CODEX ALIMENTARIUS COMMISSION

Food and Agriculture Organization of the United Nations

World Health Organization

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CL 2017/24-CF
March 2017

TO	Codex Contact Points Contact Points of international organizations having observer status with Codex
FROM	Secretariat, Codex Alimentarius Commission, Joint FAO/WHO Food Standards Programme
SUBJECT	**REQUEST FOR COMMENTS AT STEP 3 ON PROPOSED DRAFT MAXIMUM LEVELS FOR CADMIUM IN CHOCOLATE AND COCOA-DERIVED PRODUCTS**
DEADLINE	**25 March 2017**
COMMENTS	Codex Contact Point The Netherlands Email: info@codexalimentarius.nl

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BACKGROUND

1. The 6th Session of the Codex Committee on Contaminants in Foods (CCCF06) (2012) was informed that a proposal for an assessment of exposure to cadmium (Cd) from cocoa and cocoa-derived products was made for inclusion in the priority list of contaminants and naturally occurring toxicants by the Joint FAO/WHO Expert Committee on Food Additives (JECFA). The Committee agreed to include the proposal in the list and noted that relevant data would be needed to undertake the assessment (REP 12/CF, paras. 158-163, Appendix XI).

2. Following the request of CCCF06, the exposure assessment to cadmium from cocoa and cocoa-derived products was considered by the 77th JECFA Meeting (2013). The outcome of JECFA77 was considered by CCCF08 (2014).

3. At CCCF08, the JECFA Secretariat informed CCCF on the outcome of the JECFA77 evaluation regarding the exposure assessment to cadmium from cocoa and cocoa products which concluded that total cadmium exposure including for high consumers of cocoa and cocoa products was not considered to be of concern. The Committee agreed to discuss the possible establishment of maximum levels (MLs) for cadmium in cocoa and cocoa products (REP14/CF, paras. 6-7).

4. In this regard, Ecuador presented its proposal for new work on MLs for cadmium in chocolate and cocoa-derived products. The Delegation noted that although the JECFA77 assessment reported that cadmium intake through the consumption of chocolate and cocoa-derived products is not a health concern, the lack of MLs for cadmium in cocoa and its products could threaten the exports of some member countries, especially developing countries which are the main exporters of cocoa.

5. The Committee agreed to initiate new work on MLs for Cd in chocolate and cocoa-derived products and to establish an Electronic Working Group (EWG) led by Ecuador, co-chaired by Ghana and Brazil, to prepare proposals for MLs for comment and consideration by CCCF09 (2015), subject to the approval of the 37th Session of the Codex Alimentarius Commission (CAC37) (REP14/CF, paras. 141-142, Appendix XI).

6. CAC37 (2014) approved the new work on MLs for cadmium in chocolate and cocoa-derived products as proposed by CCCF08 (REP14/CAC, Appendix IV).

7. At CCCF09 (2015), Ecuador, as Chair of the EWG, informed the Committee that in view of the diverse comments received, it would be difficult to reach agreement and that the EWG should continue to develop the proposal for consideration at the next session. The Committee agreed to reestablish the EWG, chaired by Ecuador and co-chaired by Brazil and Ghana to reconsider the proposed draft for MLs for cadmium in chocolate and cocoa-derived products, taking into account the comments submitted to that session. In addition, the EWG should clearly identify the products for which the MLs were being established and provide the rationale for the MLs (REP15/CF, paras. 52-55).

8. At CCCF10 (2016), the following food categories on which MLs for cadmium would be set was agreed by the Committee:

- Intermediate products i.e. cocoa liquor and cocoa powder from cake.
- Finished products based on total cocoa solids content (%) i.e. chocolate and cocoa powder ready-for-consumption.

9. The Committee noted that it would be more practical to work on the MLs based on a total cocoa solids content as this information is readily available on the label.

10. The Committee also agreed that the Codex Secretariat would issue a Circular Letter (CL 2016/22-CF) requesting information on: (1) occurrence data for Cd and designation of origin in the following intermediate products: cocoa liquor and cocoa powder from cake; (2) occurrence data for Cd linked to total cocoa solids content (%) or chocolate classification (e.g. bitter, with milk) in the following final products: chocolates and cocoa in powder ready-for-consumption; and to provide the geographic origin of the cocoa raw materials as well as information on the manufacturing country, when available.

11. The Committee further agreed to re-establish the EWG, chaired by Ecuador and co-chaired by Brazil and Ghana, to continue work on the development of MLs for cadmium in the food categories identified in paragraph 8 (REP16/CF, paras. 101-119).

10. The EWG reviewed the data available on GEMS/Foods in accordance with CL 2016/22-CF. The summary of the information and data analyzed by the EWG, work process, key points of discussion and conclusions in support of the recommendations of the EWG are provided in Appendix I. The List of Participants is contained in Appendix II.

12. Codex Members and observers wishing to submit comments on the recommendations of the EWG are kindly invited to do so as indicated in the box of the Circular Letter. The recommendations together with the comments submitted in reply to this CL will be considered by CCCF11 (2017).

13. In submitting comments, Codex members and observers are kindly invited to take into account the information provided in Appendix I.

GENERAL RECOMMENDATIONS

1) The EWG recommends to CCCF the following MLs.

Name of the product	**Total dry solids of cocoa (%)**	**Proposed ML**
Milk chocolate ≥ 25 Family milk chocolate ≥ 20 Milk chocolate couverture ≥ 25 Gianduja milk chocolate ≥ 25 Table chocolate ≥ 20 Milk chocolate Vermicelli/milk chocolate flakes ≥ 20	≤ 30%	0.1
Dry mixtures of cocoa and sugars: Sweetened cocoa, sweetened cocoa powder, drinking chocolate ≥ 25, Sweetened cocoa mix, Sweetened mixture with cocoa ≥ 20, sweetened cocoa- flavored mix ≥ 20		0.65
Chocolate ≥ 35 Gianduja chocolate ≥ 32 Semi – bitter chocolate para mesa ≥30 Chocolate Vermicelli/chocolate flakes ≥32 Bitter table chocolate ≥ 40	>30% - 50%	0.3
Chocolates and products with declared cocoa content more than 50% and less than 70%	>50% - <70%	0.6
Chocolates and products with declared cocoa content more than 70%	>70%	0.8

2) The CCCF should consider the following performance criteria for methods of analysis:

Parameters	ML for ≥ 0.1 $mg.kg^{-1}$	ML for < 0.1 $mg.kg^{-1}$
Minimum Applicable Range	[ML - 3 s_R, ML + 3 s_R] s_R = reproducibility standard deviation	[ML - 2 s_R, ML + 2 s_R] s_R = reproducibility standard deviation
LOD	≤ML 1/10	≤ML 1/5
LOQ	≤ML 1/5	≤ML 2/5
Precision	HorRat Value ≤ 2	RSD_{TR} < 22% RSD_R= reproducibility standard deviation RSD_R ≤ 2. $PRSD_R$
Recovery (%)	80 - 110 (from 0.1 to 10 $mg.kg^{-1}$)	60 - 115 (for 0.01 $mg.kg^{-1}$)
Trueness	Other guidelines are available for expected recovery ranges in specific areas of analysis. In cases where recoveries have been shown to be a function of the matrix other specified requirements may be applied. For the evaluation of trueness preferably certified reference material should be used.	

3) The EWG also recommends to postpone the establishment of ML to intermediate cocoa products and to access the possibility to have a future discussion on ML to Chocolate with more than 50% de cocoa total solids with appellation of origin.

APPENDIX I
(For information)

INTRODUCTION

1. Contamination of heavy metals in human diet has become a topic of concern in many countries around the world as exposure to elevated concentrations may cause health problems in humans. The 73rd Session of Joint FAO/WHO Expert Committee on Food Additives (JECFA) (2010), previously identified major contributors to Cd exposure as cereals/grains, vegetables, meat and poultry offal, and seafood (especially shellfish).

2. The JECFA's evaluation (77th Session) stressed that the total exposure of Cd in diets with high levels of consumption of cocoa and cocoa derived products was likely to be overestimated and did not consider it as a concern as intakes did not exceed the PTMI for cadmium.

3. However, the lack of a ML for Cd for chocolate and cocoa derived products could threaten exports of some countries, especially those in development, that are the largest exporters of cocoa (REP 14/CF). Therefore, the CCCF is undertaking this work to ensure consumer health and facilitate fair trade through the harmonization of MLs for Cd in chocolate and cocoa derived products.

DEFINITIONS

4. In this document the following concepts are defined:

Cocoa: Fruit of the trees of the species *Theobroma cacao*.
Chocolate: Chocolate (in some regions also named bittersweet chocolate, semi-sweet chocolate, dark chocolate or "chocolat fondant") shall contain, on a dry matter basis, not less than 35% total cocoa solids, of which not less than 18% shall be cocoa butter and not less than 14% fat-free cocoa solids.
Cocoa bean: The seed of the cacao fruit (*Theobroma cocoa)*; commercially, and for the purpose of this document, the term refers to the whole seed which has been fermented and dried.
Cocoa (Cacao) Mass (Cocoa/Chocolate Liquor): Cocoa (Cacao) Mass or Cocoa/Chocolate Liquor is the product obtained from cocoa nib, which is obtained from cocoa beans of merchantable quality which have been cleaned and freed from shells as thoroughly as is technically possible with/without roasting, and with/without removal or addition of any of its constituents.
Cocoa Butter: Is the fat obtained from cocoa beans with the following characteristics: Free fatty acids (expressed as oleic acid): not more than 1.75% m/m (percentage by mass); unsaponifiable matter: not more than 0.7% m/m, except in the case of press cocoa butter that should not exceed 0.35% m/m.
Dry mixtures of cocoa and sugars: The name of the products defined in section 3.1.2 will be used, of CODEX STAN 105 - 1981.
Nibs: Small fragments of cocoa beans roasted at different temperatures according to the formula established by the manufacturer.
Cocoa powder: Product obtained from cocoa cake transformed into powder.
Percentage of total cocoa solids: It refers to the total percentage of ingredients by weight in the product that comes from the cocoa bean, including liquor and cocoa butter.
Non-fat dry cocoa solids: Are all cocoa components (carbohydrates, fiber, protein and minerals), which were subtracted the fat and moisture.
Total cocoa solids: Are all cocoa components, therefore, is the sum of the fat or cocoa butter plus no fatty components (non-fat cocoa solids).

ACRONYMS

5. The following acronyms are mentioned:

bw: body weight
CAC: Codex Alimentarius Committee
CCCF: Codex Committee on Contaminants in Foods
Cd: Cadmium
CL: Circular Letter
LOD: Limit of Detection
LOQ: Limit of Quantification
WHO: World Health Organization
FAO: Food and Agriculture Organization
ND: Not detectable
EWG: Electronic Working Group
JECFA: Joint FAO/WHO Expert Committee on Food Additives
ICCO: International Cocoa Organization
ML: Maximum Level
PTMI: Provisional Tolerable Monthly Intake

ECONOMIC IMPORTANCE OF CHOCOLATE AND COCOA DERIVED PRODUCTS WORLDWIDE

6. Cocoa is a valuable cash crop, nonperishable and generally produced by small farmers, who drive economies of developing countries. According to ICCO, the cocoa growing areas are, according to their importance, West Africa, Latin America and Southeast Asia.

7. Europe demands most of cocoa beans for the production of ground cocoa, which will be processed into cocoa products (ICCO, 2007). The vast majority of imports of cocoa beans comes from West Africa (93%); followed by Latin America and Southeast Asia (ICCO, 2012).

8. According to Trade Map data (Trade Map, 2017), in 2015 chocolate and other food preparations containing cocoa represented 56.0% of global value imported for cocoa and cocoa preparations followed by cocoa beans and nibs (20.6%), cocoa butter (11.6%), cocoa liquor (7.1%), cocoa powder without added sugar (4.6%), and cocoa shells, husks, skins and other cocoa waste (0.1%).

9. The cocoa bean market worldwide is distinguished by two categories: 1) the “fine flavor” cocoa bean and 2) “basic cocoa” or “ordinary cocoa” bean. According to the ICCO, the global share of fine flavor cocoa beans is about 5-7%, representing 100 - 170 thousand tons from Ecuador, Indonesia, Papua New Guinea, Colombia, Venezuela, and Trinidad and Tobago, among other countries. On the other hand, “basic cocoa” or “ordinary cocoa” beans, which come from Africa, Asia, and Central and South America, represent around 93-95% of the world production (ICCO, 2012).

10. The characteristics of the “fine flavor” cocoa are distinctive in its aroma and flavor, which are mainly demanded by manufacturers of fine chocolates. Traditional consumers of “fine flavor” cocoa are Western Europe (Belgium, Luxembourg, The Netherlands, France, Germany, Italy, Switzerland and the UK), representing the largest consumer markets.

METHODS OF ANALYSIS

11. Methods of analysis to determine Cd in cocoa include Flame Atomic Absorption Spectrometry (F-AAS), Graphite Furnace with Atomic Absorption Spectrometry (GF-AAS), Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) and Inductively Coupled Plasma Mass Spectrometry (ICP-MS). The general sample preparation can be conducted by digestion in an open system (dry incineration [Lee & Low, 1985] or wet digestion [Yanus et al., 2014]) or in a closed system (microwave - Nardi et al., 2009, Jalbani et al., 2009) which is the most common method used in several laboratories. The use of hydrogen peroxide is recommended because cocoa and cocoa products are rich in fat. Sample preparation depends on the detection methods chosen. For example, an open system like dry incineration may affect the results in low limit of detection (LOD) techniques since contamination in these procedures is very common (Nardi et al., 2009; Villa et al., 2014).

12. CODEX STAN 228, 2001: General Methods of Analysis for Contaminants suggests some Cd analytical methods such as atomic absorption spectrometry (AAS) after incineration or microwave digestion and Anodic stripping voltammetry.

Table 1 presents the LOD (detection limit) for Cd by different analytical methods mentioned above.
Table 1. Detection limits with different methods.

Technique	Detection limit (µg/L)
F-AAS	0.8 – 1.5
ICP-OES	0.1 – 1.0
GF-AAS	0.002 – 0.02
ICP-MS	0.00001 – 0.001

Source: EFSA, 2009.

13. Taking into account the performance criteria for analysis, set out in the Procedural Manual of the Codex Alimentarius Commission, several methods not included in the CODEX STAN 228/2001 could be used for analysis of Cd.

14. Laboratories may select any valid method of analysis; however, the method selected should meet the criteria described in the Procedural Manual of the Codex Alimentarius Commission, Table 2.

15. Performance criteria required for maximum levels over 0.1 mg.kg^{-1} established in the Procedural Manual of the Codex Alimentarius Commission are the same as those established in the EU regulation for the LOD, limit of quantification (LOQ) and precision. The recovery should range from 80% to 110%.

Table 2. Performance criteria for methods of analysis.

Parameters	ML for ≥ 0.1 $mg.kg^{-1}$	ML for < 0.1 $mg.kg^{-1}$
Minimum Applicable Range	[ML - 3 s_R, ML + 3 s_R] s_R = reproducibility standard deviation	[ML - 2 s_R, ML + 2 s_R] s_R = reproducibility standard deviation
LOD	≤ML 1/10	≤ML 1/5
LOQ	≤ML 1/5	≤ML 2/5
Precision	HorRat Value ≤ 2	RSD_{TR} < 22% RSD_R= reproducibility standard deviation RSD_R ≤ 2. $PRSD_R$
Recovery (%)	80 - 110 (from 0.1 to 10 $mg.kg^{-1}$)	60 - 115 (for 0.01 $mg.kg^{-1}$)
Trueness	Other guidelines are available for expected recovery ranges in specific areas of analysis. In cases where recoveries have been shown to be a function of the matrix other specified requirements may be applied. For the evaluation of trueness preferably certified reference material should be used.	

Source: CAC, 2015.

TOXICOLOGICAL EVALUATION

16. Cd accumulates primarily in the kidneys and liver, and its biological half-life in humans is estimated to be 10-35 years. Cd accumulation may eventually lead to renal tubular dysfunction, which manifests in an increase of the excretion of low molecular weight proteins in urine. When this low molecular weight proteinuria exceeds a specific value (greater than 1000 ug/g creatinine), the kidney damage is generally considered to be irreversible. A high intake of Cd can also lead to distortions in calcium metabolism and the formation of kidney stones. Cd also affects the skeletal and respiratory systems (WHO, 2010).

17. Vegetables and cereals are the main sources of background Cd exposure in the typical diet, although Cd is found in meat and fish to a lesser extent, while crustaceans and mollusks can accumulate large amounts from the aquatic environment (Satarug, 2010).

18. Cd was evaluated in Sessions 16, 33, 41, 55, 61, 64, 73 and 77 of JECFA. In 2010, JECFA decided to express the tolerable intake as a monthly value, establishing a Provisional Tolerable Monthly Intake (PTMI) of 25μg/kg b.w.

19. JECFA estimated exposure to Cd from consumption of products containing cocoa and its derivatives for the average population diet in the 17 GEMS / Food dietary groups. These estimates ranged from 0.005 to 0.39 μg / kg bw / month, which is equivalent to 0.02 to 1.6% of the PTMI. This represents an estimate of the average Cd dietary exposure of cocoa and its derivatives for the entire population. Similar dietary exposures to Cd in the population for individual cocoa products were estimated from national data, which ranged from 0.001 to 0.46 μg/kg bw/month (0.004 to 1.8% PTMI).

20. Because 5% of the PTMI of Cd from cocoa-derived products for the general population was not exceeded relative to cadmium dietary intake in even one of the GEMS/Food Consumption Cluster Diets suggests that cadmium consumption from cocoa-derived products does not significantly contribute to the total cadmium exposure of the consumer. Thus MLs established for cocoa-derived products should be based primarily on practical achievability worldwide, i.e., As Low As Reasonably Achievable (ALARA) principle (GSCTFF, CODEX STAN 193-1995).

21. The potential dietary exposure to Cd for large consumers of products containing cocoa and its derivatives, in addition to Cd derived from other foods, were estimated to be 30-69% of the PTMI for adults and 96% of the PTMI for children from 0.5 to 12 years old. The Committee noted that this Cd total dietary exposure for large consumers of cocoa and its products was probably overestimated and did not consider it cause for concern (JECFA, 2013).

CADMIUM OCCURRENCE IN COCOA PRODUCTS

22. As described above, the cocoa beans and nibs represent 20.6% of global value imported for cocoa and cocoa preparations, however, these products are not directly consumed because they must first undergo industrial processing to obtain liquor, powder and cocoa butter, which are the raw materials for production of chocolates and cocoa derived products.

23. Taking into account the above and following the Procedural Manual (24th Edition) which states “Number of commodities which would need separate standards indicating whether raw, semi-processed or processed”, for the purpose of this document, the cocoa bean (raw product) is separated from processed products, liquor, powder and cocoa butter.

24. According to Yanus et *al.* (2014), processing to obtain cocoa powder and cocoa butter influences the distribution of Cd, and over 95% of Cd is accumulated in cocoa powder.

25. Chocolate liquor is not directly consumed, but is used as an ingredient in the manufacture of chocolate and baked products. It can be used in different types of chocolate products at levels between 10 to more than 90% of the formulation.

26. Cocoa powder is also not directly consumed, as it is used as an ingredient in various types of products. For example, cocoa powder as a component in bakery products can contribute approximately 5% to the formula, while chocolate powder in drinks can contribute 30% when mixed with water or milk.

27. Lee & Low (1985) evaluated intermediate products in the stages of chocolate manufacturing (roasted cocoa, liquor, paste, cake, nibs and shell) and noted no Cd contamination during processing. They also noted that the addition of ingredients such as milk and sugar does not contribute to Cd concentrations in the final chocolate products.

DATA COLLECTION

28. The General Secretariat of the Codex issued the Circular Letter CL 2016/22-CF (July 2016), in which it invited members and observer countries to submit data on the presence of Cd in cocoa intermediate and finished products to WHO (GEMS/Food).

29. The data and information requested were:

30. Occurrence data for Cd and designation of origin in the following intermediate products: cocoa liquor and cocoa in powder from cake.

31. Occurrence data for Cd linked with total dry cocoa solids content (%) or chocolate classification (e.g. bitter, with milk) in the following final products: chocolates and cocoa in powder ready-for-consumption.

32. Geographic origin of the cocoa raw materials as well as information on the manufacturing country, when available.

33. Subsequently, the EWG downloaded the information from the GEMS/Food platform, taking into account the following criteria:

Region or regions of the WHO: all regions were chosen.

Contaminant (s): Cadmium.

Food Category (s): Sugar and confectionery (including cocoa products).

Name of food: cocoa beans, cocoa liquor, cocoa powder, confectionery, sugar and confectionery NES (not elsewhere specified).

34. The EWG considered it appropriate to establish two criteria for acceptance of data, in order to work only with those that were relevant:

Data that have been uploaded to the platform between 2006 and 2016.

Data that clearly identifies the “local food name”.

35. New data has been incorporated in this final version, because just recently the EWG has had access to all the information provided by the countries GEMS/Food database, All the data available that follow the criteria established in paragraph 40 are presented in Tables 3, 4, 6, 7, 9, 10, 13, 14, 15, 16 and 17:

Table 3. Provision of data in GEMS/Food, from 2006 to 2016

Food	No. samples	Countries that uploaded information
Cocoa liquor/mass	337	Germany, Brazil, Chile, Ecuador, Spain, Indonesia, Singapore
Cocoa powder	926	Australia, Brazil, Canada, Chile, Ecuador, Germany, Indonesia, Japan, Singapore, Spain, United States of America.
Cocoa butter	15	Brasil, Denmark, Spain
Dry mixtures of cocoa and sugars	368	Germany, Brazil, Denmark, Ecuador, Slovakia, United States, Indonesia, Japan, Singapore
Chocolate*	1279	Australia, Brazil, Canada, Ecuador, United States and Japan.

***** Only the samples that presented information on the percentage of total dry solids of cocoa have been considered.

36. Cocoa butter was not considered in the following discussions since it was not a relevant source of Cd.

DATA ANALYSIS FOR THE PROPOSAL ON MAXIMUM LEVELS:

37. For the analysis and processing of the information obtained from GEMS/Food, Tables 4 and 7 were elaborated with a summary of Cd occurrence data for cocoa liquor and cocoa powder, including the minimum, maximum and average values.

38. In addition, from the minimum and the maximum values, the range ($R = x_{max} - x_{min}$) and the frequency were established. Tables 6, 9 and 10 show the distribution of Cd content in the food groups cocoa liquor, cocoa powder, and dry mixtures of cocoa and sugars. Similar tables for three different types of chocolate are provided at Tables 13, 14, 15, 16 and 17.

39. The CCCF has previously used a figure of approximately 5% of samples as a ‘cut-off’ point for determining an achievable ML. That is, if 95% of samples have Cd content below a certain level, then this level is deemed achievable and may be proposed as an ML. Taking this into account, proposed MLs have been derived, where applicable, based on the distribution tables, for the EWG consideration.

CADMIUM IN COCOA LIQUOR SAMPLES

40. From all available data in GEMS/Food, only Brazil, Ecuador and Spain sent information indicating the origin of data. Table 4 shows a general description of this information.

41. Table 4 was elaborated based on the information provided by the cited countries, describing the origin of samples, which means that the countries indicated in Table 4 were not necessarily the ones who published the information.

Table 4. Summary of cadmium occurrence and country of origin of cocoa liquor samples, provided by Brazil, Ecuador and Spain.

*Origin of samples		n+/n	Minimun (mg/kg)	Maximun (mg/kg)	Average (mg/kg)
Region	**Country				
Latin America and the Caribbean	Brazil	16/16	0.045	0.19	0.1
	Ecuador	24/24	0.22	1.46	0.64
	Mexico	2/2	0.25	0.27	0.26
North America	Canada United States of America	11/11	0.02	0.48	0.14
Africa	Cameroon Ivory Coast Ghana	45/45	0.01	0.15	0.08
Asia	China, Indonesia, Malasia, Singapur	46/46	0.05	0.37	0.18
Europe	Germany, Belgium, Spain, France, Italy, United Kingdom, Russia	113/113	0.03	0.88	0.19

n + / n: number of positive samples / total samples. **Source**: GEMS / Food

* Only for the case of Ecuador is specified the origin of its raw materials (Ecuador), in the other cases (Brazil y España) it refers to the country of manufacture of the product,

** Information provided by Brazil, Ecuador and Spain.

42. As it can be seen in Table 4, cocoa liquor from the Latin American and Caribbean region has the highest average Cd concentration (0.64 mg/kg from Ecuador), while the average Cd contents of cocoa liquor samples originated from North America, Asia and Europe are not significantly different (0.14, 0.18 and 0.19 mg/kg respectively), and the African region shows the lowest average value (0.08 mg/kg).

43. However, within the information provided by the Latin America and the Caribbean, it is evident that Ecuador has the highest concentrations of Cadmium in samples of cocoa liquor ($x_{max,\ Ecuador}$ = 1.46 mg/kg), whereas in Brazil and Mexico, the maximum values are 0.19 and 0.27 mg/kg respectively, indicating that even in the same region, cadmium concentrations vary from country to country.

44. Additionally, it could be assumed that cocoa liquors which are from North America and Europe could be mixtures of raw materials (cocoa beans or different cocoa liquors) from Latin America, Africa and Asia. This information would explain why these values are lower compared with Cd concentrations in cocoa liquors from Latin America and the Caribbean.

45. In addition, the European Cocoa Association (ECA) sent a report about Cd occurrence in cocoa liquor. Table 5 presents a summary of the data provided by the ECA, indicating the country of origin, number of samples, and minimum, maximum and average values. It is important to note that these data were only provided in a summarized form, and data on individual samples were not available. In this way it was impossible to perform the calculations of respective intervals and ranges of frequencies and therefore the data could not be taken into account in the general analysis.

Table 5. Summary of Cadmium occurrence in samples of cocoa liquor, presented by ECA.

Continent	Country	N° of samples	Minimum (mg/kg)	Maximum (mg/kg)
Africa	Cameroon, Ivory Coast, Ghana, Guinea, Madagascar, Sao Tome and Principe, Uganda	326	0.00*	0.72
Latin America and the Caribbean	Brazil, Costa Rica, Ecuador, Granada, Mexico, Peru, Dominican Republic, Trinidad and Tobago, Venezuela	483	0.00*	3.9
Asia	Indonesia, Malasia	99	0.00*	0.6
Mixtures		35	0.00*	0.49
Unknown		257	0.00*	1.20

* This value has not been set to ND, since this data has been reported as the source.

SOURCE: European Cocoa Association - ECA

46. As in Table 4, it can be seen that the Latin American and Caribbean Region has the highest Cd concentrations ($X_{\text{max Latin America and the Caribbean}}$ = 3.9 mg/kg). It is also possible to confirm that samples from mixtures of cocoa liquors presented the lowest values (X_{mixtures} = 0.49 mg/kg), followed by the samples from Asia and Africa with maximum values of 0.6 and 0.72 mg/kg, respectively.

47. The highest maximum Cd concentration (3.9 mg/kg) in ECA dataset is notably higher than data from GEMS/Food (1.46 mg/kg). Although the additional data provided by ECA cannot be used to undertake a more detailed analysis of Cd content in cocoa liquor, it can be used to validate data submitted to GEMS/Food, particularly in terms of regional differences of Cd content in cocoa liquor. It is important to highlight that GEMS Food database has only 42 records from Latin America and the Caribbean while ECA presented 483 records, it can explain the difference between the two database maximum value.

48. In order to present an analysis of the entire set of data on Cd in cocoa liquor in the GEMS/Food database, the data are presented as a distribution in Table 6. It should be noted that the data in Table 5 were not considered in the analysis.

Table 6. Distribution of cadmium content in samples of cocoa liquor (range and percentage)

Range (mg/kg)	No. of observations	Percentage (%)
ND - ≤ 0.3	278	82.5
>0.3 - ≤ 0.6	39	11.6
>0.6 - ≤ 0.9	9	2.7
>0.9 - ≤ 1.2	9	2.7
>1.2	2	0.7
TOTAL	337	100

ND: not detectable**, SOURCE**: GEMS/Food

49. From 337 data entries presented, the minimum and maximum values obtained are ND and 1.46 mg/kg respectively. The maximum value in the ECA dataset was notably higher, at 3.9 mg/kg.

50. It should be noted that in Table 4, 257 entries are presented, and in Table 6, 337 samples are presented, since in Table 4 only the data that were presented indicating the origin was considered, however, for the analysis of the Table 6 it was taken into account all data uploaded to GEMS/Food.

CADMIUM IN COCOA POWDER SAMPLES AND SAMPLES OF DRY MIXTURES OF COCOA AND SUGARS

51. As several products were considered within the categorization of cocoa powder, the EWG reviewed each of them and established a sub-classification; those considered “cocoa powder” (*intermediate product*) and those considered as “dry mixtures of cocoa and sugars” *(ready for consumption)*, according to the following criteria.

52. In the case of cocoa powder (*as an intermediate product*), the EWG considered CODEX STAN 105-1981; which mentions (section 2, paragraph 2.1)”cocoa powder”, “cocoa powder reduced in fat” and “cocoa powder extremely low in fat” “are products obtained from cocoa cake...”, additionally, the EWG used the 100% cocoa as demarcation to analyze these data separately.

53. In the case of dry mixtures of cocoa and sugars (*ready for consumption*), the EWG considered CODEX STAN 105-1981, taking into account that those products have other ingredient(s) added (for example sugar, among others). It should be noted that the data presented to GEMS/Food for this food group had different percentages of cocoa solids.

Cadmium in cocoa powder samples (*intermediate product*)

54. Only three countries (Brazil, Ecuador and the United States) recorded data according to what was requested in the CL, which means that they sent information indicating the origin. Table 7 shows a summary of these data.

Table 7: Summary of occurrence of cadmium in cocoa powder samples (100% total cocoa solids), indicating the origin of samples

Origin*		n+/n	Minimum (mg/kg)	Maximum (mg/kg)	Average (mg/kg)
Region	**Country****				
Latin America and the Caribbean	Brazil	18/18	0.038	0.45	0.2
	Colombia	1/1	3.15		
	Ecuador	7/7	0.7	3.64	2.25
	Mexico	1/1	0.98		
	Peru	9/9	0.92	1.29	1.2
	Dominican Republic	1/1	0.46		
North America	Canada, United States of America	12/12	0.08	0.8	0.36
Africa	Cameroon and Ivory Coast	21/21	0.08	0.26	0.16
Asia	China, Indonesia, Singapore, Thailand	72/72	0.17	0.99	0.45
Europa	Germany, Belgium, Spain, United Kingdom, Holland, France, Italy, Poland, Russia, Sweden, Switzerland	159/159	0.041	1.3	0.26
Southwest Pacific	Australia	2/2	0.126	0.18	0.16
Mixed Origin	Peru, Indonesia, Ecuador	1/1	1.88		

n+/n: number of positive samples/total samples;
Fuente: GEMS/Foods
* Only for the case of Ecuador is specified the origin of its raw materials (Ecuador), in the other cases (Brazil and United States of America) it refers to the country of manufacture of the product,
** Information provided by Brazil, Ecuador and United States of America.

55. According to the information provided in Table 7, the highest maximum concentrations of Cd in samples of cocoa powder are found in samples sourced from the Latin America and Caribbean Region and, within this region, samples from Colombia, Ecuador and Peru show the highest maximum concentrations ($x_{\text{max Colombia}}$ = 3.15 mg/kg, $x_{\text{max Ecuador}}$ = 3.64 mg/kg, $x_{\text{max Peru}}$ =1.29 mg/kg). In an exception, Europe presented a maximum value higher than value from Peru ($x_{\text{max Europe}}$ = 1.3 mg/kg).

56. Opposite to the Latin American and Caribbean Region, African region had considerably lower Cd concentrations ($x_{\text{mean Africa}}$ = 0.16 mg/kg; min – max = 0.08 – 0.26 mg/kg).

57. As in the case of cocoa liquor, ECA only provided summary information on Cd concentrations in samples of cocoa powder. Table 8 below presents a summary of the data set presented by ECA, indicating the country of samples origin, number of samples, minimum maximum values of the available information. It is important to note that these data were only provided in a summarized form, and data on individual samples were not available. In this way it was impossible to perform the calculations of respective intervals and frequency ranges and therefore could not be taken into account for the general analysis of data.

Table 8. Summary of Cadmium occurrence in samples of cocoa powder, presented by ECA.

CONTINENT	COUNTRY	N° OF SAMPLES	MINIMUM VALUE (mg/kg)	MAXIMUM VALUE (mg/kg)
Africa	Cameroon, Ivory Coast, Ghana, Tanzania	53	0.00*	1.3
Latin America and the Caribbean	Brazil, Ecuador, Mexico, Peru, Dominican Republic	154	0.00*	2.04
Asia	Indonesia, Malasia, Tailand	59	0.00*	1.00
Mixtures		365	0.00*	0.00*
Unkown		989	0.00*	0.00*

* This value has not been set to ND, since this data has been reported as the source.
SOURCE: European Cocoa Association– ECA

58. As in Table 7, data in Table 8 indicate that cocoa powder from the Latin American and Caribbean region has the highest maximum concentration of Cd ($X_{\text{max Latin America and the Caribbean}}$= 2.04 mg/kg), with samples from Africa, origin ‘mixtures’ and Asia having lower maximum Cd concentrations of 1.3, 1.3 and 1.0 mg/kg, respectively. It should be noted that the samples of cocoa powder with origin ‘unknown’ included a sample with a maximum Cd value of 6.0 mg/kg. Again, data provided by the ECA on cocoa powder generally supports the data submitted to GEMS/Food for this food group, in terms of regional differences; however it included a maximum value that was notably higher than that included in GEMS/Food.

59. In addition, in general, data obtained from GEMS/Food also supports the common understanding that Cd concentrations are generally higher in cocoa powder than in cocoa liquor, with the highest maximum concentration of Cd in cocoa powder and cocoa liquor being 3.64 and 1.46 mg/kg, respectively.

60. Continuing the methodology described above, Table 9 presents the distribution of Cd concentrations in samples of cocoa powder, taking into account the 831 entries provided in the GEMS/Food. Again, it should be noted that the ECA data in Table 8 were not considered in the analysis.

Table 9. Distribution of Cd content in samples of cocoa powder (range and percentage)

Range (mg/kg)	**No. of Observations**	**Percentage (%)**
ND - ≤ 0.6	846	91.4
> 0.6 - ≤ 1.2	61	6.6
> 1.2- ≤ 1.8	14	1.5
> 1.8 - ≤ 2.4	0	0.00
> 2.4 - ≤ 3.0	1	0.10
>3.0	4	0.40
TOTAL	926	100

ND: not detectable**, SOURCE**: GEMS/Food

61. It should be noted that Table 7 shows 381 entries, and Table 9 shows 926 entries, since Table 7 only considered the data that was presented indicating the origin.

62. From 926 samples presented in Table 9, the minimum and maximum values obtained were respectively ND and 3.64 mg/kg.

Cadmium in samples of dry cocoa and sugar mixtures (*ready for consumption*)

63. In the case of dry cocoa and sugar mixtures, we had access to the origin of the samples only from Brazil, Ecuador and USA data (in which the total percentage of cocoa solids was indicated). 28 samples were submitted by Brazil whose origin was Sweden and all the samples reported non-detected results. The samples submitted by Ecuador (2 samples) had Ecuador origin and they presented values of 0.48 and 0.91 mg/kg. The samples reported by the United States (4 samples) showed values of 0.08, 0.01 and two samples of 0.04 mg/kg, however, the origin of the samples was not reported.

64. As described above, Table 10 presents the distribution of Cd concentrations for the entire data set of 368 entries loaded into GEMS/Food.

Table 10. Distribution of Cadmium content in samples of dry mixtures of cocoa and sugars (range and percentage)

Range (mg/kg)	**No. of Observations**	**Percentage (%)**
ND - ≤ 0.4	334	90.76
> 0.4 - ≤ 0.8	19	5.16
> 0.8- ≤ 1.2	8	2.17
> 1.2 - ≤ 1.6	4	1.09
> 1.6	3	0.82
TOTAL	368	100

ND: not detectable**, SOURCE**: GEMS/Food

65. From 368 data samples analyzed, the minimum and maximum values were respectively ND and 1.91 mg/kg. The cut-off point of 95% was used to recommend an ML of 0.65 mg/kg (this would impact on only 5% of the global trade of this product).

CATEGORIZATION OF CHOCOLATES

66. There are already Codex Standards for cocoa and cocoa products with categorization for each case[1]. We summarized the Codex categorization in Table 11.

Table 11. Summary table of total cocoa solids requirements of cocoa products

Cocoa products	Total cocoa solids (% on dry matter)
Chocolate powder	≥29
Chocolate	≥35
Sweet chocolate	≥30
Couverture chocolate	≥35
Milk chocolate	≥25
Family milk chocolate	≥20
Milk chocolate couverture	≥25
White chocolate	-
Gianduja chocolate	≥32
Gianduja milk chocolate	≥25
Chocolate para mesa	≥20
Semi-bitter chocolate para mesa	≥30
Bitter chocolate para mesa	≥40
Chocolate Vermicelli /chocolate flakes	≥32
Milk chocolate Vermicelli /milk chocolate flakes	≥20

67. Information on the categorization of chocolate and cocoa products already exists under the Codex Alimentarius, and this was sent by a preliminary communication to EWG, requesting comments and observations on the categorization of chocolates for the establishment of MLs.

68. Some EWG members indicated that they consider it appropriate to classify the chocolates according to Codex standards however, if the Codex categorization is not relevant, other categorization should be considered.

69. Other EWG members indicated that it is necessary to align with the mandate of the Committee (according to what is described in the 10th Meeting of the CCCF) and, therefore, it is necessary to propose a classification based on data from GEMS / Food taking into account that this information was requested by CL 2016/22-CF, July 2016.

70. Based on the classifications that can become very scattered according to the market of origin of each chocolate, it is very complex to classify the chocolates, however, one of the most popular (popularly known) ways to classify chocolates is to relate them between their total dry cocoa solids or their mixtures, for example, dark chocolate, milk chocolate, white chocolate, among others.

[1] Codex Stan 141/1983: cocoa liquor and cocoa cake; Codex Stan 86/1983: cocoa butter; Codex Stan 105/1981: cocoa powders and dry mixtures of cocoa and sugars; Codex Stan 87/1981: chocolate and chocolate products

71. The CL requested data on the presence of Cd linked to the total content of cocoa solids (%) for chocolate, OR chocolate classification (e.g. bitter, with milk). For the purpose of unifying these concepts, the EWG proposes the following table with the categorization of chocolates based on the total dry cocoa solids (%) content.

Table 12. Proposal for the classification of chocolates based on total dry cocoa solids (% on dry matter)

Type of chocolate	Total cocoa solids (% on dry matter)
Sweet Chocolate	≤ 30%
Semi-bitter chocolate	>30% - 50%
Bitter Chocolate amargo or dark chocolate	>50%

* This classification refers to all products within the percentage threshold of total dry cocoa solids.

Table 13. Proposal for the classification of chocolates on the basis of total dry solids of cocoa (% on dry matter).

Type of chocolate	Total of cocoa solids (% on dry matter) *
Sweet chocolate	≤ 30%
Semi bitter chocolate	>30% - 50%
Bitter chocolate or dark chocolate	>50% - 70%
	>70%

* This classification refers to all products within the percentage threshold of total dry cocoa solids.

72. In view of the fact that some Member Countries and Observers considered that the categorization of chocolates could eventually cause confusion, the EWG Member proposed the following table which could be aligned to products categorized according to various Codex standards as well as Proposals of the EWG.

Name of the product	Total dry solids of cocoa (%)
Milk chocolate ≥ 25 Family milk chocolate ≥ 20 Milk chocolate couverture ≥ 25 Gianduja milk chocolate ≥ 25 Table chocolate ≥ 20 Milk chocolate Vermicelli/milk chocolate flakes ≥ 20	≤ 30%
Chocolate ≥ 35 Gianduja chocolate ≥ 32 Semi – bitter chocolate para mesa ≥30 Chocolate Vermicelli/chocolate flakes ≥32 Bitter table chocolate ≥ 40	>30% - 50%
Chocolates and products with declared cocoa content more than 50% and less than 70%	>50% - <70%
Chocolates and products with declared cocoa content more than 70%	>70%

73. In order to carry out the analysis of the data described below, only those data that presented information on the total dry cocoa solids were taken into account. In addition, some data showed the origin of chocolate production and in a few cases the geographical origin of raw material.

74. The same working methodology was maintained as in the other food groups, including determining the minimum, maximum, range and frequency values.

Sweet Chocolate (total cocoa solids ≤ 30%):

75. The document circulated in EWG had only 42 samples of chocolate with total cocoa solids less than 30%, and some EWG members noted that this amount is not enough to determine an ML. However, after the round of comments, WHO provided more data information so the analysis presented in the following paragraphs could be expanded.

76. 219 samples of chocolate with total dry cocoa solids below or equal to 30% were submitted by Brazil, Canada, Ecuador and the United States. The reported manufacturing countries were: Germany, Belgium, Brazil, China, Spain, The United States, France, Italy, Japan, Malaysia, Mexico, Poland, the United Kingdom, Switzerland and Turkey.

77. It was performed data analysis and Table 13 shows the distribution of cadmium in samples of chocolate with a percentage less or equal to 30% total cocoa solids.

Table 13. Distribution of the cadmium content in samples of chocolate ≤ 30% total cocoa solids (range and percentage)

Range (mg/kg)	No. of Observations	Percentage (%)
ND - ≤0.1	213	97.3
>0.1 - ≤ 0.2	5	2.3
>0.2 - ≤ 0.3	0	0
>0.3	1	0.5
TOTAL	219	100

ND: not detectable**. Source:** GEMS/Food

78. As it can be seen, the analysis shown in Table 13 indicates that practically 97% of data are below 0.1 mg/kg, considering additionally that one third of the samples presented values of ND.

79. The CCCF is requested to consider an appropriate limit that could be a ML of 0.1 mg/kg.

Semi bitter Chocolate (>30% -<50% total cocoa solids):

80. This chocolate shall contain, as dry matter, not less than 30% of total cocoa solids (including a minimum of 15% of cocoa butter and a minimum of 14% of non-fat cocoa solids), additionally, a semi-bitter chocolate could be defined as a darker and more bitter chocolate (opposite to a sweet chocolate) because of its amount of cocoa solids, which implies that as the percentage of cocoa in the chocolate increases, the amount of sugar is reduced.

81. In this case, Australia, Brazil, Canada, Ecuador, Japan and the United States presented a total of 508 samples, whose manufacturing origins were: Belgium, Ecuador, France, Germany, Italy, Japan, Malaysia, Mexico, Poland, United Kingdom, Russia, Singapore, Switzerland and Turkey.

82. Table 14 shows the distribution of Cd content for this category of chocolate.

Table 14. Distribution of cadmium content in samples of chocolate greater than 30% to 50% cocoa solids (range and percentage)

Range (mg/kg)	No. of Observations	Percentage (%)
ND - ≤ 0.1	371	73.0
>0.1 - ≤0.3	125	24.6
>0.3 - ≤ 0.4	10	2.0
>0.4 - ≤0.6	0	0.0
>0.6	2	0.4
TOTAL	508	100

ND: not detectable**. Source:** GEMS/Food

83. According to the analysis in Table 14, 97.6% of the samples have Cd concentrations below 0.3 mg/kg. It should be noted that from 508 data, 22 presented ND results. Therefore, considering this is the most appropriate cut-off (95%), a ML of 0.3 mg/kg can be applied.

Bitter chocolate or dark chocolate (> 50% total cocoa solids):

84. This product must contain, as dry matter, a minimum of 40% of cocoa in solids (including a minimum of 22% of cocoa butter and a minimum of 18% of fat free cocoa solids). On the other hand, a compilation of several concepts indicates that this type of chocolate must contain at least 50% of cocoa solids; therefore, the higher the cocoa content, the more bitter flavor of the product, and the lower percentage of sugars and fats.

85. The analysis for this case was carried out with a total of 552 samples from GEMS/Food and the countries that submitted data were: Australia, Brazil, Canada, Ecuador, Japan and the United States. It should be emphasized that the United States and Ecuador indicated the origin of raw material of samples as Colombia, Ecuador, Ghana, Honduras, Indonesia, Jamaica, Madagascar, Panama, Papua New Guinea, Peru and Venezuela; while the manufacturing origin was: China, Belgium, Spain, the United States, France, Italy, Mexico, Poland, United Kingdom, Russia, Singapore, Switzerland and Turkey.

86. Table 15 shows the distribution of Cd content in samples of ‘bitter chocolate or dark chocolate’ with greater than 50% total dry cocoa solids.

Table 15. Distribution of cadmium content in samples of chocolate with total dry cocoa solids greater than 50% (range and percentage)

Range (mg/kg)	No. of Observations	Percentage (%)
ND - ≤0.6	510	92.4
>0.6 – ≤1.2	35	6.3
>1.2 -≤1.8	4	0.7
>1.8 – ≤ 2.4	2	0.4
>2.4	1	0.2
TOTAL	552	100

ND: not detectable**. Source:** GEMS/Food

87. In this case, only 3 samples reported ND values, however, 92.4% of the observations had Cd concentrations ≤0.6 mg/kg. As it can be seen, approximately 98% of the data report Cd values below 1.2 mg/kg. The cut-off point of 95% was used to recommend an ML of 0.72 mg/kg (this would impact on only 5% of the global trade of this product).

Chocolate >50% - 70% and chocolate >70% of total dry solids of cocoa:

88. Two members of EWG proposed that the classification for bitter or dark chocolate could be derived in two groups: chocolate> 50% - ≤70% and a chocolate containing > 70% total dry cocoa solids, in this sense, the distribution of cadmium content for each case is shown in Tables 16 and 17.

Table 16. Distribution of Cd content in samples of chocolate with total dry solids of cocoa between 50% and 70% (range and percentage)

Range (mg/kg)	No. of Observations	Percentage (%)
ND - ≤0.6	250	93.6
>0.6 – ≤1.2	12	4.5
>1.2 -≤1.7	3	1.1
>1.7	2	0.7
TOTAL	267	100

ND: no detectable**. Source:** GEMS/Food

89. It can be seen that 93.6% of the observations presented concentrations of Cd ≤0.6 mg/kg and approximately 98% of data reported values of Cd below 1.2 mg/kg. The cut-off point of 95% was used to recommend an ML of 0.63 mg/kg (this would impact on only 5% of the global trade of this product).

Table 17. Distribution of the Cd content in samples of chocolate with total cocoa solids higher than 70% (range and percentage)

Range (Mg / kg)	Number of Observations	Percentage (%)
ND - ≤0.8	220	92.8
>0.8 – ≤1.5	11	4.6
>1.5 -≤2.3	4	1.7
>2.3	2	0.8
TOTAL	237	100

ND: not detectable**. Source:** GEMS / Food

90. For this case, it can be seen that 92.8% of the samples had Cd values below 0.8 mg/kg, while approximately 97% of the samples had Cd values below 1.5 mg/kg. The cut-off point of 95% was used to recommend an ML of 0.81 mg/kg (this would impact on only 5% of the global trade of this product).

91. It should be noted that in Tables 16 and 17, data submitted by Canada was not considered since the information of total cocoa solids content was showed as > 50% and it was not known in which group each sample would be.

White chocolate:

92. White chocolate has a cocoa butter base and therefore it is not directly relevant to cadmium concentrations. Additionally, all the 5 samples of white chocolate available in GEMS/Food reported ND results.

Chocolate with more than 50% de cocoa total solids with Appellation of origin

93. There was not sufficient information in GEMS Food database to access if high cocoa content chocolate with appellation of origin from Andean countries should have more flexible ML. The CCCF should consider to call for data for this specific product.

CONCLUSIONS

94. Cocoa production is mostly associated with small and medium-sized farmers for whom cocoa production is the basis of the family economy.

95. It is so premature to establish ML for cocoa liquor and cocoa powder, because, comparing with ECA data probably the data in GEMS Food database doesn't reflect the real occurrence from Latin America and Caribbean countries.

96. The evaluation of the JECFA (77th Session) noted that the total exposure to Cd in diets of consumers with high levels of consumption of cocoa and cocoa products was apparently overestimated and JECFA did not consider it to be a matter of concern.

97. Cd levels in cocoa intermediate products can vary considerably between regions and countries. The region of least concern with regard to Cd levels is Africa; however, cocoa intermediate products from other sources such as the South American origins have inherently higher Cd contents.

98. Mixtures or blending are important for reducing Cd in final products; however, this could be a critical practice for products with appellation of origin, as evidenced by the information provided in the sections described above.

99. In the case of cocoa liquor and cocoa powder, whose samples origins are from North America and Europe, it would be assumed that they are products made of raw material mixtures/blends (cocoa beans) from different cocoa producing regions, which would explain why these Cd values are lower compared with the results from countries belonging to the Latin American and Caribbean region (appellation of origin).

100. There is a large amount of data provided by the European Cocoa Association - ECA, which were not considered in the analysis and recommendation of this document (cocoa liquor: 1200 samples, cocoa powder: 1620 samples), In view of the fact that the total data breakdown was not available, this data could be used to carry out a more comprehensive analysis and thus to recommend MLs according to all the available information.

101. Although cocoa beans were not considered for ML establishment, the information on Cd concentrations in cocoa beans could help to show that processing cocoa beans to obtain cocoa powder and cocoa butter influences the distribution of Cd, whereby more than 95% accumulate in cocoa powder.

102. Also, taking into account that some data submitted showed relatively low cadmium concentrations and possibly these low values may be due to mixtures (with liquors and cocoa powders coming from different origins), the establishment of a ML for these products, could possibly give values that do not reflect the reality of the producing countries - in particular of the countries of Latin America and the Caribbean -, since the analysis should be framed in proposing a ML considering the origin of the raw material (cocoa beans) but not of the mixtures, it would therefore be premature for the EWG to recommend ML for these products until adequate information is available, which could be the subject of future work for this EWG.

Annex

CHOCOLATE PROCESSING

A typical schema for industrial processing of cocoa beans is shown in Figure 1.

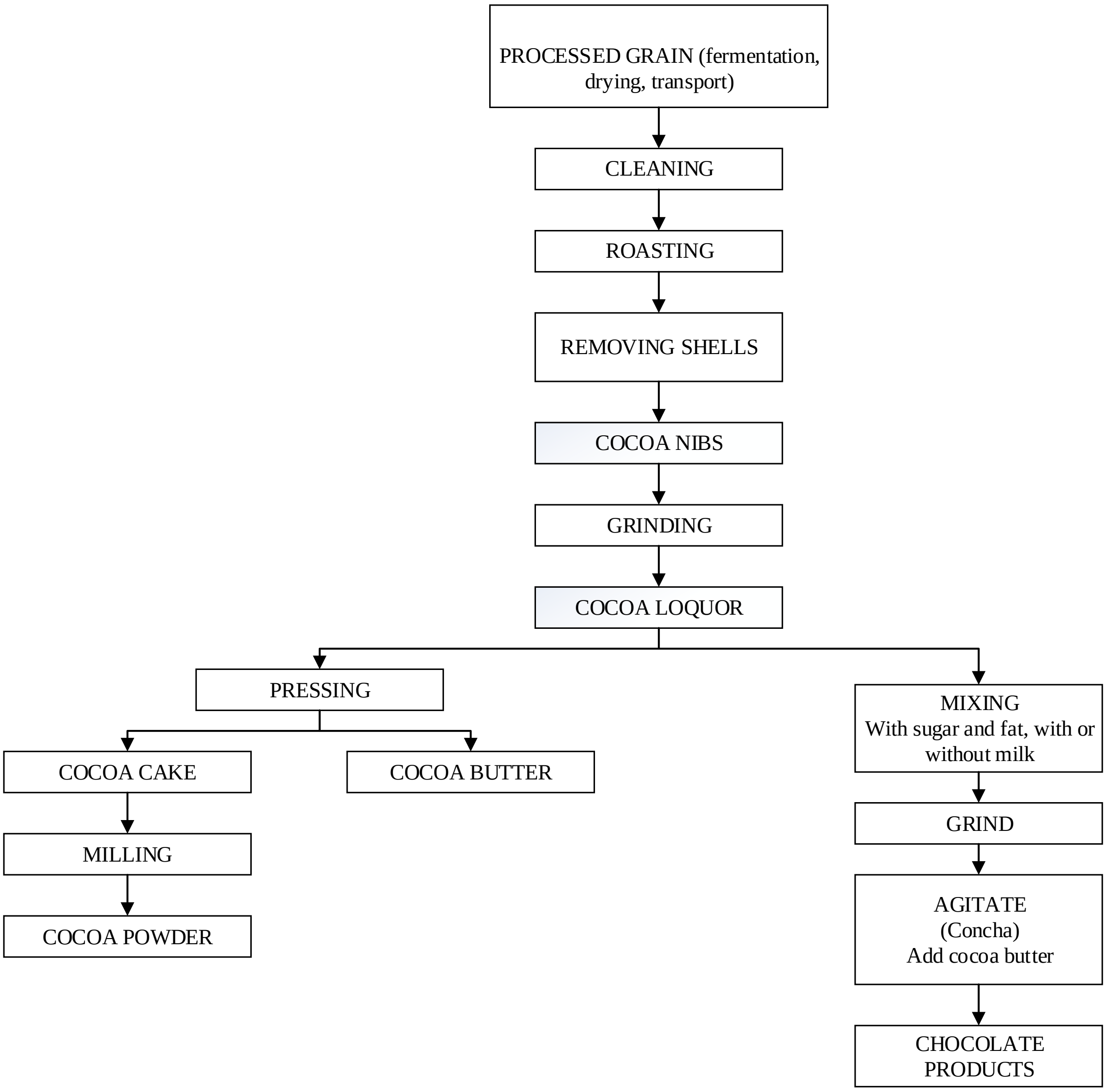

Figure 1. Schematic diagram of manufacturing process for cocoa and its derivatives.

Source: Adapted from Beckett, 2008.

The operations before chocolate processing are the most important of the whole procedure, because they give chocolate special characteristics or properties.

There are several technologies for the transformation of cocoa beans in different products, as described below.

Reception of raw material (cocoa beans): This step ensures that all quality specifications of cocoa beans before storage are fumigated in order to guarantee their permanence for several months without any alteration.

Shelling: In this process, the outer shell of the cocoa bean is removed. There are two alternatives for this process: the first one is to subject the pre-roasted beans with shells to low temperatures and then remove the shells. The second one refers to the drying of cocoa beans with shells under infrared radiation, then roasting, and removing the shells. The cocoa nibs are the result of this process.

Roasting: This process aims to achieve optimum flavor and reduce the hardness of cocoa beans, which facilitates shredding. Roasting of cocoa beans transforms chemical precursors, developed during the fermentation and drying process, into compounds having chocolate flavor and aroma.

Alkalizing: This process is intended to increase the intensity of flavor and color of the final product (potassium carbonate is usually used). This process can be done in several stages on beans, nibs, cocoa liquor or cake.

Grinding: The cocoa nibs are pulverized and finely ground in grinding mills to produce cocoa liquor (the heat of grinding causes the cocoa butter to melt).

Pressing: In this process, cocoa liquor is pressed to extreme pressure to separate the solid portion (cocoa cake) from the melted cocoa butter. Cocoa cake is pulverized to produce cocoa powder.

Formulation and mixtures: During this process, final chocolate is produced by mixing cocoa liquor, additional cocoa butter, and other ingredients (sugar, with or without milk solids, emulsifiers, other flavors such as vanilla) and finely grinding the mixture (refining process).

Conching: This process improves the flavor of final chocolate by mixing or rolling the chocolate mixture for periods up to several days. This process reduces acidity by loss of volatile acids and results in the discrete particles of the mixture, such as sugars, milk, and cocoa powder, becoming coated with cocoa butter.

Tempering: During this process, the final chocolate is heated and cooled to produce the most stable forms of cocoa butter crystals. This process improves the stability, the texture, and the appearance of the final chocolate product.

Moulding and cooling: The final chocolate is placed in moulds in order to obtain a certain shape for chocolate’s final presentation. It is heated to 60ºC and then cooled to produce a solid chocolate product.

Packing: The final chocolate products are wrapped and packaged.

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APPENDIX II

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