CODEX ALIMENTARIUS COMMISSION E

Food and Agriculture Organization of the United Nations

World Health Organization

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Agenda Item 11 **CX/CF 13/7/11**
February 2013

JOINT FAO/WHO FOOD STANDARDS PROGRAMME

CODEX COMMITTEE ON CONTAMINANTS IN FOODS

Seventh Session
Moscow, Russian Federation, 8 – 12 April 2013

PROPOSED DRAFT CODE OF PRACTICE TO REDUCE THE PRESENCE OF HYDROCYANIC ACID IN CASSAVA AND CASSAVA PRODUCTS

(AT STEP 3)

Codex Members and Observers wishing to submit comments at Step 3 on the proposed draft Code of practice to reduce the presence of hydrocyanic acid in cassava and cassava products (see Appendix 1), including possible implications for their economic interests, should do so in conformity with the *Uniform Procedure for the Elaboration of Codex Standards and Related Texts* (Codex Alimentarius Commission Procedural Manual) before **25 March 2013**. Comments should be directed:

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BACKGROUND

1. At the 3rd meeting of the Committee on Contaminants in Foods in 2009, Australia presented a discussion paper on cyanogenic glycosides[1]. The Committee agreed to request the Joint FAO/WHO Committee on Food Additives (JECFA) to re-consider the data available on cyanogenic glycosides and advise on the public health implications of cyanogenic glycosides and their derivatives in food.[2] In addition, and taking into account any assessment by JECFA, the CCCF would consider developing a code of practice for producing, processing and marketing of foods which may contain cyanogenic glycosides or their derivatives.

2. The 6th session of CCCF agreed to establish an electronic working group led by Australia and co-chaired by Nigeria to start new work on a code of practice and maximum levels for hydrocyanic acid in cassava and cassava products for comments at Step 3 and consideration by the next session pending approval by the 35th session of the Codex Alimentarius Commission.

3. In order to carry out this task, the Committee agreed that the working group would:

- undertake a review of the MLs for hydrocyanic acid in existing Codex commodity standards for bitter cassava and sweet cassava with a view of the possible revision of these MLs and the establishment of new MLs for additional commodities, such as ready-to-eat cassava chips;
- develop a code of practice to reduce the presence of hydrocyanic acid in cassava in which the agricultural aspects and the methods of processing are addressed; and
- identify methods of analysis suitable for analysis of hydrocyanic acid in foods.[3]

[1] ALINORM 09/32/41, paras. 105-108 and 119.
[2] ALINORM 09/32/41, para. 119, ALINORM 10/33/41, para. 100, REP11/CF, para. 92, REP12/CF, para. 40.
[3] REP12/CF, paras. 165-166.

4. This work of the eWG has been progressed as two documents:

- The review of the levels for HCN in bitter and sweet cassava and MLs for cassava products in existing commodity standards and consideration of MLs for additional cassava commodities (includes identifying methods of analysis of HCN in foods) (CX/CF 13/7/10).
- The Code of practice for reduction of HCN in cassava and cassava products (CX/CF 13/7/11).

5. The preparation of the ML review document was led by Australia and the Code of Practice was led by Nigeria. Working group members were Brazil, Canada, China, Columbia, Dominican Republic, European Union, FAO, Federated States of Micronesia, Fiji, Ghana, Indonesia, International Organization of the Flavor Industry, Jamaica, Japan, Malaysia, New Zealand, Nigeria, Papua New Guinea, Philippines, Republic of Korea, Samoa, Solomon Islands, Suriname and Vanuatu (see Appendix 2, List of Participants).

6. The working group considered that there is sufficient information available to permit the development of a code of practice and developed a proposed draft for consideration by the Committee as presented in Appendix 1.

Appendix 1

PROPOSED DRAFT CODE OF PRACTICE FOR THE REDUCTION OF HYDROCYANIC ACID (HCN) IN CASSAVA AND CASSAVA PRODUCTS

INTRODUCTION

1. Hydrogen cyanide is a volatile compound which evaporates rapidly in the air at temperature over 28°C and dissolves rapidly in water. It may easily be lost during transport, storage and analysis of samples.

2. Hydrogen cyanide is a chemical compound that can be released from cyanogenic glycosides that are natural constituents of some plants such as: bitter almonds, sorghum, cassava, lima beans, stone fruits and bamboo shoots. Therefore reduction and removal measures of hydrogen cyanide (HCN) should focus on the precursor i.e. cyanogenic glycosides and cyanohydrins.

3. Hydrogen cyanide may be toxic to humans and animals, and the severity of the toxicity depends on the quantity consumed.

4. Cassava is an important staple crop containing cyanogenic glycosides. The cassava plants including the roots also contain the enzyme linamarase that breaks down the cyanogenic glycosides to release cyanohydrin, which dissociates at low levels of acidity to produce hydrogen cyanide. The extent of the breakdown of the cyanogenic glycosides and the eventual release of hydrogen cyanide depends on the amount of linamarase present in the cassava tissue; the extent of the disruption of the tissue, the acidity of the product, and the heat treatment are key factors in determining the concentration of residual cyanogens in cassava products. It is evident that high concentrations of cyanogenic glycosides may result in higher concentrations of Hydrogen cyanide.

SCOPE

5. This Code of Practice intends to provide national and local authorities, manufacturers and other relevant bodies with guidance on how to produce cassava products with safe concentrations of residual cyanogenic compounds.

GENERAL REMARKS

6. This Code outlines measures that have been proven to prevent and/or reduce concentrations of Hydrogen cyanide in cassava products. When applying the code for cassava processing methods should be carefully chosen from the viewpoint of benefit and feasibility. In addition, these should be implemented in accordance with the relevant national and international legislation and standards.

7. It is recognized that reasonable application of technological measures such as Good Manufacturing Practices (GMP), can be taken to prevent or reduce significantly the concentrations of hydrogen cyanide in cassava products.

MEASURES TO REDUCE THE PRECUSOR OF HYDROGEN CYANIDE

8. The potential cyanide content in cassava varies with the variety of cassava, the environmental conditions in which it is grown (e.g. drought) and time of harvest.

9. Varieties with low cyanide content have been developed and should be used during cultivation.

10. Harvesting should be done at the appropriate time because studies have shown increased cyanide in late harvested cassava.

TYPICAL PRODUCTION PROCESS

11. Processing is effective in reducing cyanogenic compound content to minimum concentrations when done appropriately. Inadequate or poor processing as sometimes occurs during famine and periods of social stress or the rush to market can lead to high residues of HCN in the final product.

12. The production process for cassava products varies with the intended product. Some examples of cassava products include gari, fufu, cassava flour, cassava starch, tapioca, cassava chips etc. Figures 1-6 illustrate the steps in the production processes of some cassava products.

GARI PRODUCTION

13. For gari, a fermented, granular cassava food product; the production process involves selection of cassava tubers, peeling, washing, grating, dewatering and fermentation, sieving, frying, cooling/drying, sieving and packaging. The process typically follows the steps listed below.

    a. **Selection**: Fresh and wholesome cassava tubers are selected from the lots for processing

    b. **Peeling**: Peeling is carried out to remove the outer inedible parts of the roots; these are known to contain most of the cyanogenic glycosides.

    c. **Washing**: This is done to remove dirt and other contaminants. It is advisable to also wash before peeling to reduce the microbial load.

d. **Grating the cassava roots**: Grating is done either manually by rubbing peeled and washed cassava roots against a metal sheet with perforations made with a nail or mechanically using a grater. During grating, the cyanogenic glycosides are hydrolyzed by the enzyme, linamarase.

e. **Dewatering and Fermentation**:

i. In traditional fermentation, fermentation and dewatering are carried out at the same time by packing the grated cassava in sacks and pressed under pressure by putting weights on the sacks or using hydraulic press.

ii. Fermentation is done to develop the taste of the gari. The fermentation period could be between 12 – 24 hours, resulting in the production of gari with an almost bland taste and high starch content, or could vary from 48 – 164 hours resulting in the production of gari with sour taste and lower starch content.

iii. During fermentation, especially within 12 – 24 hours, cyanohydrins, which is the intermediate product of the breakdown of the cyanogenic glycoside rapidly dissociates to produce hydrogen cyanide which is volatile and easily lost. However as fermentation is allowed to progress beyond this time, the cassava mash becomes acidic (this is responsible for the sour taste) and the acidity retards the spontaneous dissociation of the cyanohydrins and fixes them in the food. These cyanohydrins slowly dissociate under normal storage conditions; the rate of dissociation is increased by contact with alkalis and/or heat.

f. **Sieving**: Sieving is done to remove the large lumps and fibres and also to obtain a homogeneous product for a more uniform roasting of individual particles during the roasting operation.

g. **Roasting**: Should be properly done by placing the sieved fermented grated cassava on a pan stirring until it becomes dry. Palm oil may be added during roasting as is done in some parts of Nigeria. Roasting has an effect on the amount of residual cyanogenic compounds in the final product and the shelf life/storability of the product.

FUFU AND FUFU POWDER PRODUCTION

14. The production of fufu, and fufu flour involves: Peeling of the roots, washing, cutting, fermentation, mashing and sieving/pounding, dewatering and drying. The process follows the steps listed below.

a. Selection of fresh whole cassava roots

b. **Peeling**: peeling is carried out to remove the outer inedible part which is known to contain most of the cyanogenic glycosides.

c. **Washing**: the peeled cassava roots are washed with water.

d. **Cutting**: the washed cassava roots are cut into small pieces. These will facilitate the fermentation process.

e. **Fermentation**: Fermentation is carried out in tanks or other suitable fermentation vessels for 3-4 days.

f. **Mashing/Pounding**: The fermented cassava pieces are mashed and passed through a sieve, and when the roots are not soft enough to be mashed by hand, they are pounded or passed through a grater before the fibres are removed by adding water to the mash and filtering.

g. **Dewatering**: Excess water is removed from the mash by packing the mash into a woven polyethylene sack and pressing with weights or a hydraulic press to produce fufu.

h. **Drying**: Instant fufu flour is produced by either sun drying of the dewatered mash or artificially using a mechanical dryer.

DRIED CASSAVA CHIPS

15. Cassava chips are dried granules derived from clean, fresh cassava (Manihot esculenta Crantz). The production of dried cassava chips involves peeling, slicing or chipping, and drying.

a. **Peeling**: Peeling is carried out to remove the outer inedible parts of the root; these are known to contain most of the toxic cyanogenic glycosides.

b. **Chipping/slicing**: The objective of chipping is to expose the maximum surface of the cassava roots and encourage rapid drying. Best drying in terms of quickness and quality of the end product is achieved when the peeled cassava is thinly sliced - less than 10 mm thick.

c. **Drying**: Sun-drying of cassava chips is carried out on any convenient flat surface, the objective is to produce dry cassava chips which are clean, having white color, free from extraneous matter and can be safely stored for long periods.

OTHER CASSAVA PRODUCTS

16. Cassava chips used as a snack food may be made from extruded flour or from dried cassava chips.

a. **Peeling**: Peeling is carried out to remove the outer inedible parts of the root; these are known to contain most of the cyanogenic glycosides.

b. **Slicing**: The objective of slicing is to expose the maximum surface of the cassava roots and encourage a rapid drying. Best drying in terms of quickness and quality of the end product is achieved when the peeled cassava is thinly sliced less than 2 mm

c. **Frying, heating food up to temperatures above 180°C**: The surface dries out, sealing the water content inside.

17. There are several other cassava based food products such as Lafun, an unfermented Cassava flour; Atteke - steamed fermented cassava granules; Chikwangue, Bila - a soaked cassava Fijian food; Farinha - a roasted cassava product produced in Brazil; Bikedi - a traditional fermented cassava root food and Ntoba mbodi - a semi solid fermented cassava leaves soup both consumed in Congo. Their methods of preparation are similar to the foregoing process steps although in some instances may differ; examples are soaking, wrapping of tubers, etc.

PRACTICES BASED ON GOOD AGRICULTURAL PRACTICES

18. Cultivars of sweet cassava should be carefully selected and planted

19. Conditions of severe drought during planting should be avoided or minimized through cultivation practices such as wetting, instead of neglecting the plant.

RECOMMENDED PRACTICES BASED ON GOOD MANUFACTURING PROCESSES

20. Raw Materials Selection

Selection of cassava Roots: Cassava roots for the preparation of cassava products should be harvested not more than 24 hours before processing.

21. The cassava selected from the lots should be of high quality. They should be free of bruises, not mechanically damaged, not microbiologically spoiled and should not be woody.

Preparation of Cassava Products

22. Process flow charts for preparation of different cassava products are given in Figures 1-6. However the following, not in any particular order, are recommended practices for each of the unit operations in the flow charts of the products.

23. **Peeling**: This should be done with clean stainless knives. Ensure that the peels including rinds (inedible part) are completely removed; they are known to contain very high concentrations of cyanogenic glycosides which can be toxic.

24. **Washing**: Wash the peeled roots in water at least twice to remove pieces of the peel, sand and other dirt.

25. **Grating**: Grating should be properly done using stainless steel equipment to rupture the cassava tissue for a fast breakdown of cyanogenic glycosides.

26. **Soaking**: Soaking in water is often done for one to three (1-3) days, before or after the chipping operation during which some fermentation takes place that gives the chips the sour flavour favoured by some consumers. It also allows hydrogen cyanide to diffuse out making the product safer for human consumption. The National Root Crop Research Institute in Nigeria suggested that optimal hydrocyanic acid reduction can be achieved through a combination of 15 minute soaking and 2 minute blanching of cassava chips.

27. **Fermenting**: Put cassava mash in a clean sack and tie. Allow to stand in a fermenting trough for 2-3 days. Arrange the sacks in such a way that there is no contact with sand or dirt that can contaminate the mash. Allow free seeping of water from the sacks. Fermenting should not be less than 2 days to ensure adequate cyanide detoxification. The practice of processing cassava roots which have stored overnight without fermenting the mash is not encouraged because the gari produced by this method invariably contains high concentrations of cyanide.

28. **Pressing**: At the end of the fermentation period the mash in the sacks is pressed to remove as much moisture as possible. Pressing is completed when water is no longer dripping from the sacks. If dewatering is not complete, there would be lumps during toasting which reduce the quality and yield of gari.

29. **Cake breaking / Sifting or Sieving**: The cassava mash cake produced by the dewatering/pressing process is disintegrated using clean hands followed by sifting/sieving with a non-rusting sifter into a clean basin. A sifter made of stainless steel material is preferable.

30. **Toasting**: Toast and stir constantly in a large shallow cast-iron pan over fire, with a piece of gourd or wooden paddle until the product, gari in this instance, is dried.

31. **Cooling**: Collect the toasted product in a clean basin and spread on a raised platform lined with clean polythene material or white cloth to cool to room temperature.

32. **Packaging**: Packaging of processed cassava products should be in clean, insect-and moisture-proof materials that guarantee the wholesomeness of the product and retention of its nutritional, physical and sensory qualities. The packaging material should not impart any toxic substance or undesirable odour/flavour to the cassava product.

33. **Chipping**: Chipping of cassava should be done thinly 10 mm for efficient, fast and adequate drying.

34. **Drying**: should be done in a hygienic and dust free environment where animals and birds cannot get to it.

35. **Storage**: Storage of finished product or dried intermediate product should be in a cool, dry, well-ventilated, insect-and rodent-free store/enclosure.

36. **Cooking**: Only Cassava known to have low cyanide should be used for direct cooking and consumption i.e. the sweet type, because cyanogenic glycosides are heat stable.

GENERAL RECOMMENDATIONS

37. National, state and local governments as well as non-governmental organizations (NGOs, commercial associations and cooperatives) should be involved in promoting effective cassava cultivation with the introduction of low cyanide, high yielding and well-adapted varieties of cassava and processing methods as a means to ensure maximum reduction of residual cyanogens in cassava food products.

38. Campaigns for introduction of other staples, vegetables, pulses and fruits to decrease the daily cyanide intake and broaden the diet should also be embarked on.

39. Non-industrial, small-scale producers of cassava and cassava products should have access to materials with information on the specific recommendations based on Good Manufacturing Practice and guidance on methods for reducing residual cyanogens in cassava products.

40. Food Safety Authorities and Public Health Monitoring bodies may consider introducing scientific kits such as picrate kits (Egan et al., 1998; Bradbury et al., 1999) to monitor cyanide concentrations in cassava products the point of use and urinary thiocyanate concentrations in the population (Hague and Bradbury, 1999).

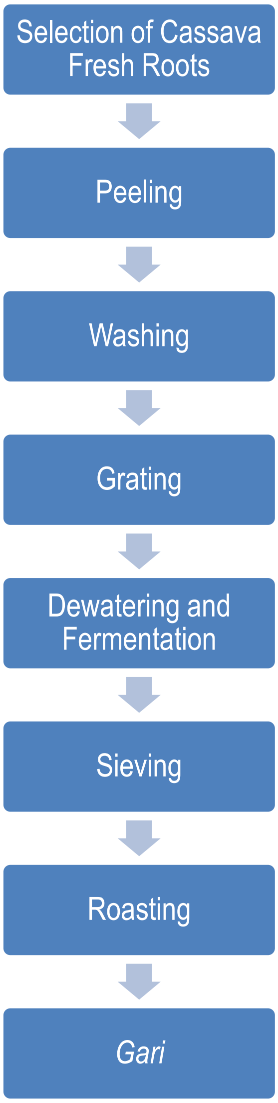

Figure 1: Flow chart for production of gari

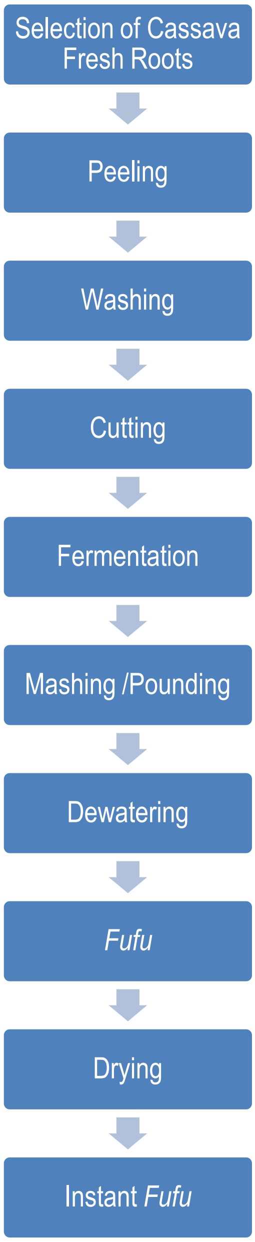

Figure 2: Flow chart for production of Fufu/Instant fufu

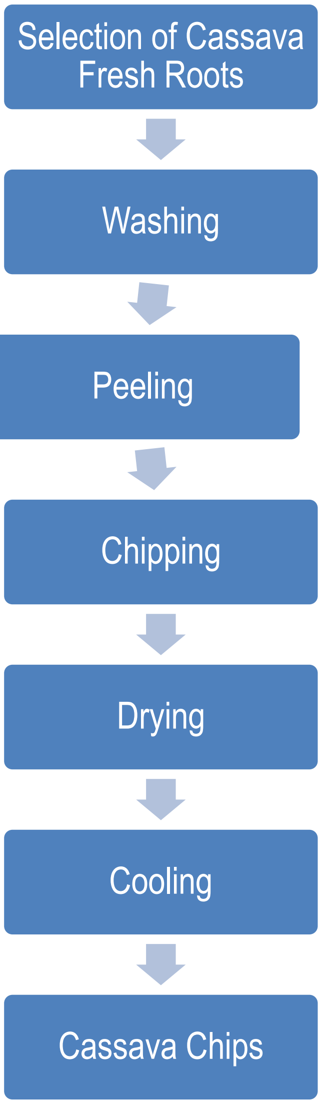

Figure 3: Flowchart for production of Cassava chips

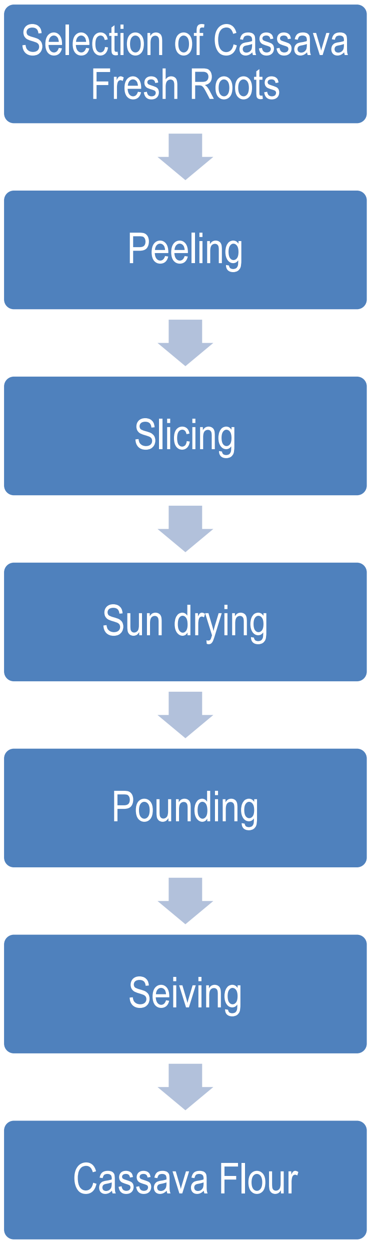

Figure 4: Flowchart for Production of Unfermented Cassava Flour

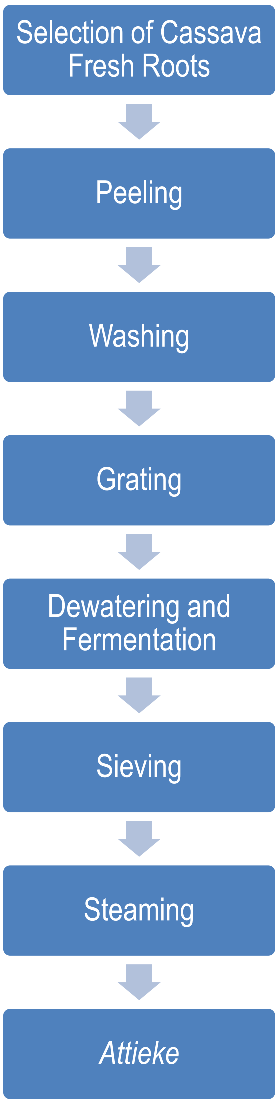

Figure 5: Flowchart for production of Attieke

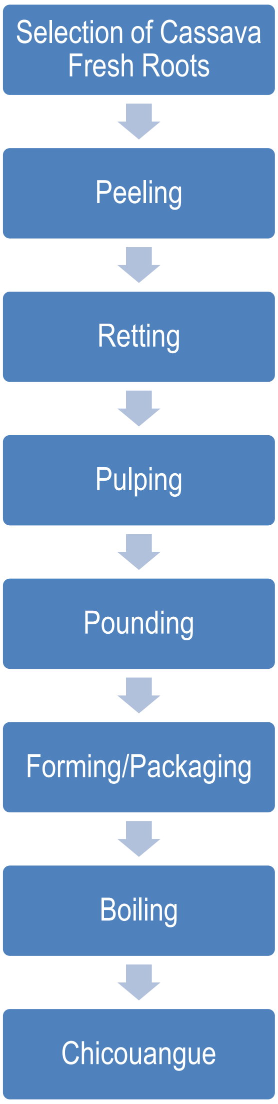

Figure 6: Flowchart for Production of Chicouangue

Appendix 2

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