CODEX ALIMENTARIUS COMMISSION

Food and Agriculture Organization of the United Nations

World Health Organization

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Agenda Item 16 **CX/CF 18/12/16**

JOINT FAO/WHO FOOD STANDARDS PROGRAMME

CODEX COMMITTEE ON CONTAMINANTS IN FOODS

12th Session
Utrecht, The Netherlands, 12 - 16 March 2018

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

(Prepared by the Electronic Working Group led by Peru)

BACKGROUND

1. The 11th Session of the Committee on Contaminants in Foods (CCCF11) (2017) agreed[1] that Peru would lead an electronic working group (eWG) to prepare a discussion paper on the development of a Code of practice for the prevention and reduction of cadmium contamination in cocoa. The list of participants is contained in Appendix III.

2. The work process leading to the conclusions and recommendations is presented in Appendix II.

3. The Committee is invited to consider the conclusions and recommendations including the project document (Appendix I) as follows:

CONCLUSIONS

- Human intake of cocoa is low, so health risks from exposure to Cd through cocoa consumption are low and “not considered to be a health concern” FAO/WHO (JECFA 2013)
- Codex MLs for cocoa or cocoa products have not yet been established to date so exporting countries from Latin America and the Caribbean could be affected by country - specific standards. Ongoing interventions at FAO/WHO *Codex Alim*entarius or (JECFA) are essential to ensuring that reasonable MLs are adopted.
- More research on mitigation measures and their correspondent validation in different agro ecosystems is needed to prevent and reduce Cd contamination in cocoa beans and cocoa products. Moreover, carry out investigation works to validate the proposed use of soil microbiology (mycorrhizal fungi, actinomycetes, etc.) under field conditions to reduce the absorption of Cd in Cocoa beans.
- The development of skills in harvest and post-harvest technologies (research, mass application, standardization of criteria, specialized personnel) are required.
- It is very important the implementation of cadmium traceability through the use of records and the improvement of their use along the cacao production chain from planting, harvest, to post-harvest and industrialization.
- Re-evaluate existing measures and adapt them to the agroecosystem of production areas with the participation of specialists.
- It is necessary that risk mitigation measures be cost effective. Cost-benefit analysis is required to understand the applicability of mitigation technologies as solutions in the short and long term, especially for small farmers.
- To have a Code of Practice to prevent and reduce the contamination of cadmium in cocoa beans will be beneficial for trade worldwide.

[1] REP17/CF, paras. 154-155

RECOMMENDATIONS

- Progressive implementation of available mitigation measures for reduction of cadmium levels in food should be put in practice by farmers and food business operators This recommendation encourages further investigations to fill any possible gaps in knowledge on mitigation measures
- Improvement of infrastructure and equipment for fermentation and drying process with modules adapted to tropical environment conditions of the production areas may reduce Cd contamination. It is also recommended the installation of laboratories officially accredited for Cd assessing.
- It will be of great help that the Committee on Contaminants of Food can assist to make a survey about validated practices ("on farm assessments that gave good results and were profitable") for the Prevention and Reduction of Cadmium Contamination in Cocoa among cocoa producing country members of Codex in order to consolidate them in the Code of Practice. It will also be helpful to conduct the proposed survey prior starting a new work on developing the Code of Practice.

APPENDIX I

PROJECT DOCUMENT

PROPOSAL FOR NEW WORK ON A "CODE OF PRACTICE FOR THE PREVENTION AND REDUCTION OF CADMIUM CONTAMINATION IN COCOA BEANS"

(For consideration by CCCF)

1. Objective and scope of the project.

The purpose of the new proposal is to develop a Code of Practice (COP) that will provide guidance to Member States and the cocoa production industry on the prevention and reduction of cadmium (Cd) contamination in cocoa beans during production and post-harvest processing. This COP applies to the cocoa beans marketed internationally.

2. Relevance and timeliness.

At its 77th Session, the Joint FAO / WHO Expert Committee on Food Additives (JECFA) determined that the estimates of mean population dietary exposure to Cd from products containing cocoa and its derivatives for the 17 GEMS/Food Cluster Diets ranged from 0.005 to 0.39 µg/kg bw per month, which equated to 0.02 – 1.6% of the PTMI of 25 µg/kg bw.

The potential dietary exposures to Cd for high consumers of products containing cocoa and its derivatives in addition to Cd derived from other foods were estimated to be 30-69 % of the Provisional Tolerable Monthly Intake (PTMI) for adults and 96% of the PTMI for children 0.5 – 12 years of age. JECFA noted that this total Cd dietary exposure for high consumers of cocoa and its products was likely to be overestimated and they did not consider it a matter of concern.

With the entry into force of the European Union Regulation 488/2014 on 1 January 2019 on maximum levels (MLs) of Cd in foodstuffs including chocolates and cocoa products a Code of Practice that outlines techniques to prevent and reduce Cd contamination in cocoa to as low as reasonably achievable may help to reduce Cd exposures and support fair trade.

3. Evaluation with regard to the criteria for setting priorities for work:

General criterion

A COP will outline a range of agricultural and industrial measures that will help to reduce levels of Cd in cocoa and cocoa products to levels that are as low as reasonably achievable (ALARA), noting that there is an electronic working group (EWG) chaired by Ecuador and co-chaired by Brazil and Ghana that is proposing a Codex MLs for Cd in chocolate and cocoa-derived products.

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

The COP will provide a consistent source of guidance to cocoa producers and post-harvest processors in all of Member States to prevent and reduce cadmium contamination in cocoa beans. It will thus provide assurance to exporters that levels of Cd in cocoa and cocoa products meet the ALARA principle, and also Codex MLs that are under development.

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

The scope of work involves developing a COP that will provide technical guidance on the reduction of Cd contamination in cocoa beans in all aspects of production. The development of this COP will help to reduce exposures to Cd and support international trade.

- Work already undertaken by other organizations in this area.

At its 77th meeting, JECFA assessed the potential health risk arising from Cd contamination of cocoa and its derivatives in the food supply. At the 8th session of CCCF (2014) the Committee agreed to establish an EWG to prepare new work on MLs for Cd in chocolate and cocoa-derived products.

4. Relevance to the Codex Strategic Objectives

The proposed activity falls within the following strategic objective of Codex:

Objective 1.2: Proactively identify emerging issues and needs of Members and, where appropriate, develop relevant food standards

The development of a COP will help to prevent and reduce Cd contamination in cocoa and cocoa products, thus helping to reduce exposures to this contaminant and potential disruptions to international trade in this commodity.

5. Main topics to be discussed

Production systems (growing areas, soil health, shading, pruning, optimal time of harvest, etc.), cocoa genetics (clones, germplasm), post-harvest technology (fermentation, drying), traceability and review of possible causes of Cd uptake by plants.

6. Relationship between the proposal and existing Codex documents and work in progress

Existing Codex documents

- CAC/RCP Standard 56-2004: Code of Practice for the Prevention and Reduction of Lead Contamination in Foods.
- CAC/RCP 77-2017: Code of Practice for Prevention and Reduction on Arsenic Contamination in Rice.

Work in progress (CCCF12)

- Proposed Draft on Maximum Levels for Cadmium in Chocolate and Cocoa-Derived Products.

7. Calendar for this new work

Start date: June 2017

Date proposed for adoption at Step 5: May 2020, and proposed

Date for adoption by the Commission: May 2021.

APPENDIX II

BACKGROUND INFORMATION

(For information to Codex Members and Observers when considering the conclusions and recommendations)

BACKGROUND

1. At the 61st the Joint FAO/WHO Expert Committee on Food Additives (JECFA61) (2003) it was estimated that the total dietary intake of cadmium (Cd) ranged from 2.8 to 4.2 µg/kg bw per week. This was calculated from available data on concentrations and food consumption data taken from the GEMS/Food regional diets and corresponded to approximately 40-60% of the Provisional Tolerable Weekly Intake (PTWI) of 7 µg/kg bw/week. Regarding major dietary sources of Cd, the following foods contributed 10% or more to PTWI in at least one of the GEMS/Food regions: rice, wheat, starchy roots/tubers, and molluscs. Vegetables (excluding leafy vegetables) contributed >5% to the PTWI in two regions.

2. JECFA73 (2010) re-evaluated Cd as there had been a number of new epidemiological studies that had reported Cd-related biomarkers in urine following environmental exposure. Urinary β2-microglobulin level was chosen as the most suitable biomarker for Cd toxicity because it was widely recognized as a marker for renal pathology and consequently had the largest amount of available data. Because of the long half-life of Cd in human kidneys (15 years), it was concluded that determination of a critical concentration of Cd in the urine was most reliable using data from individuals 50 years of age and older. Considering the exceptionally long half-life of Cd and the fact that daily or weekly ingestion through food would have a small or even negligible effect on overall exposure, JECFA decided to express the tolerable intake as a monthly value in the form of a Provisional Tolerable Monthly Intake (PTMI). The Committee withdrew the PTWI of 7 µg/kg and established a PTMI of 25 µg/kg body weight.

3. JECFA77 (2013) conducted an assessment of exposure from cocoa and cocoa products at the request of the 6th Session of the Committee on Contaminants in Foods (CCCF06, 2012). The estimates of mean population dietary exposure to Cd from products containing cocoa and its derivatives for the 17 new GEMS/Food Cluster Diets ranged from 0.005 to 0.39 µg/kg bw per month, which equated to 0.02-1.6% of the PTMI of 25 µg/kg bw. The potential dietary exposures to Cd for high consumers of products containing cocoa and its derivatives, in addition to Cd derived from other foods, were *e*stimated to be 30-69% of the PTMI for adults and 96% of the PTMI for children 0.5-12 years of age. The Committee noted that this total Cd dietary exposure for high consumers of cocoa and cocoa products was likely to be overestimated and did not consider it to be of concern.

4. Notwithstanding JECFA'S conclusions, and noting that cocoa is a valuable, non-perishable commercial crop that contributes to the economies of developing countries, measures should be taken to ensure that Cd levels in cocoa beans and cocoa products are as low as reasonably achievable (ALARA). This will help to avoid any potential for Cd contamination becoming a public health problem, as well as to ensure that fair trade is not compromised**.** The ALARA principle should be understood, in this case, as practices to prevent or reduce contamination, without becoming impracticable due to the costs that may be added to production**.**

5. At CCCF 11 (2017) Peru introduced a proposal for a Code of Practice (COP) for the Prevention and Reduction of Cd Contamination in Cocoa Beans and explained that the proposed COP aimed to guide Member states and the cocoa production industry in preventing and reducing Cd contamination in cocoa beans during the production and processing phases (post-harvest). After a general discussion the Committee agreed to establish an EWG chaired by Peru to prepare a discussion paper and project document on the opportunity to develop such a COP and the risk mitigation measures available that would support the development of a Code of Practice, for discussion at the next session of CCCF 12.

GOAL, OBJECTIVE, SCOPE

Goal

6. Provide guidance to producers and post-harvest processors of cocoa beans to prevent and reduce Cd contamination in cocoa beans.

7. The development of a COP that will help limit Cd contamination in cocoa beans and cocoa products will assist to avoid any potential for Cd contamination becoming problem. It will also aid to ensure that levels are maintained below MLs under consideration by CCCF supporting market access for cocoa beans and their products, particularly for some member countries where cocoa is a valuable commercial crop.

Objective

8. Provide recommended production practices to prevent and reduce Cd contamination in cocoa beans.

Scope of the Code of Practice

9. It covers the primary production of cocoa beans and its post-harvest processing, including traceability.

INTRODUCTION

10. The cocoa or cacao tree (*Thebroma cacao* L*)* is a tropical tree, the source of cocoa beans used to manufacture chocolates, confectionery products and beverages.

11. C is a non-degradable contaminant, and is the most soluble of all heavy metals with great ability to bioaccumulate in plant and animal tissues.

12. Waters in arid areas contain chloride, which makes Cd available in foods because Cd salts with chloride are more soluble and more mobile than other salts.

13. It is important to study different measures for Cd prevention and reduction in cocoa beans and cocoa products, including plant genetics and agronomic approaches.

14. With the estimated half-life of Cd in soils ranging from 15 to 1,100 years (Kabata-Pendias, A., Pendias, H. 1984) this is a long-term problem and contamination needs to be prevented or minimized.

15. Cd uptake depends on a variety of abiotic factors (e.g. soil, water and air), as well as plant and agricultural practices that need to be investigated.

- Factors determining Cd uptake by plants (McLaughlin, M. 2016)

Factors	Effect on Cd uptake by plants
Edaphic factors	
1. pH	Uptake increases when the pH decreases
2. Salinity	Uptake increases with salinity
3. Level of Cd	Uptake increases with the concentration
4. Trace elements	For example zinc (Zn) deficiency increases its uptake
5. Macronutrients	May increase or decrease uptake
6. Temperature	High temperature increases uptake
Crop factors	
1. Species and cultivars	Vegetables > roots > cereals > fruits It reads: Vegetables absorb more than roots, roots more than cereals, and cereals more than fruits
2. Plant tissues	Leaf > grain > fruits and edible roots
3. Leaf age	Old leaves > young leaves
4. Interaction with metals	Presence of Zn reduces Cd uptake

16. It is paramount to know the distribution of Cd in soils, horizontally or vertically for its characterization and then its mitigation if necessary

17. National authorities can consider establishing environment quality standards on permissible Cd levels in water, soil and air for crops in order to know whether or not Cd levels represent risk.

18. Cd levels in cocoa has attracted attention lately, and the European Union decided to establish MLs for Cd concentrations in cocoa products becoming effective in January 1, 2019 the Regulation European Union N° 488/2014 of the Commission and there is a great concern that these MLs may threaten the exports from some member countries affecting mainly small farmers of cocoa producing countries in Latin America and the Caribbean.

19. High concentrations of Cd in soils (compared to average concentration) may be due to the application of sewage sludge and farm manure, which occasionally contain excessive concentrations of Cd (Steineck et al., 1999, Eriksson, 2000; Bergkvist et al., 2003 cited by EFSA, 2009)

20. Soil remediation may be one of a number of viable tools to reduce the solubility of Cd, thus preventing excessive uptake and accumulation of Cd in plants (Hooda 2010; Kirkham 2006; Park et al. 2011 cited by Chavez, E. et al 2016).

21. Member countries from Latin America and the Caribbean are conducting investigations to fill the gaps in knowledge regarding appropriate mitigation measures, i.e. Mycorrhizas (Ramtahal, G. et al 2012).

22. The traceability of raw materials is a basic requirement for food safety. Ideally it should be possible to trace a particular lot of cocoa beans from the end user back to the farmers who produced it. For traceability systems to work, it is essential that appropriate records and marking/coding systems are maintained from the farmer through the collector/cooperative onwards and that the integrity of lots is maintained without mixing or blending throughout the supply chain (CAOBISCO/ECA/FCC, 2015) The International Cocoa Organization (ICCO) Total Quality project demonstrated that it is possible to achieve high levels of traceability in mainstream cocoa exports from a major cocoa producing country like Cote d'Ivoire with benefits throughout the supply chain from the farmer to the consumer (ICCO, 2013)

I. RISK MITIGATION MEASURES

SOURCE DIRECTED MEASURES

Identification of sources of contamination: Geogenic or anthropogenic?

23. Geogenic sources depend to a large extent on what has been called geoavailability (Galan, E., Romero, A. 2008). The chemical composition of the parent rock and weathering processes condition, naturally, different concentration of heavy metals in soils (Alloway, B.J. 1995).

24. The main anthropogenic sources of heavy metals in soils including Cd in addition to those previously mentioned related to mining, can be (Galan, E., Romero, A. 2008):

- Agricultural activities: irrigation, inorganic fertilizers, pesticides, manure, limestone amendments and, above all, sewage sludge.
- Industrial activities: the main polluting industries are the iron and steel factories, which emit metals associated with Fe and Ni ores. The manufacture of batteries produces considerable amounts of Pb. The industries that produce chemicals, drugs, pigments and dyes, tanning of skins, etc. In general, highly industrialized areas include Cd.
- Household waste: approximately 10% of garbage is made up of metals, including Cd. Their burial can contaminate the groundwater, while incineration can contaminate the atmosphere by releasing volatile metals and consequently polluting soils. On the other hand, uncontrolled wastes are obviously an important contamination source for soil and superficial waters.

25. House sources of Cd in Municipal solid waste according to categories and percent by weight are NiCd batteries 52%, Plastics 28%, Electric and Electronic devices 9%, Pigments 4%, etc. (EPA 1989 cited by Winzeler M. et al. (1992).

Air emissions of cadmium concentration can be transferred to the soil by wet or dry deposition and can enter the food chain (UNSEEA, 2012).

Agricultural practices to reduce Cd uptake:

Agricultural practices as mitigation measures in the field

26. The Cd uptake by cocoa plants from soil is greater at low soil pH: Thus growers can consider the practice of liming to increase pH and immobilize Cd in acidic soils (McLaughlin, M. 2016)

27. Organic matter complexes with Cd and minimizes its subsequent bioaccumulation. Organic amendments are environmentally friendly and a cost - effective technique (Amjad, M. et al 2017).

28. Cd and Zn are strongly correlated in the soil. Synergism between Zn and Cd both in plant and soil suggests that Zn has a direct effect on Cd accumulation in cocoa. When Zn is deficient, plants may uptake higher levels of Cd. The mitigation consists on increasing the levels of zinc in soil to reduce Cd availability and its bioaccumulation in plants (McLaughlin, M. 2016)

29. Planting areas: As a prevention, the planting of cocoa trees should be in areas where there is no high Cd content, so agricultural soils should not have more than 1.4 mg / kg of Cd (CCME of Canada, 1999; DS 011-2017 MINAM Peru).

30. Screening of phosphate fertilizers: The use of contaminated phosphate fertilizers containing Cd in agriculture increases the risk of Cd content which can enter the soil an bioaccumulate in the crop.

31. Screening of pesticides: Reducing the application rates of fungicides that contain Zn, Cooper (Cu) or Manganese (Mn), or avoiding the use of pesticides as in organic farming may result in the reduction of heavy metals including Cd and other chemical contamination in cocoa beans (FAO,1972)
32. Experiments conducted in the United States and Australia show that the application of lime for pH correction reduce acidity, significantly decreasing the absorption of cadmium (FHIA, 2011; McLaughlin, M. 2016).
33. Pruning: In areas where soil levels of Cd are high, remove pruned material from the ground as they could contain Cd which will be released into the top layers of the soil after decay. The practice should be to remove pruned material from the crop field.
34. Determination of cocoa germplasm of low cadmium uptake and accumulation: Cd uptake and accumulation may be related to varietal differences (native and exotic). As a mitigation practice the identification of cocoa clones that in field conditions do not accumulate cadmium in cocoa beans is promising, although this is a longer-term measure as a plant takes 5 to 7 years to reach fruiting stage.(Arevalo, 2017)

Mitigation measures for post-harvest processing

35. Fermentation process: Cocoa beans from just-ripe healthy pods are used in the fermentation since the beans from immature, overripe or damaged/diseased pods will be of lower quality and may produce food safety issues (CAOBISCO/ECA/FCC, 2015). The containers to be used for the transportation of the cocoa beans from the field to the fermentation and drying establishments must be clean and exclusively used for cocoa beans
36. Drying process: Cocoa beans should be dried off the ground so that they are not in direct contact with soil, tarmac or concrete floors and are inaccessible to animals which may be contaminated with Cd; furthermore, ensure that beans cannot be contaminated by smoke, fumes from dryers or vehicles (CAOBISCO/ECA/FCC, 2015).

Other mitigation measures

Phytoremediation

- Identification of plants as candidates of hyperaccumulators, especially native: *Leucaena, Vetiver grass, Desmodium, Inga, etc.* (Arevalo,2017; Gramlich et al,2018)
- *Phytoremediation practices with cocoa agroforestry systems suitable for each agro-ecological production zone* (Khasa, 2014).

37. Bioremediation

- Use of fungi and bacteria, especially native: Arbuscular mycorrhizal associations are integral and functioning parts of plant roots and are widely recognized plant growth on contaminated heavy metal soils and play an important role in metal tolerance and accumulation. (Ramtahal, G., et al 2012; Anup & Kalu, 2015).

DEFINITIONS

- Bioremediation is the use of living organisms, primarily microorganisms, to degrade environmental contaminants into less toxic forms.
- Phytoremediation is a bioremediation process that uses various types of plants to remove, transfer, stabilize, and/or destroy contaminants in the soil and groundwater.
- Provisional Tolerable Monthly Intake (PTMI). It is a value that represents permissible human monthly exposure to those contaminants unavoidably associated with the consumption of otherwise wholesome and nutritious food.
- Air emissions are defined by the UN System of Environmental Economic Accounts (SEEA) as unwanted gaseous or particulate materials released to the atmosphere as a direct result of production, accumulation or consumption activities in the economy.
- Traceability is the ability to follow the movement of a food through specified stages of production, processing and distribution using records.
- Geoavailabilty of an element or chemical compound of a terrestrial material is that portion of its total content that can be released to the surface or near the surface (or biosphere) by mechanical, chemical, or natural biological processes.
- Synergism: Interaction between two or more substances that produces an effect greater than the sum of their individual effects. Also called synergetic effect or synergistic effect.

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APPENDIX III

LIST OF PARTICIPANTS

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