CODEX ALIMENTARIUS COMMISSION

Food and Agriculture Organization of the United Nations

World Health Organization

Viale delle Terme di Caracalla, 00153 Rome, Italy - Tel: (+39) 06 57051 - E-mail: codex@fao.org - www.codexalimentarius.org

E

Agenda Item 9 **CX/CF 24/17/9**

January 2024

JOINT FAO/WHO FOOD STANDARDS PROGRAMME

CODEX COMMITTEE ON CONTAMINANTS IN FOODS

17th Session
15-19 April 2024
Panama City, Panama

CODE OF PRACTICE/GUIDELINES FOR THE PREVENTION OR REDUCTION OF CIGUATERA POISONING

(At Step 4)

(Prepared by the Electronic Working Group chaired by the United States of America and co-chaired by France, Panama, and Spain)

Codex members and observers wishing to submit comments at Step 3 on Code of Practice as presented in Appendix I should do so as instructed in CL 2024/06-CF available on the Codex webpage[1]

BACKGROUND

1. At the 32nd Session of the Codex Committee on Fisheries and Fishery Products (CCFFP32, 2016), the Pacific Nations raised ciguatera poisoning (CP) as an issue that is increasingly affecting the tropical and subtropical regions of the Pacific Ocean, Indian Ocean, and Caribbean Sea between the latitudes of 35°N and 35°S.

2. The issue of CP was discussed at the 11th Session of the Codex Committee on Contaminants in Foods (CCCF11, 2017)[2]. CCCF11 agreed to request scientific advice from FAO/WHO to enable the development of appropriate risk management options, resulting in the *2018 FAO/WHO Report of the Expert Meeting on Ciguatera Poisoning*.[3]

3. CCCF15 (2022) agreed to establish an electronic working group (EWG) chaired by the United States of America (USA) and co-chaired by the European Union (EU) to prepare a discussion paper on the development of a code of practice (CoP) or guidelines to prevent or reduce CP. The EWG was asked to build upon the work already undertaken by the FAO in collaboration with the International Atomic Energy Association (IAEA) and the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization (IOC-UNESCO).[4]

4. The EWG Chair and Co-Chair, prepared the paper on prevention or reduction of CP, including an outline of topics that could be included in a CoP, for discussion by CCCF16 (2023). CCCF16 agreed that there was general support to start work on a CoP to prevent or reduce CP, as CP is of major public health concern even though there are still some knowledge gaps/challenges. A Member questioned the appropriateness of a CoP noting the knowledge gaps and whether it would be more appropriate to work on Guidelines. CCCF16 agreed to be flexible on this matter for developing either a CoP or Guidelines.[5]

---

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 REP17/CF11, paras. 33-38

3 FAO and WHO. 2020. *Report of the Expert Meeting on Ciguatera Poisoning. Rome, 19–23 November 2018.* Food Safety and Quality No. 9. Rome.

4 REP22/CF15, para 224

5 REP23/CF16, paras. 70-80

5. CCCF16 agreed to:[6]

   i. Start new work on a CoP/Guidelines for the prevention or reduction of ciguatera poisoning;

   ii. Forward the project document to CAC46 for approval; and

   iii. Establish an EWG, chaired by USA and co-chaired by France, Spain, and Panama, working in English, to prepare a proposed CoP/Guidelines for comments and consideration by CCCF17.

6. The 46th Session of the Codex Alimentarius Commission (CAC46, 2023) approved new work on a CoP/Guidelines for the prevention or reduction of ciguatera poisoning.

WORK PROCESS

7. The EWG Chair along with the co-Chairs prepared two drafts of the document and requested comments from the EWG members via the Codex online forum. Comments on the first draft of the document were received from the following countries: Costa Rica, Japan, Netherlands, Spain, and Venezuela. Comments on the second draft of the document were received from the following countries: Germany, France, Netherlands, New Zealand, Singapore, and Spain.

8. EWG members were invited to contribute additional references and information that could be used in preparation of the document and to consider whether the document should be finalized as a CoP or guidelines.

KEY POINTS OF DISCUSSION

9. In developing the CoP, the EWG considered comments from the members and made the following conclusions:

- **Paragraph 2**: One country questioned whether the genus Fukuyoa should be mentioned, as the contribution of Fukuyoa to CP is not completely understood. There was general agreement that it is beneficial to retain mention of Fukuyoa in the CoP.

- **Paragraph 16**: Several EWG members supported the idea of using migratory patterns in the development of maps of toxic algae/fish, but the EWG did not identify any practical measures to include in the CoP. A general statement that migratory information may be useful for complex maps was included.

- **Paragraphs 30-31**: Several EWG members commented that details about analytical methods could be beneficial to the CoP. Others felt that the CoP should not include methods, as these could change over time and some current methods lack official validation. There was general agreement that a list of specific methods should not be included, but that the CoP could mention some types of methods that are applicable to CTX testing and refer to the methods presented in the 2020 *FAO/WHO Report of the Expert Meeting on Ciguatera Poisoning*.

- **Paragraphs 48-49**: Several EWG members supported the idea that human activity may impact prevalence of CP, but the EWG did not identify any practical measures related to monitoring or assessing human activity for CP reduction to include in the CoP. There was general agreement that the CoP could include a general statement that government officials could determine if changes to ecosystems are contributing to an increase in Gambierdiscus or Fukuyoa blooms or CTX-contaminated fish, and if steps can be taken to decrease these effects.

- **Annex I**: There was discussion about whether a list of marine organisms known or suspected to be associated with CP should be included in the CoP, given that it is not exhaustive, is included for example purposes only, and may become out of date. In addition, it is not common for Annexes to be included in Codex CoP documents. There was general agreement in the EWG that the Annex would be helpful and should be retained if possible.

CONCLUSIONS

10. The EWG concluded that a CoP would be appropriate for this work. The EWG also concluded that the CoP should include a list of marine organisms known or suspected to be associated with CP (Annex I), as well as a mention of general types of methods that are applicable to CTX testing, rather than a list of specific analytical methods.

11. The CoP is provided in Appendix I. The list of countries and observer organizations that joined the EWG can be found in Appendix II.

[6] REP23/CF16, para. 81

RECOMMENDATIONS

12. CCCF is invited to:

   i. Consider the CoP as set out in Appendix I and determine its readiness for advancement in the step procedure, and

   ii. If not ready for advancement, to identify key issues that would need further consideration in order to progress with the finalization of the CoP, including the decisions described in paragraph 9 above.

APPENDIX I

CODE OF PRACTICE FOR THE PREVENTION OR REDUCTION OF CIGUATERA POISONING

(For comments at Step 3)

I. Introduction

1. Ciguatoxins (CTXs) are a class of toxins produced by marine dinoflagellates. These toxins enter the food chain through consumption by herbivorous fish or shellfish and can bioaccumulate in higher trophic level predatory fish. Ciguatera poisoning (CP) is an illness resulting from human consumption of marine organisms, primarily fish and shellfish, that have accumulated CTXs. CP has become a global health issue and is increasing in prevalence. Coastal communities that rely on local fishing as a food supply and as a source of income are particularly at risk from increasing occurrences of CP. In 2018, FAO and WHO convened a joint expert meeting to perform an evaluation of CTX and provide guidance for development of risk management options (published in 2020 as *the Report of the Expert Meeting on Ciguatera Poisoning: Rome, 19-23 November 2018*).

2. The benthic dinoflagellate genus *Gambierdiscus* is the main producer of CTXs, and some species of *Fukuyoa* may also produce CTX-like toxins. These dinoflagellates tend to grow in tropical and subtropical marine environments, in calm waters and near shallow reefs. Benthic refers to their growth near the bottom of an aquatic environment; *Gambierdiscus* and *Fukuyoa* are also known to attach to various substrates (e.g., turf algae, macroalgae, and coral). Recent reports have identified these organisms in more temperate regions as well, including Korea, Japan, northern territories of New Zealand, southern Australia, the northern Gulf of Mexico, and the Mediterranean Sea, as sea temperatures rise as a result of climate change. CTXs were initially categorized as belonging to one of three major classes that corresponded with their global location; however, experts now recommend that toxins be categorized into four classes, derivatives of CTX-4A, CTX-3C, C-CTX, and I-CTX, according to their chemical structure (I-CTX structures have not been fully determined). CTXs are lipophilic, do not degrade under heat or mild pH changes, and are known to be resistant to degradation by cooking, freezing, or canning processes. They may undergo structural transformations as they are metabolized by marine organisms, often increasing in toxicity as they do so. More than 30 unique analogues of CTXs have been reported and many more have yet to be fully characterized.

3. CTXs can accumulate in herbivorous marine fish and other marine organisms, such as gastropods and bivalves, that feed in marine reef environments and consume CTX-containing benthic dinoflagellates. The impact to humans is primarily through fish, whereby humans consume wild-caught, herbivorous fish or predatory fish that have accumulated toxins from consumption of herbivorous fish (risk of intoxication from aquacultured fish is considered to be low). Size and age are believed to influence CTX accumulation; however, the diet of the individual fish is the primary contributor. CTXs are lipophilic and may be present in tissues such as meat (flesh), head, liver, viscera, and roe (eggs). The 2020 *FAO/WHO Report of the Expert Meeting on Ciguatera Poisoning* referenced more than 425 species of fish that have been identified as having been contaminated with CTXs, including examples such as barracuda, amberjack, grouper, snapper, and parrotfish. Many of these fish are territorial, which can help identify vulnerable fishing areas, though territories can overlap and change with time. CTXs do not appear to be fatal to fish and there are no outward signs that a fish has CTX contamination, such as change in behaviour, taste, odour, or texture; meaning that toxin analysis is required.

4. Humans experience CP when they consume fish or other marine organisms contaminated with CTXs. Generally, the symptoms of CP are acute and can appear within several hours of consuming contaminated food or up to 48 hours after consumption. CP symptoms include gastrointestinal issues (e.g., vomiting, diarrhoea), neurological issues (e.g., dizziness, headaches), cardiovascular issues (e.g., hypotension, bradycardia), and some symptoms that are especially characteristic of CP, such as cold allodynia and dysesthesia. In general**,** CP is not fatal, but exposure to CTXs can exacerbate existing cardiovascular or nervous system health issues and result in death. There is no specific treatment for CP, but symptoms can be managed with palliative care if the illness has been correctly identified.

5. Reports of CP have been made since the 1500s. At present, CP is believed to be the most common type of marine biotoxin-related food poisoning worldwide. The global incidence rate of CP is estimated to be 10,000 to 500,000 cases per year. In general, CP incidence rates may be underestimated due to a lack of mandatory incidence reporting, misidentification of CP symptoms, limited collection of epidemiological data on a global level, and other reasons. If clinicians do not know the characteristic symptoms they may misdiagnose CP, leading to underreporting of the disease.

6. Consuming CTX-contaminated fish was once geographically limited to local residents and visitors to tropical and subtropical regions, but global trade of fish and an increase in ocean temperatures due to climate change have caused CP illnesses to be observed among a wider range of non-CTX endemic countries. Isoforms of CTXs that were formerly found to be endemic to specific regions can now be found in other areas of the world. Some regions have been monitoring CP cases for many years, developing expertise in analysis and area management, and some are experiencing an increase in CP as an emerging issue and must learn how to develop monitoring programs and regulations to protect the public.

7. Successful surveillance and monitoring of CTXs depends on the availability of accurate analytical methods validated according to international standards. Presently, such formal validation is limited due to the lack of certified standards and certified or uncertified matrix reference materials. The analytical methods currently available for detection of CTXs are diverse and take advantage of different properties of the toxins (e.g., structure, cytotoxicity) and encompass both screening and quantitative measurements. Most CTX detection methods are suitable for analysing a variety of matrices (i.e., algae or seafood tissues) and some have sufficient sensitivity to detect CTXs at the levels that may be associated with adverse health effects in humans (e.g., the U.S. Food and Drug Administration has established guidance levels of 0.1 µg/kg C-CTX-1 equivalents and 0.01 µg/kg CTX-1B in fish; the EFSA CONTAM Panel (2010) indicated that 0.01 µg P-CTX-1 equivalents/kg fish is expected not to exert effects in sensitive individuals). CTX analogues are believed to vary depending on the strain of toxin producing algae, as well as the metabolism of marine organisms. CTXs are collected from CTX-producing algae or extracted from contaminated marine organisms; a limited number of analogues can be synthesized (e.g., P-CTX-3C, P-CTX-1B, and 51-hydroxy-CTX-3C). The algae grow slowly and can be difficult to culture, and a large quantity of ciguatoxic fish material is required for the isolation of toxins, which means production of standards is limited.

8. In their 2020 report, FAO/WHO concluded that "effective and integrated risk management options would require definition of toxin profiles in each region, both in algal strains and in seafood to define risk evaluation protocols […] conclusions should be considered as of local or regional significance only […]" Some of the recommendations from the FAO/WHO report are included in the "Recommended Practices" sections below.

II. Scope

9. This document provides guidance on recommended practices to prevent or avoid CP for different types of stakeholders including government authorities, fish sector operators (fishers, seafood processors, and seafood retail workers), health care professionals, and consumers. Because of differences in CTXs, analytical methods and standards, and regional incidence levels of CP, not all recommended practices will be applicable in all situations or to all stakeholders.

III. Recommended practices

Government-sponsored surveillance and monitoring programs

10. As knowledge improves and reliable methods become available, national authorities could establish or strengthen programs to monitor CTXs in algae, sentinel fish species, and fish for consumption. Overall, the function of monitoring programs is to provide information that may be used to develop warnings of the potential for CP problems and provide feedback notices to the fishing industry or consumers to warn against fishing in certain areas. It may be impractical (i.e., costly, and labour-intensive) to test fish to a sufficient degree for the complete prevention of CP, but recommendations outlined below should help to reduce the prevalence of CP.

11. Monitoring may be undertaken with a two-tiered approach: initial test of algae or fish using a functional biological screening method, then confirmation of any positive results using a chemical analytical method to identify well-known toxins and determine CTX content. Local officials should determine if there are sentinel species of fish that consume toxic algae and whether monitoring those fish as well as predatory fish that feed in the area is appropriate. A list of fish known or suspected to be associated with CP is included as Annex I. This list is non-exhaustive and is provided as an example to users of the CoP.

12. National or regional authorities should define the causative organisms of CTX in their region. Monitoring of algae in the local region can be used to positively identify blooms of *Gambierdiscus* or *Fukuyoa* and characterize their toxin content when present in sufficient quantity. Passive sampling of toxins in the water column by Solid Phase Adsorption Toxin Tracking (SPATT) devices containing lipophilic resins can be used to collect toxins from water and have the potential to serve as an early warning tool but are not used routinely for CTX monitoring. More details on analysing benthic algae are presented in Analytical Methods section below.

13. Monitoring of both algae and fish is recommended, as the concentration and/or CTX profile of benthic dinoflagellates does not always correlate to contamination in fish; i.e., a high concentration of CTX in an algal bloom may not correlate to a high concentration of CTX in local fish, and certain species of fish may contain high concentrations of CTXs even though the density of dinoflagellates in the sea water is low. This relationship has been used by some national authorities to set limits on size or species of fish permitted for consumption from a particular region.

14. Because toxin profiles may differ when collected from algae versus when collected from fish (due to metabolism), it is important to experimentally determine the correlation between environmentally sampled toxins and toxins isolated from fish and humans to enable traceback and targeted surveillance activities. It may be possible to identify the preferred substrate for dinoflagellates (e.g., seagrass and macroalgae) and if there is a selectivity or preference by herbivores for consumption of those substrates in a region.

15. National or regional authorities could consider developing maps of areas toxic algae grow and identifying the species of fish that feed in those areas. These maps may be useful to competent authorities when trying to determine if an area needs to be closed to fishing by commercial firms or recreational fishermen (some species of fish are known to exhibit high site fidelity). Maps indicating toxic fish or algae should be updated at reasonable intervals as blooms or migratory patterns may change season-to-season or with climate change, and results can be more precise as testing methods improve. Creating high-risk maps may not be appropriate for all regions, e.g., it may be difficult for countries or regions with many islands and coral reefs.

16. A more complex map could include information on the temporal and geographic toxin profiles of CTXs in the local area for both algae and fish. It may be possible to use information on the migratory patterns of reef fish (i.e., species of fish that migrate from an area with low *Gambierdiscus* or *Fukuyoa* density to one of high density) and the temporal swings in toxicity of the area and correlate them to possible toxin load, but this has not yet been practically demonstrated.

17. National or regional authorities could develop a database to collect information on human illnesses, which includes the species of the fish suspected of causing the illness and its original catch area if known (for countries reporting CP). Ideally, the data collected by these programs should include the origin of contaminated fish, the fish species involved, the CTX analogue profile, the concentration of toxins, symptoms experienced by the patient, the amount of fish consumed, testing results from meal remnants, and other relevant information. Examples of monitoring programs that report information on CP are.

- Ciguawatch Initiative (https://ciguawatch.ilm.pf/)
- EuroCigua project II (https://www.sanidad.gob.es/en/areas/sanidadExterior/euroCiguaII/home.htm)
- EU/Rapid Alert System for Food and Feed: (https://food.ec.europa.eu/safety/rasff-food-and-feed-safety-alerts)
- Institut Louis Malardé: ILM (www.ilm.pf, www.ciguatera.pf)
- UNESCO-IOC: HAEDAT (https://ipt.iobis.org/hab/resource?r=haedat)
- U.S. FDA: How to Report Seafood-Related Toxin and Scombrotoxin Fish Poisoning Illnesses (https://www.fda.gov/food/outbreaks-foodborne-illness/how-report-seafood-related-toxin-and-scombrotoxin-fish-poisoning-illnesses)

18. National or regional authorities could utilize social science approaches such as surveys and interviews to solicit information from local fishers about which areas yield toxic fish. Local fishers often possess knowledge about areas of CP risk, and this information represents a cost-effective way to supplement more costly surveillance methods.

19. When authorities are notified of CP cases occurring in an area not known to be endemic for CP, it is important to first identify the species of fish involved, locate the area of capture, determine the amount (weight) of fish the patient consumed, and recover any meal remnants for confirmation of CTXs. Investigation of the concentration of CTXs in the algae, fish, and other animals in the area would be the next step to determine if an area needs to be restricted to fishing.

Other governmental activities

20. When possible, national, regional, and local authorities could develop maximum levels (MLs) for the concentration of CTXs permitted in susceptible fish (e.g., the U.S. Food and Drug Administration has established guidance levels of 0.1 µg/kg C-CTX-1 equivalents and 0.01 µg/kg CTX-1B in fish; the EFSA CONTAM Panel (2010) indicated that 0.01 µg P-CTX-1 equivalents/kg fish is expected not to exert effects in sensitive individuals).

Because of current limitations in analytical methods and toxic equivalency factors of different CTXs, MLs may not be appropriate for all toxins or regions.

21. Some countries have established limits on size and/or species of fish that can be caught and sold because they are prone to causing CP. Some examples are given below:

- In Australia, the Sydney Fish Market maintains a list of banned fish species (forbidden to be sold), as well as a list of species that may be sold depending on place of origin and season. There is a size limit for some fish species depending on origin as well.
- Costa Rica maintains a ban on the importation of certain species or those that exceed a size limit requirement.
- France maintains a positive list of certain marine fish species that are permitted for import.
- Guadeloupe maintains a list of species that cannot be sold because of links to CP cases. This list is currently being updated by analysing fish remnants involved in CP cases in Guadeloupe and Martinique (DNA identification and CTX analysis).
- Réunion maintains a list of species posing a risk of CP mainly based on historical reported outbreaks (last update in 2009). This regulation considers these species and their origin (import or locally fished). Exceptions can be made on the basis of an analytical plan and health certificates from the exporting countries.
- Canary Islands (Spain) has a protocol to be carried out in authorized points of first sale, by which certain species must be checked above a certain weight.
- Japan maintains a list of domestic and import fish species that are forbidden, as well as a positive list of imported fish that can be sold if the same species caught in the specific sea area of the exporting country are usually eaten, no food poisoning has occurred, and it is tested and confirmed to be free of CTX. In addition, Okinawa and Tokyo prefectures have established a list of fish species that they recommend to not be sold or consumed and a size limit (length and/or weight) of some fish species known to be linked to CP.

22. If appropriate, national, regional, and local authorities should develop regulations and voluntary guidelines to minimize the possibility that CTX-contaminated fish are caught or sold. Depending on the point of application, these may include requirements for food hygiene systems that include Hazard Analysis and Critical Control Point (HACCP) plans. Authorities may conduct inspections to ensure that the HACCP plan contains the appropriate critical limits, monitoring procedures, and record-keeping elements, and is properly and consistently implemented.

23. If monitoring and surveillance is conducted, national or regional authorities should report the results of their monitoring to stakeholders and post warnings/fishing advisories in areas where fish species linked to CP may be caught.

24. When establishing regulations or other activities such as surveillance and monitoring protocols, it is recommended that authorities seek the advice of experts on CP. It may be beneficial to consult a committee with varied backgrounds and expertise to make the most informed decisions.

Analytical methods

25. Standardized protocols for testing of algae or fish matrices should be used so that results are comparable across laboratories or between regions and countries. This includes monitoring *Gambierdiscus* and *Fukuyoa* diversity (e.g., molecular approach vs. morphotaxonomy, how to approach inclusion of new species) or when collating epidemiological data. CTX testing should be done using single or multi-laboratory validated methods to ensure comparability of results.

26. When possible, molecular techniques such as DNA barcoding should be used to determine the species of fish contaminated with CTXs (either at the time the fish is caught or as a meal remnant). Information on fish species can be used to help trace contaminated products back to their origin and to determine if follow-up CTX testing of other fish in the harvest area is necessary. Testing meal remnants for the presence of CTXs is important to link CP cases with the source of the CTXs.

27. Analytical methods with the capability to quantify toxins should be used, either methods that measure individual CTX analogues or methods that report the sum of all toxins present (i.e., cannot distinguish individual analogues). Because CTX profiles are known to vary by location or marine species, different reference standards may be needed based on the toxin profile observed and method used.

28. When possible, laboratories should store aliquots of CTX-contaminated fish or algae. These naturally contaminated samples can be used for development of standard materials or to share with other researchers performing method validations.

29. Entities with expertise in analytical methods are strongly encouraged to share knowledge and expertise and initiate collaboration with regions that are developing or improving their surveillance and monitoring activities.

30. Because analytical technologies will continue to evolve, it is not appropriate to recommend specific methods in a CoP. Detection of CTXs can be performed using a number of techniques, each with differing sensitivities, advantages, and limitations. Methods that have been reported in the literature are: the neuroblastoma assay (N2A), receptor-binding assay (RBA), enzyme-linked immunosorbent assay (ELISA), mouse bioassay (MBA), and liquid chromatography/mass spectrometry (LC-MS).

31. As mentioned in paragraph 11, monitoring may be undertaken with a two-tiered approach: initial qualitative screening of algae or fish using a functional biological method (e.g., RBA) followed by quantitative analysis of positive samples to determine the overall concentration of CTXs. For CTXs where the structure is known and/or standards are available, confirmation of positive results can be performed using a method that can identify CTX analogues and determine their individual contribution to the overall CTX concentration (e.g., LC-MS). Stakeholders are encouraged to contact their national authorities for assistance or consult with international agencies such as IAEA on method development and sharing of technology. The *FAO/WHO Report of the Expert Meeting on Ciguatera Poisoning* contains a list of methods available as of 2020.

Fish sector operators

32. Fish sector operators (people who work in the areas of fishing, seafood processing, and seafood retail) should be aware of any national or regional legislation for food hygiene systems that include HACCP plans pertaining to CTXs or CP in relevant commodity species. If not specifically required by authorities, firms should consider adding CP to their HACCP plans to reduce the likelihood of CTX-contaminated fish entering the marketplace. These plans could include any relevant national limits on size or source of fish, traceability of fish products from fishing areas to retail, training on CP hazards and regulations, and criteria for rejecting shipments.

33. When possible, HACCP plans should contain limits on the areas or time of the year where and when fish can be caught, describe how monitoring will be conducted and how frequently, establish criteria for rejection of the commodity, and utilize an organized record-keeping system.

34. HACCP plans should include a hazard analysis; for CP, that would include local awareness of the species of fish caught which may be susceptible to CTX accumulation and an understanding of the location of the potentially toxic areas for avoidance. If appropriate, restrictions on the species and/or size of fish known to accumulate CTXs could be part of the HACCP plan. HACCP plans could include a requirement that fish above a size limit are tested for CTXs before sale, but such wide-scale testing could be very costly or burdensome.

35. Fish sector operators should institute policies for traceability of fish and accurate identification of the species being sold, especially for fish that are intended for export, so that the processing or retail firm can confirm that the product was not caught from a restricted area or is a locally restricted species.

36. Seafood processors who purchase fish directly from fishers should obtain information about fishing locations to determine the potential for ciguatoxic fish based on knowledge of the regions where CP occurs (comparing to risk maps, see paragraph 15, from national authorities where available). Primary seafood processors should avoid purchasing fish species associated with CP from established or emerging areas linked with CP.

37. When MLs of CTXs in fish for consumption are established or recommended by national, regional, or local authorities (see paragraph 20), fish sector operators could set critical limits on CTX concentrations in surrogates to reduce the likelihood that commercial fish are contaminated. Surrogates could be water, algae, or sentinel fish in a particular fishing area depending on what has been determined to be appropriate for the region (see paragraphs 13-14).

38. CTXs are known to concentrate in fish viscera, liver, heads, and roe. Therefore, it is highly recommended that these organs or body parts from fish species linked to CP are not consumed. Fish production establishments should have policies and procedures for handling and disposal of animal by-products and animal-derived products to minimize risks to public and animal health and to protect the integrity of the food and feed chain.

Data sharing and training

39. Countries and regions are encouraged to share their guidance and best practices with interested parties, including training of scientists in relevant methodologies, to improve the global prevention of CP and encourage harmonization of data and reporting systems.

40. Entities wishing to begin or strengthen their surveillance and monitoring programs are encouraged to contact CP experts for consultation. International agencies such as IAEA and IOC-UNESCO are promoting such work and could be contacted for assistance. Examples of training and guidance resources are:

- U.S. FDA: Fish and Fishery Products Hazards and Controls (www.fda.gov/food/seafood-guidance-documents-regulatory-information/fish-and-fishery-products-hazards-and-controls)
- Ciguawatch Initiative (https://ciguawatch.ilm.pf)
- IOC-UNESCO HAB Programme (https://hab.ioc-unesco.org/ciguatera/)
- Australia: Sydney Fish Market Seafood Handling Guidelines (https://www.sydneyfishmarket.com.au/Seafood-Trading/Quality/Food-Safety)

41. Agencies or other public recognized institutions that have CP or CTX databases should publish annual reports or other summaries on monitoring of illnesses to aid other regions in developing strategies for prevention and avoidance of CP.

Advice to Consumers and Healthcare Professionals

42. Regional or local authorities should provide advice on CP to consumers and healthcare providers. Some examples of consumer advice that have been used by national or regional authorities are:

- a fact sheet to consumers that contains information on the susceptible fish species, symptoms of illness, and how to preserve meal remnants for testing.
- advisory information for recreational fishermen of areas where CP has been documented.
- a comic explaining the hazards for consumers.
- educational materials for patients and health professionals that includes a description of symptoms.

43. Consumers should be alert for advisories in regions where fish that may contain CTXs are caught, either commercially or recreationally.

44. Consumers should avoid eating fish caught from a restricted area. They should also consider limiting the portion size they consume from fish species that have been linked to CP, and avoid eating the liver, roe, head, or viscera of any CP associated species.

45. If a person suspects they have CP, they should seek medical attention and avoid eating additional portions of the suspect food. Certain beverages and food (mainly alcohol, fish, and nuts) can cause recurrent symptoms of CP in affected individuals and should be avoided for at least 6 months after experiencing CP.

46. If a food is suspected of causing CP, it is advisable to freeze any meal remnants or parts of the specific fish consumed and to contact the local food safety authority for further instruction.

47. Since CTXs may be transmitted through breastfeeding and unprotected sexual intercourse, individuals who are experiencing CP symptoms could refrain from these activities.

48. National authorities should advise healthcare professionals of the possibility of CP in patients, even in regions where CP is not endemic. If appropriate, authorities could offer training on how to identify CP in patients and how to notify a national database of CP illnesses. Patients with symptoms of CP should be asked thoroughly about the types of fish they have consumed as well as consumption times and places.

Minimizing negative impacts of human activity

49. Correlations between human activity and increases in algal blooms/CP incidence have been suggested. Based on surveillance and monitoring, government officials could determine if changes to ecosystems are contributing to an increase in *Gambierdiscus* or *Fukuyoa* algae or CTX-contaminated fish in the area, and if steps can be taken to decrease these effects.

Annex I: List of marine organisms known or suspected to be associated with CP

This list was excerpted from the 2020 *FAO/WHO Report of the Expert Meeting on Ciguatera Poisoning*, with additions from Codex members. This list is not exhaustive, but rather provides examples of the variety of organisms and regions that may be associated with CP.

SCIENTIFIC NAME	COMMON NAME	LOCATION WHERE FOUND
Acanthurus dussumieri	Dussumier's surgeon fish (palani)	Hawaii (U.S.A.)
Acanthurus gahhm	Surgeonfish	Kiribati
Acanthurus leucopareius	Whitebar surgeonfish	French Polynesia
Acanthurus lineatus	Surgeonfish	Kiribati
Acanthurus maculiceps	Surgeonfish	Kiribati
Acanthurus nata	Surgeonfish	Kiribati
Acanthurus nigroris	Bluelined surgeon fish (maiko)	Hawaii (U.S.A.)
Acanthurus olivaceus	Orangeband surgeon fish (naenae)	Hawaii (U.S.A.)
Acanthurus striatus	Surgeonfish	Kiribati
Acanthurus xanthopterus	Yellowfin surgeon fish	Hawaii (U.S.A.), Nuku Hiva (Marquesas)
Aphareus furca	Black forktail snapper (wahanui)	Hawaii (U.S.A.)
Aprion virescens	Blue-green snapper	French Polynesia, Enewetak Island, Bikini Island
Arca zebra	Turkey wing ark clam	
Arothron nigropunctatus	Pufferfish	Kiribati
Balistapus undulatus	Triggerfish	Kiribati
Bodianus bilunulatus	Tarry hogfish (a'awa)	Hawaii (U.S.A.)
Bodianus rufus	Spanish hogfish	Saint Barthélemy (Caribbean Sea)
Caranx ignobilis	Giant trevally (ulua)	Enewetak Island
Caranx latus	Horse-eye jack	French West Indies, Saint Barthélemy (Caribbean Sea), Bahamas, Saint Thomas (Caribbean Sea)
Caranx lugubris	Black jack	French West Indies, Enewetak Island
Caranx melampygus	Bluefin trevally	Nuku Hiva (Marquesas), French Polynesia, Enewetak Island
Caranx papuensis	Brassy trevally	French Polynesia, Tubuai (Australes)
Caranx sp.	Trevally (ulua, papio)	Hawaii (U.S.A.)

SCIENTIFIC NAME	COMMON NAME	LOCATION WHERE FOUND
Carcharhinus amblyrhynchos	Grey reef shark	Enewetak Island
Carcharhinus leucas	Shark	Madagascar
Carcharhinus limbatus	Black-tip shark	Enewetak Island
Cephalopholis argus	Blue-spotted grouper, roi	Nuku Hiva (Marquesas), Hawaii (U.S.A.), French Polynesia, Kiribati
Cephalopholis argus	Large grouper	Enewetak Island, Kiribati
Cephalopholis miniata	Coral cod / coral grouper	Fiji, Arafura Sea (Australia)
Chaetodon auriga	Butterflyfish	Kiribati
Chaetodon meyeri	Butterflyfish	Kiribati
Cheilinus undulatus	Humphead wrasse	French Polynesia, China, Hong Kong SAR, Enewetak Island
Chlorurus frontalis	Pacific slopehead parrotfish	French Polynesia, Tubuai (Australes)
Chlorurus microrhinos	Steephead parrotfish	French Polynesia, Tubuai (Australes)
Cnidaria sp.	Jellyfish (omnivorous)	American Samoa
Conus spp.	Cone snails	Hawaii (U.S.A.)
Coris aygula	Clown coris (wrasse)	French Polynesia, Tubuai (Australes), Enewetak Island), Kiribati
Crenimugil crenilabis	Fringelip mullet	Nuku Hiva (Marquesas), French Polynesia
Ctenochaetus striatus	Striped bristletooth surgeon fish	Nuku Hiva (Marquesas), Tahiti
Diodon hystrix	Porcupinefish	Kiribati
Diodon liturosus	Porcupinefish	Kiribati
Diplodus vulgaris	Sea Bream	
Epibulus insidiator	Wrasse	Kiribati
Epinephelus coeruleopunctatus	Large grouper	Kiribati
Epinephelus coioides	Orange-spotted grouper	China, Hong Kong SAR
Epinephelus fuscoguttatus	Large grouper	Enewetak Island, Kiribati
Epinephelus hoedtii	Large grouper	Enewetak Island
Epinephelus lanceolatus	Giant grouper	China, Hong Kong SAR

SCIENTIFIC NAME	COMMON NAME	LOCATION WHERE FOUND
Epinephelus maculatus	Large grouper	Enewetak Island
Epinephelus marginatus	Dusky grouper	
Epinephelus merra	Small grouper	Kiribati
Epinephelus microdon	Marble grouper	French Polynesia, Enewetak Island, Bikini Island
Epinephelus morio	Red grouper	Saint Barthélemy (Caribbean Sea)
Epinephelus multinotatus	Large grouper	Kiribati
Epinephelus mystacinus	Misty grouper	Saint Thomas (Caribbean Sea)
Epinephelus polyphekadion	Large grouper	Kiribati
Epinephelus spilotoceps	Large grouper	Kiribati
Epinephelus spp.	Grouper	Canary Islands (Spain)
Epinephelus tauvina	Large grouper	Bikini Island, Kiribati
Forcipiger longirostris	Butterflyfish	Kiribati
Gymnosarda unicolor	Dogtooth tuna	Nuku Hiva (Marquesas), French Polynesia, Enewetak Island
Gymnothorax flavimarginatus	Moray eel	Kiribati
Gymnothorax funebris	Green moray eel	Saint Barthélemy (Caribbean Sea)
Gymnothorax javanicus	Moray eel	Tuamotu Archipelago and Tahiti (French Polynesia), Tarawa, Kiribati, central Pacific Ocean, Hawaii (U.S.A.), Kiribati
Hippopus hippopus	Giant clam	Vanuatu
Hipposcarus harid	Parrotfish	Enewetak Island
Hipposcarus longiceps	Parrotfish	Kiribati
Holothuria spp.	Sea cucumber	Hawaii (U.S.A.)
Kyphosus cinerascens	Blue sea chub	French Polynesia, Tubuai (Australes), Nuku Hiva (Marquesas), Enewetak Island
Lethrinus callopterus		Enewetak Island
Lethrinus miniatus	Trumpet emperor bream	French Polynesia, Enewetak Island
Lethrinus olivaceus	Longface emperor bream	Nuku Hiva (Marquesas)
Liza vaigiensis	Thinlip grey mullet	Nuku Hiva (Marquesas), Miyazaki (Japan)

SCIENTIFIC NAME	COMMON NAME	LOCATION WHERE FOUND
Lutjanus argentimaculatus	Mangrove red snapper	China, Hong Kong SAR
Lutjanus bohar	Two-spot red snapper (red bass)	Mauritius, Minamitorishima (Marcus) Island (Japan), French Polynesia, Tubuai (Australes), Nuku Hiva (Marquesas), Hawaii (U.S.A.), French Polynesia, Enewetak Island, Bikini Island, Kiribati, India, Indonesia, Viet Nam
Lutjanus buccanella	Blackfin snapper	Saint Croix, United States Virgin Islands
Lutjanus fulvus	Snapper	Kiribati
Lutjanus gibbus	Humpback red snapper	Nuku Hiva (Marquesas), French Polynesia, Enewetak Island, Bikini Island
Lutjanus griseus	Grey snapper	French West Indies
Lutjanus kasmira	Bluestripe snapper (taape)	Hawaii (U.S.A.)
Lutjanus monostigma	One-spot snapper	Nuku Hiva (Marquesas), Enewetak Island, Bikini Island
Lutjanus sebae	Red emperor	Mauritius (Nazareth, Saya de Malha, Soudan)
Lutjanus spp.	Snapper	Antigua, Okinawa (Japan), West Africa, Baja California (Mexico), Saint Thomas (Caribbean Sea)
Lutjanus stellatus	Star snapper	China, Hong Kong SAR
Lycodontis javanicus	Eel	Enewetak Island
Macolor niger	Snapper	Enewetak Island, Kiribati
Malacanthus plumieri	Sand tilefish	Saint Barthélemy (Caribbean Sea)
Marthasterias glacialis	Starfish	Madeira, Azores
Monachus schauinslandi	Hawaiian monk seal	Hawaii (U.S.A.)
Monotaxis grandoculis	Big-eye bream, emperor	French Polynesia, Enewetak Island, Kiribati
Mugil cephalus	Mullet	
Mugil liza	Lebranche mullet	
Mugil trichodon	White mullet	
Mulloidichthys auriflamma	Goldstriped goatfish	Hawaii (U.S.A.)
Mulloidichthys martinicus	Yellow goatfish	Saint Barthélemy (Caribbean Sea)
Muraena helena	Mediterranean moray	

SCIENTIFIC NAME	COMMON NAME	LOCATION WHERE FOUND
Mycteroperca bonaci	Black grouper	Key Largo, Florida (U.S.A.)
Mycteroperca fusca	Island grouper	Canary Islands (Spain)
Mycteroperca prionura	Sawtail grouper	Baja California, Mexico (Sierra-Beltran *et al*., 1997)
Mycteroperca venenosa	Yellowfin grouper	Guadeloupe and Saint Barthélemy, Caribbean Sea
Myripristis berndti	Soldier fish	Kiribati
Myripristis kuntee	Epaulette soldier fish (squirrelfish)	Hawaii (U.S.A.)
Naso brachycentron	Humpback unicorn fish	Nuku Hiva (Marquesas)
Naso brevirostris	Spotted unicorn fish	Nuku Hiva (Marquesas)
Naso hexacanthus	Sleek unicorn fish	Nuku Hiva (Marquesas)
Naso lituratus	Orangespine unicorn fish	Nuku Hiva (Marquesas)
Naso unicornis	Bluespine unicorn fish	Nuku Hiva (Marquesas)
Oncorhynchus kisutch	Farmed salmon	Chile
Ophidiaster ophidianus	Starfish	Madeira, Azores
Ophiocoma spp.	Ophiuroids (brittle stars) starfish	Hawaii (U.S.A.)
Oplegnathus punctatus	Spotted knifejaw	Miyazaki (Japan)
Pagrus pagrus	Seabream (red porgy)	Selvagens Islands
Pamatomus saltatriz	Bluefish	Canary Islands (Spain)
Panulirus penicillatus	Lobster	Kiribati
Paracirrhites hemistictus	Hawkfish	Kiribati
Parupeneus bifasciatus	Goatfish	Kiribati
Parupeneus insularis	Twosaddle goatfish	Nuku Hiva (Marquesas)
Plectropomus areolatus	Squaretail coral grouper	China, Hong Kong SAR
Plectropomus laevis	Blacksaddled coral grouper	China, Hong Kong SAR
Plectropomus leopardus	Coral trout / leopard coral grouper	French Polynesia, Tubuai (Australes), China, Hong Kong SAR, Tahiti, French Polynesia, Enewetak Island
Plectropomus melanoleucus	Grouper	Enewetak Island

SCIENTIFIC NAME	COMMON NAME	LOCATION WHERE FOUND
Plectropomus sp.	Coral trout	Great Barrier Reef (Australia), French West Indies
Plectropomus truncatus	Squaretail coral grouper	Enewetak Island
Pomacanthus imperator	Angelfish	Kiribati
Pomadasys maculatus	Blotched javelin grunt	Platypus Bay, Queensland (Australia)
Pterois spp.	Lionfish	Guadalupe, Caribbean Sea
Pterois volitans	Lionfish	Virgin Islands
Sargocentron spiniferum	Sabre squirrelfish	Nuku Hiva (Marquesas)
Sargocentron tiere	Squirrelfish	Kiribati
Scarus altipinnis	Filament-finned parrotfish	French Polynesia, Tubuai (Australes)
Scarus ghobban	Parrotfish	Kiribati, French Polynesia, Tubuai (Australes)
Scarus gibbus	Heavy beak parrotfish	French Polynesia, Tahiti, French Polynesia, Enewetak Island
Scarus rubroviolaceus	Ember parrotfish	Nuku Hiva (Marquesas)
Scarus russelii	Parrotfish	Kiribati
Scomberomorus cavalla	King mackerel “Coronado” (king fish)	Florida (U.S.A.), Saint Barthélemy (Caribbean Sea), Guadeloupe
Scomberomorus commerson	Spanish mackerel	Hervey Bay, Queensland (Australia)
Seriola dumerili	Greater amberjack / Kahala	Canary Islands (Spain), Madeira Archipelago, Hawaii (U.S.A.), Haiti, Saint Barthélemy (Caribbean Sea), Saint Thomas (Caribbean Sea)
Seriola fasciata	Lesser amberjack	Selvagens Islands (Madeira Archipelago), West Africa (Canary Islands)
Seriola rivoliana	Almaco jack / Kahala	Canary Islands (Spain), Hawaii (U.S.A.), Saint Thomas (Caribbean Sea)
Seriola spp.	Jack	
Serranidae	Grouper	
Siganus argenteus	Rabbitfish	Kiribati
Siganus rivulatus	Marbled spinefoot rabbitfish	Eastern Mediterranean
Sphyraena barracuda	Great barracuda	Bahamas, Cameroon), Florida Keys (U.S.A.), French West Indies, Saint Barthélemy (Caribbean Sea), Guadeloupe, French Polynesia, Enewetak Island

SCIENTIFIC NAME	COMMON NAME	LOCATION WHERE FOUND
Sphyraena jello	Pickhandle barracuda	Hervey Bay, Queensland (Australia)
Sphyraena spp.	Barracuda	California (U.S.A.)
Tectus niloticus	Gastropod	French Polynesia
Tridacna maxima	Giant clam	New Caledonia, French Polynesia
Tripneustes gratilla	Sea urchin	French Polynesia
Variola albimarginata	Lyretail	China, Hong Kong SAR
Variola louti	Large grouper	Enewetak Island, Kiribati
Zancius cornutus	Moorish idol	Kiribati

APPENDIX II

LIST OF PARTICIPANTS

CHAIR United States of America

Dr. Sara McGrath
Chemist
Office of Food Safety
U.S. Food and Drug Administration
sara.mcgrath@fda.hhs.gov

Dr Lauren Posnick Robin
Chief, Plant Products Branch
Office of Food Safety
U.S. Food and Drug Administration
lauren.robin@fda.hhs.gov

CO-CHAIRS

France

Ms. Marina NICOLAS
Head of the French National Reference Laboratory for Marine Biotoxins
French Agency for Food, Environmental and Occupational Health & Safety (ANSES)
Marina.NICOLAS@anses.fr

Ms. Virginie HOSSEN
National referent about fishery products
Ministry of Agriculture and Food Sovereignty
virginie.hossen@agriculture.gouv.fr

Panama

Mr. Joseph Gallardo
Food Engineer
General Directorate of Standards and Industrial Technology
Ministry of Commerce and Industries
Contact Point and Codex Secretariat Panama
codexpanama@mici.gob.pa

Spain

Ms. Violeta García
Head of the Contaminants Management Department
Spanish Agency for Food Safety and Nutrition
vgarciah@aesan.gob.es

Mr. David Merino
Head of the Chemical Risk Management Area
Spanish Agency for Food Safety and Nutrition
dmerino@aesan.gob.es

Dr Agustín Palma
Deputy Director of Food Safety Management Spanish Agency for Food Safety and Nutrition
apalma@aesan.gob.es

Argentina

Ms. Silvana Ruarte
Director of Inspection and Control

Mr. Martin Fernandez
Laboratory profesional
INAL ANMAT

Ms. Gisele Simondi
Laboratory professional
INAL ANMAT

Australia
Nick Fletcher
Manager Standards and Surveillance
Food Standards Australia New Zealand

Stephen Pahl
Seafood Safety and Market Access Program Leader – Food Sciences
South Australian Research and Development Institute (SARDI)

Dr Andreas Seger
Research Fellow Fish Health
University of Tasmania

Alison Turnbull
Senior Research Fellow
University of Tasmania

Belgium
Dr Elien De Boeck
Regulatory expert
Federal Public Service Health
Food Chain Safety and Environment

Brazil
Larissa Bertollo G. Porto
Health Regulation Expert
Brazilian Health Regulatory Agency – Anvisa

Ligia Lindner Schreiner
Health Regulation Expert
Brazilian Health Regulatory Agency – Anvisa

China
Dr Yi SHAO
Professor
NHC Key Laboratory of Food Safety Risk Assessment
China National Center of Food Safety Risk Assessment (CFSA)

Dr Yongning WU
Professor, Chief Scientist
NHC Key Laboratory of Food Safety Risk Assessment
China National Center of Food Safety Risk Assessment (CFSA)

Dr Shuang ZHOU
Professor
NHC Key Laboratory of Food Safety Risk Assessment
China National Center for Food Safety Risk Assessment (CFSA)

Costa Rica
Licda. Karen Berrocal Artavia
Marine Phytoplankton Laboratory
Juan Bertoglia Richards Marine Biological Station
School of Biological Sciences
National University

Ana Cristina Briones
Coordinator of the National CCCF Committee
National Animal Health Service
Ministry of Agriculture and Livestock

Amanda Lasso
Technical Advisor of the National Codex Contact Point
Ministry of Economy, Industry and Commerce

Egypt
Noha Mohammed Attiya
Food Standards Specialist
Egyptian Organization for Standardization & Quality (EOS)
Ministry of Trade and Industry

European Union
Ms. Patricia Herrero Sancho
Policy Officer
European Commission / Directorate General for Health and Food Safety

Mr. Paolo Caricato
Policy Officer
European Commission / Directorate General for Health and Food Safety

Mr. Frans VERSTRAETE
Deputy Head of Unit
European Commission / Directorate General for Health and Food Safety

Germany
Dr Christopher R. Loeffler
Unit Contaminants
Department Safety in the Food Chain German Federal Institute of Risk Assessment

Dr Astrid Spielmeyer
Unit Contaminants
Department Safety in the Food Chain German Federal Institute of Risk Assessment

Ghana
Abdul-Malik Adongo Ayamba
Quality and Safety Coordinator
Ghana Standards Authority

Greece
Dionysia MINTZA
Head of Department
Ministry of Rural Development and Food

India
Dr M Muralidhara
Retired Chief Scientist
CSIR- CFTRI, Mysuru

Dr Sandeep K. Sharma
Senior Scientist
CSIR-IITR, Lucknow

Ms. Varsha Yadav
Research Associate
FICCI

Japan
Mr. Hiroyuki Uchimi
Deputy Director
Ministry of Health, Labour, and Welfare

Mr. Junki Tsukamoto
Chief Officer
Ministry of Health, Labour, and Welfare

Dr Hajime Toyofuku
Professor
Yamaguchi University

Dr Naomasa Oshiro
Section Chief
National Institute of Health Sciences

Dr Takanori Ukena
Director
Ministry of Agriculture, Forestry and Fisheries

Mr. Tetsuo Urushiyama
Associate Director
Ministry of Agriculture, Forestry and Fisheries

Mr. Tomoyuki Takahashi
Associate Director
Ministry of Agriculture, Forestry and Fisheries

Madagascar
Rafalimanana Halitiana
Expert scientifique, Enseignante chercheur
Université d'Antananarivo

Dorothée RAVOMANANA
Expert scientifique / filières agro alimentaires
Consultant formateur
Comité National du Codex Alimentarius

Malaysia
Ms. Shazlina Mohd Zaini
Principal Assistant Director
Ministry of Health

Ms. Rodiyah Mohamed
Senior Assistant Director
Ministry of Health

Dr Ahmad Faizal Abdull Razis
Associate Professor
Universiti Putra Malaysia

Mr. Roslan Abu Hasan
Head of Standard and Laboratory Services
Department of Fisheries

Netherlands
Nikki Emmerik
Senior Policy Officer
Ministry of Health, Welfare and Sport

Ms. Weiluan Chen
Science Officer
National Institute for Public Health and the Environment

New Zealand
Jeane Nicolas
Senior Adviser Toxicology
New Zealand Food Safety

Fiapaipai Auapaau
Adviser Risk Assessment
New Zealand Food Safety

Dr Kirsty Smith
Manager, Molecular Algal Ecology
Cawthron Institute

Dr Sam Murray
Senior Scientist, Marine Chemistry
Cawthron Institute

Nigeria
Babajide Jamodu
Principal Standards Officer
Standards Organisation of Nigeria

Philippines
Mr. Phelan Apostol
Food and Drug Regulation Officer III
Chairperson, Sub-Committee on Contaminants in Food
Food and Drug Administration
Department of Health

Qatar
Dr Naushad Zubair
Microbiology Technologist
Food Safety and Environmental Health Division, Ministry of Public Health

Saudi Arabia
Mohammed A. Ben Eid
Head of Chemical Risks, Food
Saudi Food and Drug Authority

Yasir A. AlAqil
Senior specifications and regulations Specialist
Saudi Food and Drug Authority

Nimah M. Baqadir
Standards and Regulations Specialist I, Food Sector
Saudi Food and Drug Authority

Lama A. Almaiman
Risk assessment expert, Food Sector
Saudi Food and Drug Authority

Dr Mohammed M. Al-Shehri
Risk assessment expert, Food Sector
Saudi Food and Drug Authority

Singapore
Joachim Chua
Specialist Team Lead (Foodborne & Natural Toxins)
Singapore Food Agency

Ng Hwee-Ee
Assistant Director
Singapore Food Agency

Lew Ker
Senior Scientist
Singapore Food Agency

Er Jun Cheng
Specialist Team Lead (Exposure Assessment)
Singapore Food Agency

South Africa
Juliet Masuku
Medical Biological Scientist

South Korea, Republic of
Jooyeon Kim
Researcher
Food Standard Division, Ministry of Food and Drug Safety (MFDS)

Thailand
Ms. Chutiwan Jatupornpong
Standards officer
Office of Standard Development
National Bureau of Agricultural Commodity and Food Standards

United Kingdom
Ian Woods
Senior Policy Advisor, Products of Animal Origin
Food Standards Agency UK

United States of America
Karen A. Swajian
Consumer Safety Officer
U.S. Food and Drug Administration

Dr Ronald A. Benner, Jr.
Science Advisor
U.S. Food and Drug Administration
Gulf Coast Seafood Laboratory

Edward L. Jester
U.S. Food and Drug Administration
Gulf Coast Seafood Laboratory

AOAC International
Katerina Mastovska
Deputy Executive Director & Chief Science Officer

Deborah McKenzie
Deputy Assistant Executive Director & Chief Standard Officer

Ana María Consuelo Gago Martínez
Professor, University of Vigo