FAO/WHO Expert Committee on Food Additives (JECFA73, 2011) conducted a re-evaluation of cadmium and established a provisional tolerable monthly intake (PTMI) of 25 µg/kg bw, reflecting the long half-life of cadmium in humans. Dietary exposure estimates indicated that cereals and cereal products, vegetables, seafood, and meat, including offal, were the major contributors to cadmium dietary exposure.

JECFA77 (2013) assessed dietary exposure to cadmium from cocoa and cocoa products following a request arising from the 6th Session of the Codex Committee on Contaminants in Foods (CCCF6, 2012). JECFA estimated total dietary cadmium exposure as 30-69% of the PTMI for adults and 96% for children aged 0.5-12 years. JECFA noted that these percentages were likely overestimates of total dietary cadmium exposure, as the estimates from the whole diet also included the contribution from cocoa and cocoa products.

JECFA91 (2021) conducted a new exposure assessment that included the contribution of cadmium from all food sources, in particular cocoa products. This assessment was based on more comprehensive occurrence data, including a wider geographical range of occurrence data in cocoa products. JECFA concluded that the major contributors to dietary cadmium exposure were cereals and cereal products, vegetables, and seafood, while the contribution of cocoa products to dietary cadmium exposure was minor (0.1-9.4%).

Between 2018 and 2022, CCCF adopted maximum levels (MLs) for cadmium in chocolate containing or declaring <30%, ≥ 30% to ≤50%, ≥ 50% to < 70%, and ≥ 70% total cocoa solids, and 100% cocoa powder, as well as the *Code of Practice for the Prevention and Reduction of Cadmium Contamination in Cocoa Beans*.

The new work aims to reduce exposures that may cause exceedance of the PTMI, through the development of a CoP that covers cadmium contamination in a range of foods in addition to cocoa beans.

Comments in response to a circular letter on the review of Codex standards for contaminants issued in 2022 (CL 2022/85-CF) suggested that a CoP should be considered prior to review/revision of current cadmium MLs as provided in a conference room document submitted to CCCF16 (2023) (CF16/CRD02).

3. Main aspects to be covered

This work will address measures, supported by scientific data, that prevent or reduce cadmium contamination. Measures to be addressed may include agricultural techniques (e.g. fertilization, irrigation), source-directed measures (reduction of cadmium in soil and water), and food processing modifications (e.g. use of filtration aids in juices and washing techniques for seaweed).

4. Assessment against the criteria for the establishment of work priorities

a. Consumer protection from the point of view of health and fraudulent practices.

To protect consumers' health, exposures to cadmium should be reduced through best practices. A CoP to reduce cadmium will identify measures that can be taken to reduce exposures.

b. Diversification of national legislations and apparent resultant or potential impediments to international trade.

Development of a CoP is needed to ensure that information on recommended practices for preventing and reducing cadmium exposures is available to all member countries. It also will provide the means to enable exporters to ensure reduced cadmium levels and to assist in compliance with any current MLs and those that may be established in the future.

c. Scope of work and establishment of priorities between the various sections of the work.

The CoP will provide measures to reduce cadmium in food, as it will address all aspects of food production from agricultural production to processing to packaging and transport.

d. Work already undertaken by other international organizations in this field.

Health-based guidance that address cadmium exposures have been developed for workplaces, for drinking water (e.g. WHO), and for agriculture (e.g. United Kingdom's Code of Agricultural Practice for Farmers, Growers, and Land Managers).

5. Relevance to Codex Strategic Goals

Goal 1: Address current, emerging, and critical issues in a timely manner.

Establishing a CoP for the prevention and reduction of cadmium contamination in foods will address the current need for guidance to ensure the health protection of consumers.

Goal 2: Develop standards based on science and Codex risk-analysis principles. This work will apply risk analysis principles in the development of a CoP by using scientific data and results from JECFA assessments to support the reduction of cadmium in foods.

Goal 3: Increase impact through the recognition and use of Codex standards. The proposed CoP ensures that information on recommended practices to prevent and reduce cadmium consists of current best practices and are available to all member countries.

Goal 4: Facilitate the participation of all Codex Members throughout the standard process. Developing a CoP through the Codex step process will make information on recommended practices to prevent and reduce cadmium available to all Codex members.

Goal 5: Enhance the work management systems and practices that support the efficient and effective achievement of all strategic plan goals. A CoP will help ensure development and implementation of effective and efficient work management systems and practices by providing basic guidance for countries and producers.

6. Information on the relationship between the proposal and other existing Codex documents. In 2022, Codex adopted the *Code of Practice for the Prevention and Reduction of Cadmium Contamination in Cocoa Beans* (CXC 81-2022). This CoP is specific to cocoa beans and does not provide information about other crops.

Cadmium MLs have been established for a variety of foods in the GSCTFF (CXS193-1995) (e.g. chocolate and cocoa products, vegetables, grains, seafood, salt) without a CoP being available.

7. Identification of any requirement for any availability of expert scientific advice

JECFA has already provided needed expert scientific advice (e.g. JECFA73, JECFA77, JECFA91).

8. Identification of any need for technical input to the standard from external bodies

Currently, there is no identified need for additional technical input from external bodies.

9. Timeline for completion of the new work

Work will commence following recommendation by CCCF and approval by the Codex Alimentarius Commission in 2024. Completion of work is expected by 2027.

APPENDIX III:

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

(For information)

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. Cadmium exposure is associated with adverse effects on kidneys, bones, and the cardiovascular system, and has carcinogenic effects. Cadmium is relatively poorly absorbed into the body, but once absorbed it is slowly excreted, with a half-life of 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, jewellery, and pigments used on pottery finishes, glassware, and on certain plastics). Food is the primary source of cadmium exposure for most people, with the exception of smokers or individuals with occupational exposures.

3. The Joint FAO/WHO Expert Committee on Food Additives (JECFA) completed evaluations 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 exposures. 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. Between 2001-2006, the Codex Committee on Contaminants in Foods (CCCF) established maximum levels (MLs) for cadmium in the *General Standard for Contaminants and Toxins in Food and Feed* (CXS 193-1995), including for leafy vegetables, stalk and stem vegetables, root and tuber vegetables, cereal grains, bivalve molluscs, and cephalopods. Between 2018-2022, CCCF adopted MLs for cadmium in cocoa powder and in chocolate containing or declaring different percentages of total cocoa solids. There are also MLs for cadmium in natural mineral waters and salt (food grade), which were taken up from commodity standards adopted in 1981 and 1987, respectively.

5. In 2022, the Codex Alimentarius Commission adopted the *Code of Practice for the Prevention and Reduction of Cadmium Contamination in Cocoa Beans*.

6. 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). Wild mushrooms and rice, grown in certain geographic regions with higher cadmium, may also contain elevated concentrations. For rice, if cadmium concentrations are of concern in a geographic region, care needs to be taken to ensure that arsenic levels are not increased with mitigation of cadmium.

7. Cadmium presence in food arises from numerous sources including soil and air. Cadmium occurs naturally in soil from the weathering of sedimentary and shale rocks. Soil cadmium also results from mining and smelting operations, sewage sludge, manure, and phosphate fertilizers. Agricultural crops can take up cadmium from the soil. Atmospheric particles of cadmium from soil dust and from industrial activities (e.g. mining) can deposit on plant surfaces (e.g. leafy greens, wheat). Crops and soil containing cadmium are also a source of contamination of livestock who may eat contaminated crops and soil.

8. Water is also a source of cadmium contamination of food. Agricultural crops can take up cadmium from irrigation water. Surface waters contaminated with run-off 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.

9. 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. Brightly coloured ceramicware, glassware, and plastic tableware for food preparation or food packaging can sometimes be a potential source of cadmium in foods, with migration and exposure controlled through adherence to proper manufacturing and labelling procedures.

10. Public health efforts through tobacco smoking cessation, air pollution reduction, hazardous waste remediation, and renovation of drinking water infrastructure have led to decreases in cadmium exposures in some populations. Reductions in cadmium levels in certain agricultural crops have resulted from particular targeted efforts (e.g. durum wheat in Canada, certain crops in Australia).

11. Cadmium levels in foods can vary widely depending on the characteristics of agricultural regions, including the levels of naturally occurring cadmium in the soil and varying contributions of cadmium in soil and water from human activities (e.g. use of sewage sludge or phosphate fertilizers). Cadmium uptake by crops or aquaculture can also be affected by the bioavailability of cadmium depending on soil and water chemistry (e.g. pH, chlorinity). Also, different crops and aquatic species have different propensities to uptake and accumulate cadmium.

RECOMMENDED PRACTICES BASED ON GOOD AGRICULTURAL PRACTICES (GAP) AND GOOD MANUFACTURING PRACTICES (GMP)

1.1 Source directed measures

12. National or relevant food control authorities should consider implementation of source-directed measures in the *Code of Practice for Source Directed Measures to Reduce Contamination in Foods with Chemicals* (CXC 49-2001).

1.2 Agricultural

13. In agricultural soils, cadmium levels can increase as a result of atmospheric deposition (e.g. forest fires and air pollution), application of sewage sludge and manure, use of phosphate fertilizers, and flooding with water contaminated with cadmium. Also, pastures and cropland near rivers contaminated from mines or other industrial activities can lead to elevated cadmium levels in crops and livestock.

14. Because cadmium uptake in crops is influenced by soil properties, including pH, organic carbon and zinc content, cation exchange capacity, clay content, and oxides of Fe, Al, and Mn, it is important that soil testing be conducted to assess mitigation options if cadmium levels in crops, are a concern.

15. Before planting a new field with crops that are prone to elevated cadmium levels (e.g. leafy greens and root vegetables), it is important to review historical data, including established maps, to determine if the location is in an area with known elevated cadmium levels. Cadmium levels can also vary within a field, so specific information on cadmium levels across a field may be helpful, if available.

16. Establish agricultural crops, if possible, in areas away from roads or take measures 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.

17. Depending on till depth, soil inputs such as fertilizers or composts may or may not result in cadmium levels at the root level. It is important to ensure that soil cadmium is managed at the root level. Also, when applying soil inputs, consider that cadmium can accumulate in soil over time.

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

19. Manures and composts may also contain cadmium. In agricultural areas with known high cadmium soil levels, ensure that fertilizers and manures that are low in cadmium are used. For example, the use of potassium and nitrogen fertilizers may be preferable over phosphate fertilizers where cadmium soil levels are a concern.

20. Given that certain crops are more susceptible to cadmium uptake and particular varieties (cultivars) uptake more cadmium, it may be preferable to plant crops and crop varieties with lower cadmium uptake on soil known to contain high levels of cadmium, while considering the need for crop rotation.

21. Cadmium bioavailability to crops is strongly affected by pH of soil at the root level. Cadmium is most mobile in acidic soils with a pH less than 5.5, while in more alkaline soil (pH greater than 6) cadmium is less mobile, binding to organic matter and other minerals. Use of 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.

22. When there is a deficiency of zinc in the soil, soil zinc levels should be increased. Cadmium competes with zinc for uptake by plant, and cadmium is more likely to enter crops and accumulate in plants when zinc soil concentration is low.

23. A greater amount of soil organic matter may increase soil cadmium adsorption and thus may help to decrease cadmium in crops. The use of organic fertilizers such as treated manure or compost increases the organic matter content of the soil and improves its microbiological activity.

24. The application of soil amendments (e.g. magnesium, sulphate, humus, charcoal, dolomitic limestone) and zinc sulphate can decrease cadmium concentrations in crops. The choice of amendments varies depending on the characteristics of the soil and the crops.

25. When growing rice, controlling flooding cycles to increase time spent in flooded conditions can limit cadmium absorption into plants, as cadmium is less bioavailable under flooded, anaerobic conditions.

26. Recommendations identified in the *Code of Practice for the Prevention and Reduction of Cadmium Contamination in Cocoa Beans* (CXC 81-2022) to reduce cadmium levels during cocoa growing include use of cover crops to improve soil organic matter and to protect soil from erosion, removal of pruned cocoa limbs and leaves from the ground, and mucilage draining of cocoa beans during fermentation.

27. Cadmium uptake in crops is also affected by chloride content of irrigation water and soil, as higher chloride levels can increase cadmium bioavailability. It is important to monitor chlorinity of irrigation water and soil to minimize cadmium uptake.

28. Livestock may take up cadmium by ingesting soil or water during grazing, consuming crops contaminated with cadmium, or consuming fertilizer directly. Because cadmium tends to accumulate in the kidneys (and to a lesser extent liver) over time, it may be prudent for cattle grown in areas with high cadmium soil levels and where kidney consumption is common, for kidneys of older cattle (> 2 years) to be excluded from the food chain.

29. Cadmium levels in offal should not exceed national or regional levels, and where no levels exist, cadmium levels in offal should be as low as reasonably achievable.

30. Mineral additives used in animal feed, such as phosphates, zinc sulphate, or zinc oxide, may contain cadmium impurities. Levels of cadmium in these additives should conform with regional and national standards to ensure animals are not consuming excess quantities of cadmium, and when no standards exist, cadmium levels should be as low as reasonably achievable.

31. Ensure livestock do not have access to farm rubbish (e.g. discarded metal such as galvanized iron) that may be a source of cadmium.

32. Local and national authorities should make farmers aware of appropriate practices for reducing and preventing cadmium contamination of livestock and crops.

Farmed and Wild-caught Seafood

33. Cadmium tends to bioaccumulate in the viscera of seafood. For seafood that is consumed whole, gutting the viscera prior to consumption can reduce cadmium exposure. For example, scallop processors in Greenland may remove scallop kidneys, which can contain high levels of cadmium, before sale. Seafood processors can use this practice to ensure reductions in cadmium levels that meet trade requirements.

34. "Brown crab meat" or the cephalothorax of crabs 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.

35. Agricultural runoff 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.

36. Given factors affecting cadmium levels in seafood, including characteristics of the aquatic system, proximity to cadmium sources, and dietary patterns of the population, regional-specific mitigation measures, such as consumer advice, or regional standards may be most appropriate.

37. Seaweed is known to bioaccumulate cadmium from seawater, with levels varying significantly based on seaweed type, geographic origin, age of seaweed, proximity to human activity, and seasonal variation. In the absence of Codex and regional standards for cadmium in seaweed, country-specific regulatory limits and consumption advisories may be the most appropriate means of reducing exposures. For example, France has a recommended limit for cadmium in edible seaweed.

38. Growing seaweed in aquatic environments that have lower cadmium levels reduces the potential for elevated cadmium in the seaweed. This includes minimizing use of fertilizers containing cadmium when growing seaweed in land-based tanks.

39. Washing or soaking seaweed during processing can help reduce cadmium levels in the finished products. For example, soaking seaweed in NaCl solution significantly reduced cadmium levels in *A. esculenta*, although the authors reported that additional soaking or rinsing treatments may be needed to reduce the Na levels in the seaweed.

40. Fermenting seaweed (*Saccharina latissimi)* using lactic acid bacteria has been found to reduce cadmium levels, although the mechanism behind this reduction needs further study. Other studies have demonstrated that binding of cadmium to seaweed is reduced with lower pH.

Drinking water

41. Cadmium in drinking water 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 water usage affect cadmium levels in drinking water.

42. Administrators of water systems with high cadmium levels should replace, where appropriate, problematic galvanized steel service lines, pipes, or components. The corrosivity (e.g. low pH) of the water should be monitored.

43. National or local authorities should consider establishing allowable cadmium levels or appropriate treatment techniques for controlling cadmium levels in drinking water. The WHO has established a guideline value for maximum cadmium levels in drinking water of 0.003 mg/L.

Food ingredients and processing

44. Food producers should limit cadmium in foods to levels below recommended maximum levels (MLs) in the *General Standard for Contaminants and Toxins in Food and Feed* (CXS 193-1995) or standards established by national or local authorities for foods and food additives; this is particularly important for foods intended for infants and children.

45. Where standards are not available, national, or local authorities should consider establishing standards limiting the concentration of cadmium allowed in foods. In the absence of standards, national or local authorities or industry should 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.

46. 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 land used to produce crops or aquacultural areas where seaweed or shellfish are farmed may contain elevated cadmium levels.

47. 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.

48. 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.

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

50. During processing, removal of surface cadmium should be practiced, including by thoroughly washing vegetables, particularly leafy vegetables, and removing the outer leaves of leafy vegetables. Peeling root vegetables, where appropriate, can reduce cadmium levels. Higher levels of cadmium have been found in the skin versus potato flesh.

51. Washing rice prior to cooking has been found to significantly decrease cadmium concentrations in the rice.

52. Milling of grains can reduce cadmium concentrations, as the highest cadmium concentrations are generally found in the outer layers of the grain. For example, milling rice has been shown to reduce cadmium concentrations 20-40%. Similarly, milling durum wheat has been shown to decrease cadmium levels 29-37% in semolina in comparison to the grain.

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

54. Food processors should use food-grade metals for all metal surfaces that come into contact with food and beverages. 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.

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

56. National and local 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

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

58. 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.

59. National and local authorities should consider setting standards for cadmium migration from cadmium-glazed ceramic ware and other cadmium-containing items, such as plastics and glassware, that might potentially be used for food storage, food preparation, or tableware.

60. National and local authorities could consider implementing supply chain controls pertaining to the quality and composition of raw materials (including labelling to declare such compliance) used in manufacture of food packaging and storage products for foods.

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

Consumer practices and consideration of certain foods

62. Consumers should wash vegetables and fruit thoroughly to remove dust and soil that may contain cadmium. Removing outer leaves from leafy greens and peeling root crops can reduce cadmium levels. Washing hands before preparing food will also help remove any cadmium-containing dust or soil from hands.

63. National or local authorities should educate people about the potential risks of consuming local specialty foods or collected wild foods (e.g. mushrooms) that could contain elevated cadmium levels.