

# C O D E X   A L I M E N T A R I U S

INTERNATIONAL FOOD STANDARDS



Food and Agriculture  
Organization of  
the United Nations



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Organization

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## **CODE OF PRACTICE FOR THE PREVENTION AND REDUCTION OF ARSENIC CONTAMINATION IN RICE**

**CXC 77-2017**

**Adopted in 2017.**

## 1. INTRODUCTION

- 1.1 Arsenic is a toxic metalloid that may be found in various foods, including rice. Soil in rice paddy fields can contain naturally occurring arsenic and also can be polluted by irrigation water, rain and air that are contaminated with arsenic from anthropogenic sources such as mining and smelting and materials for agricultural and livestock production. Rice plants absorb arsenic from soil, especially when soil is in reducing conditions, and accumulate it in grain and straw. Rice may contain inorganic arsenic (arsenite and arsenate) and organic arsenic (monomethylarsonic acid and dimethylarsinic acid).
- 1.2 The effectiveness of measures in the Code of Practice can vary depending on local environmental conditions (e.g. soil properties, management regimes and, temperature). Field studies should be conducted to identify measures that are feasible and effective for local or regional conditions. If possible, the field studies should be conducted across crop years because arsenic uptake in rice crops is highly variable from year to year. Implementation of measures that unnecessarily restrict supply of rice to the market should be avoided.

## 2. SCOPE

- 2.1 The Code intends to provide national or relevant food control authorities, producers, manufacturers and other relevant bodies with guidance to prevent and reduce arsenic contamination in rice as follows:
- (i) Source directed measures; and
  - (ii) Agricultural measures
- 2.2 The Code also includes guidance on monitoring and risk communication.

## 3. DEFINITIONS

- 3.1 **Paddy rice**(rice grain) is rice (species *Oryza sativa* L.) which has retained its husk after threshing (GC 0649<sup>1</sup>).
- 3.2 **Husked rice** (brown rice or cargo rice) is paddy rice from which the husk only has been removed. The process of husking and handling may result in some loss of bran (CM 0649<sup>1</sup>).
- 3.3 **Polished rice**(milled rice or white rice) is husked rice from which all or part of the bran and germ have been removed by milling (CM 1205<sup>1</sup>).
- 3.4 **Arsenic** is a metalloid and is found in the environment both from natural occurrence and from anthropogenic activity.
- Note:** In this paper, the term “arsenic” refers to inorganic and organic arsenic.
- 3.5 **Organic arsenic** is an arsenic compound that contains carbon, including monomethylarsonic acid and dimethylarsinic acid.
- 3.6 **Inorganic arsenic** is an arsenic compound that does not contain carbon. Arsenite (As(III)) and Arsenate (As(V)) are the inorganic arsenic compounds typically found in rice. Inorganic arsenic is considered the significant toxic form of arsenic in rice.
- 3.7 **Flooded condition** is a condition in which a paddy field is filled or covered with water during growth.
- 3.8 **Aerobic condition** of soil is a condition in which a paddy field, where rice is grown, is well drained, non-flooded or unsaturated.

- 3.9 **Intermittent ponding** means a variety of possible water management practices in which a paddy field is alternately in flooded and aerobic/non-flooded condition.

## 4. MEASURES TO PREVENT AND REDUCE ARSENIC CONTAMINATION

- 4.1 Inorganic arsenic is the most toxic form of arsenic in rice. Measures to reduce arsenic levels (e.g. aerobic growth) may affect inorganic and organic arsenic differently. The most important goal is to reduce inorganic arsenic levels in rice.
- 4.2 Measures to prevent and reduce arsenic contamination in rice are recommended particularly on highly contaminated areas. National or relevant food control authorities may consider implementing the measures in Section 4.3 as a priority. The measures in Section 4.4 may be implemented if necessary.

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<sup>1</sup> Classification of Foods and Animal Feeds (CXM 4-1989)

### 4.3 Source Directed Measures

**4.3.1** Sources of arsenic in the environment are: 1) natural sources, including volcanic action, elution from soil or sediment such as Holocene sediments, geogenic weathering and low temperature volatilization; and 2) anthropogenic sources, including emission from industries, especially from mining and smelting of non-ferrous metals; burning of fossil fuels; use of arsenic pesticides; and disposal of timber treated with copper chrome arsenate (CCA). In the paddy environment, use of soil amendments and fertilizers contaminated with significant concentration of arsenic are also sources of arsenic<sup>2</sup>.

**4.3.2** 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). In particular, authorities can consider whether measures in the following areas are appropriate for their countries:

- Irrigation water:
  - Identification of irrigation water with high arsenic concentration.
  - Reduction of arsenic from irrigation water with high arsenic concentration.
  - Avoidance of use of irrigation water with high arsenic concentration for rice production.
- Paddy field:
  - Identification of paddy fields in which arsenic concentration in soil is high and/or where rice with a high concentration of inorganic arsenic is produced.
- Identification and control of potential sources of arsenic:
  - Atmospheric emissions and waste water from industries.
  - Materials used in agricultural and livestock production such as pesticides, veterinary medicines, feed, soil amendments and fertilizers.
  - Waste (such as timber treated with copper chrome arsenate).

### 4.4 Agricultural Measures

**4.4.1** National or relevant food control authorities should educate rice producers about practices to prevent and reduce arsenic concentration in rice. Education programmes may include:

- Publishing and disseminating technical guidance on rice cultivation techniques to reduce arsenic in rice.
- Establishing farmer field schools.

**4.4.2** Aerobic conditions or intermittent ponding during rice production, instead of flooded conditions, may reduce arsenic concentration while there is a possibility to increase cadmium concentration in rice. Studies have shown aerobic soils reduce arsenic uptake as compared to flooded soils even when there are high amounts of arsenic in the soil. Intermittent ponding can also reduce availability of arsenic for plant uptake compared to flooded soils.

**4.4.3** However, if cadmium concentrations in rice are of concern in a geographic region, risk managers should ensure that implementation of arsenic control measures would not increase cadmium concentrations in rice to unsafe levels<sup>3</sup>. If appropriate, risk managers may consider implementation of source directed measures for cadmium reduction in soil, water or fertilisers that are used for rice production<sup>4</sup>.

**4.4.4** It is also noted that implementation of aerobic or intermittent ponding conditions may result in a decrease in rice production in some areas and may not be an available practice in all areas. Aerobic growth may also have to be balanced with the use of flooding for weed control or temperature control in cooler areas.

**4.4.5** National or relevant food control authorities may identify rice cultivars with low arsenic uptake and/or low arsenic concentration and encourage public research institutes or private firms to develop such rice cultivars. Producers could select such rice cultivars, if available and suitable.

## 5. MONITORING

**5.1** The effectiveness of measures to reduce levels of arsenic should be monitored by determining the concentrations of inorganic arsenic in rice.

<sup>2</sup> Many fertilizers contain trace levels of arsenic. "Contaminated" should not be interpreted as equivalent to trace levels of arsenic.

<sup>3</sup> Use of some rice cultivars that absorb little amount of cadmium, if available, may be a solution.

<sup>4</sup> See the *Code of Practice concerning Source Directed Measures to Reduce Contamination of Foods with Chemicals* (CXC 49-2001).

- 5.2** If agricultural land or ground waters used for growing rice are widely contaminated by natural sources, non-point source or past activities, monitoring of arsenic concentrations in soil and/or irrigation water may also be necessary.

**6. RISK COMMUNICATION**

- 6.1** National or relevant food control authorities should consider sharing information on risks and benefits of consuming polished and/or husked rice among stakeholders in the light of arsenic concentrations and nutrient components, considering both concerns regarding arsenic concentrations and the nutritional benefits of rice consumption.
- 6.2** National or relevant food control authorities should consider sharing the following information with distributors and consumers and should consider encouraging them to implement practices that would reduce arsenic concentration during processing and cooking.
- 6.3** Polished rice contains less inorganic arsenic than husked rice, because polishing removes the bran layer which contains most of the inorganic arsenic. Husked rice polished at the higher polishing rate results in polished rice with lower arsenic concentrations. However, there are also benefits associated with consumption of husked rice.
- 6.4** Arsenic concentration in rice can be reduced by washing rice, applying “rinse-free”<sup>5</sup> treatment or cooking rice with large amounts of water followed by discarding excess water.
- 6.5** When water used for cooking is highly contaminated with arsenic, national or relevant food control authorities should inform consumers that they should avoid use of such water for washing and cooking rice, as rice absorbs arsenic in water. Consumers should be encouraged to use water for washing and cooking rice that contains lower concentration of arsenic.

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<sup>5</sup> “Rinse-free” rice, also known as “Museummai”, is rice in which bran that remains on the surface after polishing is completely removed and thus it is not necessary to wash before cooking.