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.**codex**alimentarius.org

E

Agenda Item 6 **CX/CF 23/16/6**
February 2023

JOINT FAO/WHO FOOD STANDARDS PROGRAMME

CODEX COMMITTEE ON CONTAMINANTS IN FOODS

16th Session
18-21 April 2023 (physical plenary meeting)
26 April 2023 (virtual report adoption)

CODE OF PRACTICE FOR THE PREVENTION AND REDUCTION OF MYCOTOXIN CONTAMINATION IN CASSAVA AND CASSAVA-BASED PRODUCTS

(At Step 7)

(Prepared by the Electronic Working Group
chaired by Nigeria and co-chaired by Ghana)

Codex members and observers wishing to submit comments at Step 6 on this document should do so as instructed in CL 2022/19-CF available on the Codex webpage[1]

BACKGROUND

1. The 15th Session of the Codex Committee on Contaminants in Foods (CCCF15, 2022) considered the Code of Practice as presented by Nigeria, Chair of the EWG. The presentation covered summaries of the CoP highlighting its major focuses for prevention or reduction of mycotoxins development in cassava and cassava-based products including the stages at which risk control practices should apply. It also emphasised processing conditions required to prevent or reduce mycotoxin contamination, critical parameters applicable to farm selection, farm preparation, cassava variety selection, planting to harvesting as well as post-harvest activities and preventive measures during transport and distribution.

2. While there was a general support by CCCF15 for the CoP and its advancement to Step 5 for adoption by CAC45 (2022), the Committee sought for scope clarification in the CoP clearly stating that it aimed at cassava and cassava-based products for human consumption rather than animal feed since a large proportion of cassava in the international market was used for feed. Also that the focus should be solely put on prevention or reduction of mycotoxin. The Chair also affirmed opened participation for interested members by using the Codex on line forum for the discussions in the electronic working group (EWG).

3. CCCF15 advanced the Code of Practice for the Prevention and Reduction of Mycotoxin Contamination in Cassava and Cassava-Based Products to CAC45 for adoption at Step 5 and re-established the EWG, chaired by Nigeria and co-chaired by Ghana to further revise the CoP with a view to finalizing the document at CCCF16[2]. CAC45 adopted the CoP at Step 5 and advanced it to Step 6 for comments and further consideration/ finalization by CCCF16[3].

WORK PROCESS IN THE EWG

4. The EWG adopted a workplan for itself featuring circulation of updated CoP reflecting the advice at CCCF15. This was followed by 2 rounds of comments by its members and a final distribution of the final revised CoP. Each distribution was accompanied with a detailed e-mail summarising and analysing inputs of each member and seeking for consensus; in an instant, allotting tasks to a member that was aptly delivered.

---

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 REP22/CF15, paras. 194-200

3 REP22/CAC45, paras. 74-75, App. III

SUMMARY OF THE DISCUSSION IN THE EWG

5. In the introduction section of the CoP, EWG members desired a balancing on both the characteristics and public health concerns of both mycotoxin of focus: aflatoxins and ochratoxin. Thus, CCCF16 will observe a more robust introduction. The EWG also considered it appropriate to include a sketch of cassava products processing flowchart, because of the impacts of each unit-process in controlling mycotoxin contamination in the products as explained in the CoP.

CONCLUSIONS

6. The revised CoP is as presented in Appendix I for consideration and advancement to Step 8 by CCCF16.

7. The Chair, and also on behalf of the co-Chair, expressed its appreciation to the EWG members who are listed in Appendix 2 for their selfless work throughout the assignment.

RECOMMENDATIONS

8. The EWG recommends CCCF to consider the COP as set out in Appendix I and advance it for final adoption by CAC46 (2023).

APPENDIX I

CODE OF PRACTICE FOR THE PREVENTION AND REDUCTION OF MYCOTOXINS CONTAMINATION IN CASSAVA AND CASSAVA-BASED PRODUCTS

(For comments)

1. INTRODUCTION

1. Mycotoxins are fungal toxins that have been reported in a wide variety of agricultural products. They can pose health and economic consequences. The most frequently occurring mycotoxins in cassava and cassava-based products are aflatoxins and ochratoxin A. The aflatoxins are mainly produced by *Aspergillus flavus*, *A. parasitic us, A. nomius and A. minisclerotigenes*; while Ochratoxin A is mainly produced by *Penicillium verrucosum and Aspergillus ochraceus* as well as *A. carbonarius* and *A. niger*. The aflatoxins are among the most potent carcinogenic, teratogenic, and mutagenic compounds known. Depending on the host species, these mycotoxins can act as nephrotoxins, hepatotoxins, immunotoxins, neurotoxins, teratogens, or carcinogens, however, the liver is the primary target for toxicity. The major aflatoxins commonly found in agricultural commodities are aflatoxin B1, B2, G1, and G2, of which aflatoxin B1 is the most potent. Ochratoxin A may cause nephrotoxic, teratogenic, immunosuppressive and carcinogenic effects, depending on the species. It also causes porcine nephropathy and has been implicated in the etiology of Balkan endemic nephropathy (BEN) in humans. Ochratoxin A is one of the most potent renal carcinogens, inducing cancer in rats at very low doses. The International Agency for Research on Cancer (IARC) has classified the aflatoxins as carcinogenic to humans (Group 1) and Ochratoxin A as *possibly* carcinogenic to humans (Group 2B).

2. The prevalence of several species of fungi that are implicated in mycotoxin production usually differs from one region to another. The fungi which can be found in soil and dust, residues of cultivated crops, stored cassava and cassava-based products at processing or storage facilities are usually associated with pre-harvest and/or post-harvest contamination of cassava and cassava-based products in regions having climate and soil conditions that permit both small or large scale cassava cultivation.

3. The severity of pre-harvest fungal infection and propagation largely depends on the prevailing environmental and climatic factors, which may differ from year to year and from region to region. It also depends on the presence of innoculums, and the farming practices that are employed. The degree of damage to the roots made during harvest or by rodents, insects and other organisms also influences the severity of contamination. Good agricultural practices (GAP) and good manufacturing practices (GMP) could play a major role in reducing the severity of contamination. Storage duration may play a role in mycotoxin production, as it is know that the risk of postharvest fungal infection and production of mycotoxins in stored grain increases with the storage duration as indicated in the *Code of practice for the prevention and reduction of mycotoxin contamination in cereals* (CXC 51-2003).

4. There are many species and cultivars of cassava. Edible types are classified into one of two categories, bitter and sweet, depending on the cyanogenic glycoside levels. The bitter and sweet varieties have high (≥ 100 mg/kg) and low (≤ 50 mg/kg) hydrocyanic acid (HCN) content, respectively as indicated in the *Code of practice for the reduction of HCN in cassava and cassava products* (CXC 73-2013). Cassava roots are usually processed and consumed in various forms, which may differ across countries. However, the primary reason for processing cassava root is to reduce the cyanogenic glycoside content. The presence of certain mycotoxins in cassava and cassava-based products destined for human food and animal feed use is not unexpected. Therefore, it is important to diligently monitor products and processes for indications of the various conditions that promote fungal contamination and mycotoxin accumulation as indicated in the *Code of practice for the prevention and reduction of mycotoxin contamination in cereals* (CXC 51-2003).

5. This Code of Practice provides science-based information for all countries to contemplate in their efforts to prevent and reduce mycotoxin contamination in cassava and cassava based products.

6. The effectiveness of this Code of Practice will be determined by regulatory authorities, extension educators, farmers, producers, processors, distributors and food business owners in each country by considering the general principles and examples of GAP and GMP provided in the Code. Additionally, other local crops, climate, and agronomic practices should be examined to facilitate implementation of these practices where applicable. This Code of Practice is expected to apply to all cassava and cassava-based products relevant to human dietary intake and health, as well as international trade.

7. This Code of Practice provides information on general principles for the reduction of various mycotoxins in cassava and cassava based products. In addition, it provides a basis for training and education of farmers, agricultural workers, processors, manufacturers, and distributors.

SCOPE

8. This Code of Practice covers cassava and cassava-based products meant for human consumption and intends to provide national and local authorities, farmers, producers, manufacturers, distributors and other relevant bodies with information and guidance to aid in the prevention and reduction of mycotoxin in cassava and cassava-based products. This guidance covers: Good Agricultural Practices (GAP), Good Manufacturing Practices (GMP), Good Storage Practices (GSP) and Good Distribution Practices (GDP).

2. RECOMMENDED PRACTICES APPLICABLE TO PRE-PLANTING STAGE

9. The farmer should avoid planting in valleys, to avoid pooling water and flooding. Water can transport fungal innoculums. Where possible, ensure proper planning for crop rotation in successive seasons. This will help in reducing innoculums in the farm which may be present from post-harvest waste that harbour toxigenic fungal spores. Particular crops (e.g. groundnuts, maize and sugarcane) have been found to be susceptible to certain species of toxigenic fungi and rotating planting with these crops should be monitored and evaluated. Crops that are said to be of low susceptibility to toxigenic fungi should be used in rotation to reduce the cross contamination from theinnoculums.

2.1 Farmland clearing and preparation

10. After selecting appropriate sites for planting, the land should be cleared, and waste properly disposed of to avoid contamination of the cassava roots with innocula from infected weed or other crops. The soil should be loosened by **tilling using clean (sanitized) and suitable farm tools and equipment** to reduce stress to cassava roots. This is particularly critical during the root growth and maturation period and also to promote healthy root development. Farmers are encouraged to adopt good agricultural practices.

2.2 Cassava variety (cultivar) selection

11. Selection and use of healthy, pest and disease free cassava stems are important for good planting. The ability to resist fungi and other plant pathogens should be considered when selecting cassava varieties. Cassava cuttings that are free of fungi should be planted.

3. RECOMMENDED PRACTICES APPLICABLE TO PLANTING AND PRE-HARVEST STAGE

3.1 Planting

12. To prevent fungal growth no dead stem should be planted. Planting practices that have been reported to prevent rot could be adopted including *vertical planting* which involves placing the cassava cuttings vertically to avoid rot, especially during the rainy season.

13. Avoid planting cassava on land where groundnut, maize, sugarcane or other highly susceptible crops were cultivated the previous year because such soils are likely contaminated with *Aspergillus flavus, Aspergillus parasitic us* and related species.

3.2 Weed control

14. Certain weeds can harbour toxigenic fungi and compete for moisture, light and nutrients thereby stifling cassava plant development. Either manual or mechanical approaches can be used for weed control; approved herbicides could also be used.

15. The use of post emergence herbicide could be recommended immediately once weeds are spotted on the field. In some cases, pre-emergence herbicides could be used before planting to minimize weed growth. Small-scale farms could use hoes and cutlasses to remove weeds, however, care should be taken to prevent mechanical injury of the plant. Note that land preparation needs to be done properly to control the weeds, at least for the first 3 months.

3.3 Pesticide use

16. Approved pesticides could be used to minimize insect damage and fungal infection in the soil or around the crop. Weather models could be used to plan the best pesticide type and application timing. When applying pesticides, users should follow all label instructions to ensure the safe and proper use of the pesticide product. Where needed, ensure access to agrochemicals authorized for use.

3.4 Irrigation

17. Where irrigation is used, ensure that it is applied evenly and that all plants in the field have an adequate supply of water. Irrigation is a valuable method of reducing plant stress in some growing situations. Excess precipitation during anthesis (flowering) makes conditions favourable for dissemination and infection by *Fusarium spp*.; thus irrigation during anthesis and the maturation of the roots should be avoided.

4. RECOMMENDED PRACTICES APPLICABLE TO HARVEST STAGE

4.1 Harvesting

18. Harvesting should involve adequate planning in order to maintain quality, and prevent crop wastage andpossible rot. The amount of roots to be harvested should be determined based on market needs and demand.

19. Cassava should be harvested when the soil is slightly soft and not overly saturated, in order to easily remove soil from the roots and avoid fungal contamination during peeling.

20. However, to meet market demand, cassava roots may be harvested all through the different climatic seasons. As such, it is necessary that measures be taken to prevent or reduce damages to harvested cassava roots, especially for hard soils, to prevent fungal growth after damage.

4.2 Conveyance tools

21. Containers and conveyances (e.g. trucks) used for collecting and transporting the harvested roots from the field to processing and storage facilities, should be clean, sanitized, dried and free of crop residues, insects and visible fungal growth before use and re-use.

4.3 Holding conditions

22. Prior to the processing step and while being held for use, cassava roots should not be exposed to the sun, high temperatures, mechanical damage, or other conditions that could promote fungal contamination, since the roots still have a high water activity suitable for microbial development. Water activity (a_w), commonly defined in foods as the water that is not bound to food molecules that can support the growth of bacteria, yeasts, and fungi. A continuous progression from harvest to final product should be planned, in order that the roots will not be stored for a long period. The ideal time is 2 to 3 days without enhanced storage methods

23. Remaining cassava roots should be taken to a suitable raw material storage room. Enhanced storage methods, such as storing in low temperatures in combination with fungicide treatment or waxing, can help extend shelf life of fresh roots by 2 to 6 weeks. This practice is suitable for storing or exporting large amounts of roots. Food handlers that can afford specialized equipment with the necessary technical skills may use improved storage methods to store fresh roots for preservation.

5. RECOMMENDED PRACTICES APPLICABLE TO POST-HARVEST STAGES

5.1 Cassava-based products

24. Cassava roots can be processed into various fermented or unfermented cassava-based products. These products, which may be specific to certain regions, have a wide range of applications including food for humans. The processing steps by which these various products are obtained differs and can be found in the *Code of practice for the reduction of HCN in cassava and cassava products* (CXC 73-2013). The approach here is to mention some of the various steps that may potentially influence fungal contamination but not for any specific product type. For some product types see Figure 1. Processing of cassava should be initiated within within 8-12 hours of receiving cassava roots as a raw material to avoid spoilage.

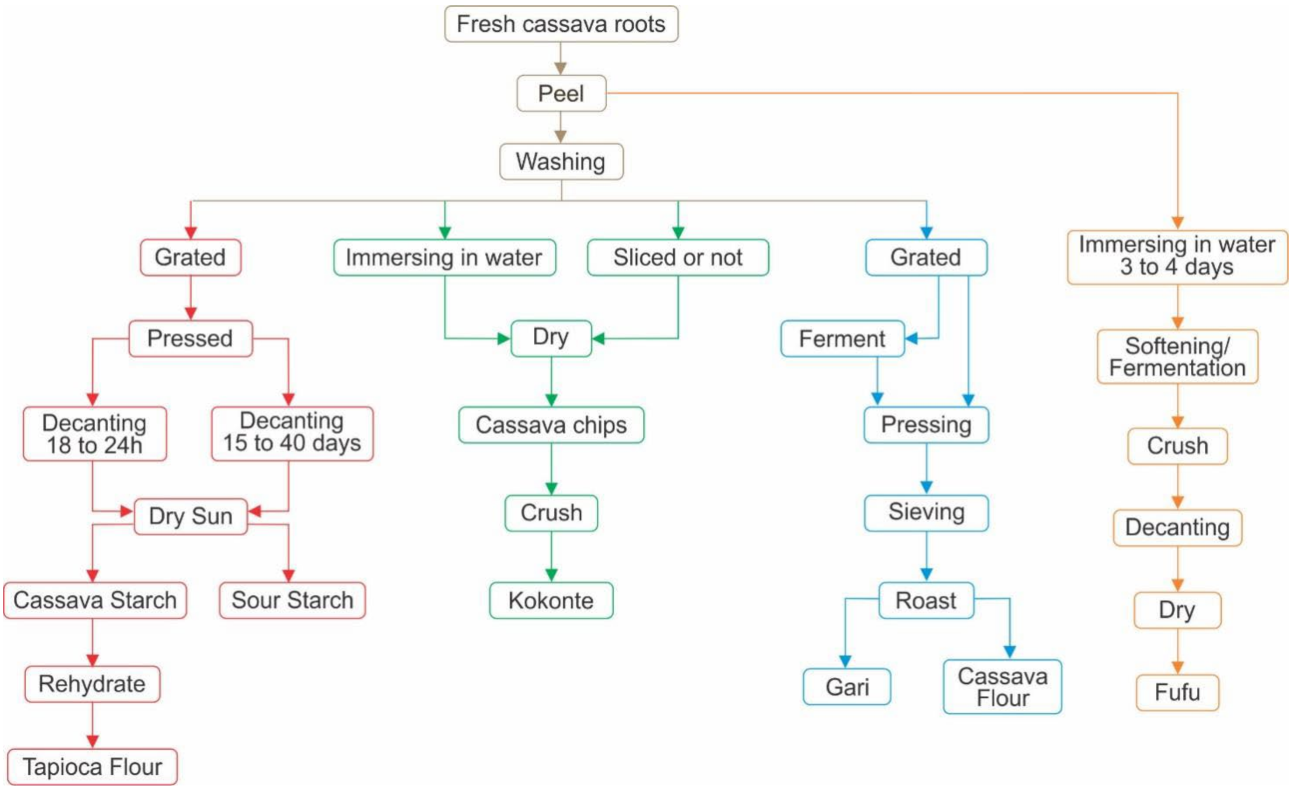

Figure 1. Flowchart of cassava products (Ono & Taniwaki, 2021).

5.1.1 Washing

25. After harvest if cassava root is to be processed immediately it should be washed to remove the surface dirt and soil acquired innoculums of toxigenic fungal species. The source of water is an important factor to be considered. Either potable water or water treated such that it is fit for its intended purpose should be used for washing to avoid potential contamination. Proper washing is vital to ensure sand or mud is removed from all parts of the root, especially the contours.

5.1.2 Peeling

26. Immediately after washing, peeled cassava roots should be processed and should not be stored unprocessed. Peeling is either done manually using a knife or is done mechanically. It is done to remove the outer inedible portion of the cassava roots. Peeling should be carried out in a clean environment, and not in one where other crops have been stored, otherwise, it may serve as a source of contamination for the cassava.

5.1.3 Boiling

27. For the processing of roots of sweet cassava varieties, it is recommended to boil the roots immediately after peeling and washing. This will expose any fungus to temperatures they cannot survive. If not used, immediately, adequate care should be taken to prevent fungal re-contamination

5.2 Size reduction: Grating, pulping and slicing or chipping

28. Where further processing of washed cassava roots includes size reduction activities, regardless of the size of the roots to be further processed, cassava variety, or type of available equipment, adequate care must be taken to ensure such unit processing does not lead to fungal contamination.

29. Where cassava chips or slices are dried at farm level or in a processing facility, the chips or slices should be dried on a cleaned, dry, raised platforms and at appropriate distance away from probable sources of contamination, such as refuse dumps. Where sun-drying is carried out, it should be done on elevated drying mats such as raffia palm, bamboo, oil palm mat, banana leaves, among others, that would ensure good hygienic practice.

30. If chips or slices are dried artificially, the dryers thermostat should be optimally maintained to achieve the desired degree of dryness of the cassava product at the right time to prevent mould growth.

31. Unhygienic practices at this stage could serve as potential sources of fungal innoculums. The environment should be kept clean, and all the tools used for grating, pulping, slicing and chipping should be cleaned and washed after each use and adequately stored dry.

5.2.1 Fermentation

32. The fermentation of cassava roots is primarily used for further cyanide elimination, flavor development and product stability. The sack and the container in which the grated pulp and the peeled root will be kept for fermentation process, should remain clean at all times and especially before use, to ensure it does not become a natural source of innoculums. Fermentation typically takes place, 2 to 5 days fermentation.

5.2.2 Dewatering

33. This process involves removing water from grated cassava roots and it is usually done by pressing. The dewatering process could last up to two days. Dewatering could be done before or after fermentation. Water removal should be optimal and care should be taken not to use contaminated processing materials such as contaminated sacks as they may become sources of fungi innoculums. Food grade sacks should be used. Adequate cleaning and sterilization of the sacks should be done frequently.

5.3 Cake breaking / granulating

34. The process involves feeding the cassava cake into a cassava grater that will break it into granules. Wet cakes can be sifted to remove lumps. Where a cassava grater is not available, a manual sifter is most often used to break the cake and sift the granules at the same time. The grater should be clean and the sacks containing cake or granules should not be placed on dirty surfaces (such as floors). Clean containers should be used to hold the wet granules to ensure product is not contaminated. Clean pans, bowls or sacks should be used in emptying the cakes.

5.4 Drying

35. Drying should thereby be done in a controlled environment and monitored. Drying cassava under the sun should be done when the intensity of the sun light is sufficient. Drying should be properly done to avoid moisture. High microbial loads may be caused by use of unclean drying surfaces and materials such as sheets on raised platforms, so care must be taken to clean surfaces. Granules or chips should be properly spread per square meter of drying surface and should not be overloaded to allow for air circulation. Platforms for drying should be raised to prevent contamination such as dust, animals, and pests. Batches of granules not adequately dried should be spread out in a ventilated room until the products are dried. Drying surfaces and materials should be clean.

5.5 Milling

36. The environment should be monitored to prevent cross contamination from dust. The dried flour should be stored in a clean moisture-proof container. The milling machine should be cleaned and washed after use.

5.6 Sieving

37. The sieve to be used in further processing steps should be stored properly and cleaned with potable water and completely dried before use.

5.7 Frying

38. Frying of gari among other fermented cassava products should be done at high temperatures and monitored in order to discourage fungal proliferation.

6. STORAGE

39. Storage facilities should be cleaned before materials are brought in, to remove dust, fungal spores, crop residues, animal and insects droppings, soil, insects and foreign materials (e.g. stones, metal and broken glass, and other sources of contamination). Sheds, silos, bins and other building materials intended for cassava and cassava-based product storage should be dried and well ventilated. Contamination from the ground water, moisture condensation, rain, entry of rodents, and insects activities can make the commodities more susceptible to fungal infection. Ideally, storage areas should be able to prevent wide temperature fluctuations. Temperature and humidity can be monitored and controlled where possible

40. For bagged cassava products, ensure that bags are clean, dry, non-toxic and stacked on pallets and incorporate a water impermeable layer between the bags and the floor. The bags should facilitate aeration and be made of non-toxic food-grade materials that do not attract insects or rodents and are sufficiently strong to allow storage for longer periods as indicated in the *Code of practice for the reduction of mycotoxin contamination in cereals* (CXC 51-2003).

41. Determine moisture content of the lot, and if necessary, dry the product to the suitable moisture content recommended prior to storage. Fungal growth is closely related with water activity (a_w), and it is recognized that fungal growth is inhibited at a_w of less than 0.60. In addition, safe storage guidance may be provided to reflect the environmental situation in each region.

7. PACKAGING

42. Cassava-based products mainly in the form of flour or granules may be stored in sacks, sealed prior to distribution and sales in the market. Packaging materials should be made of materials which should not easily absorb moisture when packed and sealed.

8. TRANSPORTATION

43. Transport containers, including vehicles such as trucks and railway vessels, boats and ships should be dry and free of old crop dust, visible fungal growth, musty odour, insects and any contaminated material that could contribute to mycotoxin levels in lots and cargoes of cassava and cassava-based products. As necessary, transport containers should be cleaned and disinfected with appropriate substances (which should not cause off-odours, off-flavour or contaminate the cassava and cassava-based products) before use and re-use and be suitable for the intended cargo. The use of registered fumigants or insecticides may be useful. At unloading, the transport container should be emptied of all cargo and cleaned as appropriate.

44. Shipments of cassava and cassava-based products should be protected from additional moisture by using covered or airtight containers or tarpaulins. Minimise temperature fluctuations and measures that may cause condensation to form on the cassava and cassava-based products, which could lead to local moisture build-up and consequent fungal growth and mycotoxin formation.

45. Avoid insect, bird and rodent infestation during transport by the use of insect-and rodent proof containers or insect and rodent repellent chemical treatments if they are approved for the intended end use of the cassava and cassava-based products.

9. INSTRUCTION FOR STORAGE AND PRODUCT USE

46. Specific storage instructions for the cassava and cassava-based products should be provided on the packaging to ensure protection from unfavourable conditions, which may promote fungi growth and contamination. The instructions for storage before (e.g. store in a cool, dry, well-ventilated area) and after the product is opened should be legible and in clear language, in order to maintain product quality. Educators should create awareness on product stacking in storage areas to avoid increased humidity and temperature, which encourage fungal growth.

APPENDIX II

List of Participants

Chair Nigeria
Dr Abimbola Opeyemi Adegboye
National Agency for Food and Drug Administration and Control
NAFDAC Nigeria

Co Chair Ghana
Mr Ebenezer Kofi Essel
Food and Drugs Authority (FDA)

BRAZIL

Ligia Lindner Schreiner
Health Regulation Specialist
Brazilian Health Regulatory Agency

Carolina Araújo Viera
Health Regulation Specialist
Brazilian Health Regulatory Agency

Ana Claudia Marquim Firmo de Araújo
Specialist on Regulation and Health Surveillance
Brazilian Health Regulatory Agency

EUROPEAN UNION

Mr Frans VERSTRAETE
European Commission

INDONESIA

Mrs Yusra Egayanti
Deputy Director Certain Food Standardization
Indonesia Food and Drug Authority

Yeji Seong
Codex researcher
Food Standard Division,
Ministry of Food and Drug Safety(MFDS),

Miok Eom
Senior Scientific Officer
Residues and Contaminants Standard Division,
Ministry of Food and Drug Safety(MFDS),

NIGERIA

Professor Hussain Makun
Head of Africa Centre of Excellence in Mycotoxin and Food Safety
Federal University of Technology. Minna Niger State

Dr. Daniel Ojochenemi Apeh
Department of Biochemistry
Federal University of Technology

Mrs Amalachukwu Ufondu
Chief Regulatory Officer
NAFDAC

Codex Contact Point
SON Nigeria National Codex Committee Secretariat
SON Abuja

THAILAND

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

Ms. Korwadee Phonkliang
Standards officer
Office of Standard Development
National Bureau of Agricultural Commodity and Food Standards

UNITED STATES OF AMERICA

Anthony Adeuya
Center for Food Safety and Applied Nutrition
Food and Drug Administration