CODEX ALIMENTARIUS COMMISSION E

Food and Agriculture Organization of the United Nations

World Health Organization

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Agenda Item 11 **CX/CF 17/11/11**
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JOINT FAO/WHO FOOD STANDARDS PROGRAMME

CODEX COMMITTEE ON CONTAMINANTS IN FOODS

Eleventh Session
Rio De Janeiro, Brazil, 3-7 April 2017

DISCUSSION PAPER ON THE ESTABLISHMENT MAXIMUM LEVELS FOR MYCOTOXINS IN SPICES

BACKGROUND

1. During the 8th Session of the Codex Committee on Contaminants in Foods (CCCF) (March 2014), India and Indonesia submitted new work proposals for the establishment of maximum levels (MLs) for aflatoxins in spices and nutmeg respectively. After a general discussion, the Committee agreed to establish an electronic Working Group (eWG), chaired by India and co-chaired by Indonesia and the European Union, that will review mycotoxins in spices to assist the Committee with the understanding on which mycotoxins to address and in which spices for consideration at its next session.[1]

2. During the 9th Session of the Committee (March 2015), the Delegation of India introduced the discussion paper and provided a summary of the work and the approach taken to understand which mycotoxins should be addressed and for which spices, to aid in the development of a priority list of spices. The Delegation indicated that MLs should be set for total aflatoxins, aflatoxin B_1 and Ochratoxin A (OTA) based on the priority list of spices in the paper. In light of the interest to continue work on MLs in spices, and the need for further clarity on the mycotoxin/spice(s) combinations for which to establish MLs for and the rationale for this, as well as the need for further prioritization of the work, the Committee agreed to re-establish the eWG, led by India and co-chaired by Indonesia and the European Union.

3. The eWG was tasked with preparing a new discussion paper on mycotoxin contamination in spices and a project document for the establishment of MLs for mycotoxins in spices. The discussion paper was also to include proposals for possible MLs to assist the next session of the Committee with making decisions on new work. [2]

4. During the 10th Session of the Committee (April 2016), the development of MLs for mycotoxins in spices was deliberated. The delegations generally agreed with the principle and approach recommended by the eWG and the need to establish MLs for the spices identified, but that clarification was needed on whether the MLs would be set for each of the spices in the priority group or for the priority group as a whole. They were also of the view that it was not necessary to establish MLs for both total aflatoxins (AFT) and aflatoxin B_1 (AFB_1), as AFB_1 was included in total aflatoxins (AFT) and that a similar approach should be taken as for peanuts and tree nuts, while a view was also expressed that the ML should be for aflatoxin B_1 as it was the most toxic and most widely distributed.

5. The Committee agreed that further work was needed to expand on the MLs through an eWG chaired by India and co-chaired by the European Union, the following terms of reference: [3]

   - provide a rationale for selection of spices (chilli, paprika, ginger, nutmeg, pepper, turmeric)
   - provide rationale for selection of total aflatoxins and OTA
   - take into account the outcome of evaluation of aflatoxins from the 83rd meeting of JECFA in 2016 (JECFA/83/SC)
   - consider trade aspects of existing national standards
   - prepare a Project document for new work with proposals for MLs for spices.

[1] REP14/CF, paras. 131-137
[2] REP15/CF, paras. 135-139
[3] REP16/CF, paras. 143-148

CONCLUSION AND RECOMMENDATION

The Committee is invited to consider the conclusions and recommendations on the establishment of MLs for mycotoxins in spices.

In doing so, Codex members and observers are kindly invited to consider the information provided in Appendix I and its annexes which provides the basis for the conclusions and recommendations on the establishment of MLs for mycotoxins in spices. Project document and list of participants of the eWG are included in Appendix II and Appendix III respectively.

6. Thirty nine countries out of 41 countries and the European Union have set their national MLs (Table 1) for “Spices” or “All foods” which include spices rather than for individual spices.

7. Based on the data provided by the eWG members, Spices were prioritized with the method explained in Section III. Annex V of this document outlines the list of spices with contaminating mycotoxins which could be addressed by the Committee for the establishment of MLs. Cinnamon was not considered in this work due to lack of data, despite its high consumption as reported in Annex III. This discussion paper could assist the Committee with determining a possible prioritisation of the work on spices.

8. In the survey (Section III), there is more support for setting MLs for groups of spices. This would necessitate that consumption amounts be similar for all spices in a group. As there is a lack of consumption data for individual spices, spices are not classified into groups for proposing MLs.

9. In the JECFA 83rd report, there is no mention about mycotoxins in spices. In GEMS cluster data (Annex III), the per capita consumption amount of total spices is less than that of peanuts in different regions. Consumption amounts of individual spices would be less than for total spices in each region.

Therefore, the Committee may consider adopting the following MLs for each spice mentioned in Annex V (reproduced here below for convenience):

- 20 µg/kg for total aflatoxins and
- 20 µg/kg for ochratoxin A

The Committee may also consider requesting JECFA to perform an exposure assessment for health impact on proposed MLs for spice(s)/mycotoxin(s) combinations mentioned in Annex V.

Annex V

Table 17: Priority list of spices (from List 1 of Annex IV)

Spice	Scientific name	Mycotoxins for which MLs will be established
1) Nutmeg (dried/dehydrated)	*Myristica fragrans* L.	Aflatoxin B_1, Total aflatoxins, Ochratoxin A
2) Chilli and Paprika (dried/dehydrated)	*Capsicum annuum* L.	
3) Ginger (dried//dehydrated)	*Zingiber officinale*	
4) Pepper (dried/dehydrated)	*Piper nigrum* L.	
5) Turmeric (dried/dehydrated)	*Curcuma longa* L.	

APPENDIX I

ANALYSIS OF DATA / INFORMATION AND SUMMARY OF THE DISCUSSION OF THE EWG

(For information)

I. OBJECTIVE

1. The specific objective of this eWG is to review available data for mycotoxins in spices for prioritization of the work. This will assist the Committee in understanding which mycotoxin/spices(s) combinations need to be addressed. This review would also help to develop guidelines for risk assessment of mycotoxins in spices. The ultimate aim of this work is to establish maximum levels (MLs) for mycotoxins in spices in order to facilitate fair trade while protecting consumer health. The maximum levels for various mycotoxins in spices vary widely across the World (Table 1) and the lack of harmonization affects global trade of spices. Some countries have regulations for mycotoxins specifying different tolerated levels for individual foods, while others have set only one tolerated level for "all foods" which also include spices.

2. As the MLs for peanuts are being used for a comparison in Section VI, Canada has provided its national ML as 15 µg/kg for total aflatoxins in nuts and nut products for reference and comparative purposes.

Table 1: Maximum Levels of Mycotoxins fixed by some countries for spices/all food products

Country/ Organisation	Product	Aflatoxin B_1 (µg/kg)	Aflatoxin Total (µg/kg)	Zearalenone (µg/kg)	T-2 Toxin (µg/kg)	Ochratoxin A (µg/kg)	Patulin (µg/kg)
1. Armenia	All foods	5		1000	100	10	
2. Barbados	All foods		20				
3. Brazil	Spices		20			30	
4. Bulgaria"[2]	Spices	2	5				
5. Chile	Spices		10				
6. Colombia	All foods		10				
7. Croatia	Spices	30					
8. Cuba	Spices[3]	5	15				
9. Czech Republic"[2]	Spices	20					
10. European Union	Spices[1]	5	10			15[a] 20[b]	
11. Finland"[2]	All Spices		10				
12. Honduras	All foodstuffs		1				
13. Hong Kong	All foodstuffs	15	15				
14. Iceland	Spices	5	10			15	
15. India	All Foods		30				
16. Indonesia	Spices powder	15	20				
17. Iran (Islamic Republic of)	Spices	5	10				
18. Jamaica	Foods and Grains		20				
19. Japan	All foods		10				
20. Latvia"[2]	Food products of plant & animal origin	5					
21. Liechtenstein	Spices	5	10				
22. Malaysia	Other foods not specified, including spices		5				
23. Mauritius	All foods	5	10				
24. Morocco	All foods	10					
25. Nigeria	All foods	20					
26. Norway	Spices	5	10		15		

Table 1: Maximum Levels of Mycotoxins fixed by some countries for spices/all food products							
Country/ Organisation	**Product**	**Aflatoxin B_1 (µg/kg)**	**Aflatoxin Total (µg/kg)**	**Zearalenone (µg/kg)**	**T-2 Toxin (µg/kg)**	**Ochratoxin A (µg/kg)**	**Patulin (µg/kg)**
27. Oman	Complete food stuffs	10					
28. Pakistan	Chilli		30				
29. Republic of Korea	Chilli powder	10	15			7	
	Curry powder, Nutmeg, Turmeric, Dried chilli, Dried paprika and spices containing nutmeg, turmeric, dried chilli and dried paprika	10	15				
30. Salvador	All Foods		20				
31. Serbia and Montenegro	Spices	30					
32. Singapore	All foods except food for infants or young children	5	5				
	Food for infants or young children	0.1	NA				
33. South Africa	All food stuffs	5	10				50
34. Sri Lanka	All foods		30				
35. Switzerland	Spices excluding Nutmeg	5	10			20	
	Nutmeg	10	20				
36. Thailand	All foods		20				
37. Tunisia	Spices	5	10			15	
38. Turkey	Spices	5	10				
39. United States of America	All food except milk[4]		20				
40. Uruguay	All foods and spices	5	20				
41. Vietnam	All Foods		10				
42. Zimbabwe	All Foods	5					

1: *Capsicum spp.* (dried fruits thereof, whole or ground, including chillies, chilli powder, cayenne and paprika); *Piper spp.* (fruits thereof, including white and black pepper); *Myristica fragrans* (nutmeg); *Zingiber officinale* (ginger); *Curcuma longa,* based on Commission Regulation (EC) No 2174/2003.

a - Spices mentioned in footnote 1, except from *Capsicum spp*. (Ref: Commission Regulation (EC) No 2015/1137)

b - Spices mentioned in footnote 1 from dried fruits of *Capsicum spp*. (Ref: Commission Regulation (EC) No 2015/1137)

2 - Countries which comes under EU with MLs for mycotoxins

3 - dried fruits, whole fruit, chili, dried chili, pepper, white and black pepper, ginger, others

4 - The action level for aflatoxin M_1 in milk in the USA is 0.5 µg/kg.

Source: Worldwide regulations for mycotoxins in food and feed in 2003 (FAO); Cuban Standard, General Standard for Contaminants and Toxins in Food and Feed-Sanitary Regulations. In process, 2016; Pakistan Standard and Quality Control Authority (PSQCA) standard # PS: 1742- 2010; Agri-Food and Veterinary Authority of Singapore; Commission Regulation (EU) No 105/2010 of 5 February 2010 amending Regulation (EC) No 1881/2006 setting maximum levels for certain contaminants in foodstuffs as regards Ochrwww.ava.gov.sgatoxin A: www.anvisa.gov.br; The National Agency on Drugs and Food Control, Republic of Indonesia: # HK. 00.06.1.52.4011-2009. Chilean Sanitary Food Regulation http://web.minsal.cl/sites/default/files/files/DECRETO_977_96%20actualizado%20a%20Enero%202015(1).pdf;

3. According to the European Spice Association, the International Organisation for Standardisation and American Spice Trade Association, there are more than 50 commodities categorized as spices, most of which are susceptible to mycotoxins. Based on maximum levels mentioned in Table 1, it could be inferred that various countries have set national MLs for “Spices” or “All foods” which include spices.

II. INTRODUCTION

4. Spices are dried/dehydrated commodities which include dried seeds, fruits, bark, roots, rhizomes, stigmas and arils. These products are used as ingredients for providing the desired seasoning, flavour or aroma to the food and are distinguished from products that are used as food additives.

5. Spices are marketed in whole, ground, and cracked/crushed forms and as spice mixes/blends. Because of these assorted forms of spices, the fungi that can contaminate them and the mycotoxins which they produce vary greatly. In the Code of Hygienic Practice for Spices and Dried Aromatic Plants (CAC/RCP 42-1995), Spices and Dried Aromatic Plants are defined as “dried components or mixtures of dried plants used in foods for flavouring, colouring, and imparting aroma. This term equally applies to whole, broken, ground and blended forms”. Commodities which are categorized as spices are considered in this work based on the list of ISO (ISO 676:1995 - Spices and condiments – Botanical nomenclature).

6. The word mycotoxin is derived from two words; *“mykes”* referring to “fungi” (Greek) and *“toxicum”* referring to “poison” (Latin). Mycotoxins are secondary metabolites produced by moulds, contaminating a wide range of commodities before and after harvest. Mycotoxins are relatively large molecules that are not significantly volatile (WHO 1978; Schiefer 1990). Commodities contaminated with mycotoxins may be toxic to humans and animals depending upon a number of factors such as extent of contamination, frequency and amount of consumption of the contaminated food by various populations, exposure and absorption into the host, species affected etc, and therefore, can be a major health issue for consumers. The presence of mycotoxins in various foods to a certain extent is unavoidable as their synthesis by contaminating fungi is environmentally induced. The main genera of mycotoxin producing fungi are listed in Table 2 below.

Table 2: Main genera of fungi producing mycotoxins

Mycotoxins	Fungi	Spices affected by mycotoxins
Aflatoxin (B_1, B_2, G_1, G_2)	Aspergillus	Chilli, Clove, Ginger, Nutmeg, Paprika, Pepper, Turmeric
Ochratoxin (Ochratoxin A)	Aspergillus, Penicillium	Cayenne pepper, Celery seed, Chilli, Garlic, Mace, Nutmeg, Paprika, Pepper, Turmeric
Patulin	Aspergillus, Penicillium	
Cyclopiazonic acid (CPA)	Aspergillus	
Fumonisin (B_1, B_2, B_3)	Fusarium	
Fusaric acid		
Type A Trichothecenes (T-2 toxin, HT-2 toxin, diacetoxyscirpenol)		
Type B Trichothecenes (Nivalenol, deoxynivalenol, fusarenon-X)		
Zearalenone		
Penitrem A	Claviceps	
Ergot alkaloids: Clavines (Argoclavine)		
Lysergic acid, Lysergic acid amids (Ergin)		
Ergopeptines (Ergotamine, Ergovaline)		

Table 2: Main genera of fungi producing mycotoxins		
Mycotoxins	**Fungi**	**Spices affected by mycotoxins**
Citrinin	Penicillium	
Roquefortine		
PR toxin		
Penitrem A		
Cyclopiazonic acid (CPA)		

III. SURVEY REGARDING THE TERMS OF REFERENCE

7. A questionnaire with respect to the terms of reference was circulated among the eWG members. eWG members from (1) Chile, (2) Cuba (3) Ghana, (4) Greece, (5) Indonesia, (6) Islamic Republic of Iran, (7) Japan, (8) Kenya, (9) Singapore and (10) United States of America responded to the questionnaire.For the query on the need for MLs for individual spices or a group of spices, three members (Ghana, Kenya, USA) supported individual spices, four members (Cuba, Chile, Indonesia, Singapore) supported groups of spices, Japan responded that it should be based on the need after studying the occurrence data. Greece responded that setting MLs for individual spices might be time consuming and counter cost-productive while setting MLs for all spices does not reflect the level of risk consumers are exposed to and would not comply with the risk assessment approach. So, the member from Greece proposed that MLs could be developed as:

   Subgroup 1a - paprika, chili, cayenne pepper. Products with very high consumption and high level of rejection incidents.

   Subgroup 1b - nutmeg. Limited consumption but very high contamination levels and incidents of rejection.

   Subgroup 1c - ginger, pepper (black and white), turmeric. Lower consumption, lower contamination.

8. For the rationale behind selection of total aflatoxins and ochratoxin A as the mycotoxins upon with to focus ML development in this work, the following are the responses.

   Total aflatoxins - supported by members from all ten countries mentioned in paragraph 7.

   Aflatoxin B_1 - supported by Chile, Greece and Indonesia

   Ochratoxin A - supported by Cuba, Greece, Islamic Republic of Iran, Kenya and Singapore

   Rationale provided by all supporting countries is such that these contaminants predominantly occur in spices. Japan mentioned that selection should be based on occurrence data.

9. USA responded that CCCF should establish MLs for total aflatoxins only, rather than total aflatoxins and aflatoxin B_1, for the following reasons:

   a) Establishing an ML only for total aflatoxins is sufficient because total aflatoxins includes aflatoxin B_1, B_2, G_1, and G_2, and a separate ML for B_1 is not necessary.

   b) Establishing MLs only for total aflatoxins is consistent with the MLs only for total aflatoxins that have been established for other commodities, i.e., peanuts, tree nuts, and dried figs, by CCCF and the Commission. This position was also supported by Cuba according to General Standard CXS_193 – 2016.

10. Member from Greece mentioned that setting a ML only for total aflatoxins, instead for total aflatoxins and aflatoxin B_1, as is the current state of regulation in the EU, has the following draw-backs:

    - It could result in significantly less shipments being rejected at the border and therefore diminished consumer protection.

    - Reporting only total aflatoxins values would result in loss of information about the occurrence of the major carcinogenic component, aflatoxin B_1. This information might be crucial in the case of future reassessment of MLs for mycotoxins or other studies.

11. All respondents showed interest in submitting data in response to JECFA's "Call for data". The USA responded that if more than one ML is proposed for total aflatoxins or ochratoxin A in spices and CCCF cannot agree on an ML, the USA recommends, similar to ready-to-eat peanuts, that CCCF request that JECFA evaluate the impact on dietary exposure to total aflatoxins and ochratoxin A at various MLs proposed by CCCF. With regards to effects on existing national MLs on trade, Kenya stated that different national MLs may lead to market segmentation. Greece mentioned that following MLs of European Union internationally would be beneficial.

IV. ACHIEVABILITY OF VARIOUS HYPOTHETICAL MLs

12. Data were collected for mycotoxins and in the collected data, total aflatoxins, aflatoxin B_1 and ochratoxin A were prominently found. To that effect, an array of MLs was selected for consideration based on the existing regulations of various countries (Table 1), namely 10 µg/kg, 15 µg/kg, 20 µg/kg and 30 µg/kg (Table 1) for total aflatoxins and for ochratoxin A. Based on the different existing national MLs, the percentage of samples exceeding these limits was determined and presented in Table 6 and Table 7. Based on Graphs 1 and 2 in Annex II, greater numbers of lots of nutmeg and paprika are exceeding the different national MLs for total aflatoxins and ochratoxin A respectively. The fewest lots exceeding the MLs under consideration were those of pepper and turmeric.

V. APPROACH

13. The eWG evaluated the data, provided by members, on global occurrence and rejection of spices due to various mycotoxins. The spices which have more importance with respect to the international trade data are given in Annex I. The summary of occurrence and rejections data provided by eWG members is shown in Annex II.

14. It was observed that some spices such as dried chilli and nutmeg were contaminated with mycotoxins up to and occasionally exceeding a concentration of 1000 µg/kg while other spices were contaminated with no more than 1 to 2 µg/kg of mycotoxins. Certain spices such as dried garlic are produced and traded in higher quantities but appear to have less evidence of mycotoxin contamination. For these commodities, a greater number of samples would be required in order to adequately assess their typical mycotoxins levels. The extent of contamination is due to susceptibility, environmental condition of the cultivated regions and post-harvest practices.

15. In Annex III, the per capita daily consumption of individual spices submitted by the United States and GEMS cluster data are listed. As the collected availability data were only from one country, the method of prioritization of spices to consider for ML development was solely based on concentration of mycotoxins present in contaminated spices. Priority was given to spices which are contaminated with relatively higher amounts of mycotoxins as they may be rejected more frequently in trade and therefore may also be more likely to negatively impact public health, depending on the consumption patterns of the spice in question.

16. Occurrence data were ample for spices such as dried or dehydrated forms of chilli, ginger, nutmeg, paprika, pepper and turmeric but there were few data collected on some other spices. Spices with less data (< 10 samples) were included in List 2 (Table 11) but more data would be necessary to understand the extent of risk due to mycotoxins. Other spices with ample data in List 1 (Table 11) are presently considered in this work.

17. The median values of mycotoxins present for every spice were found from the collected occurrence and rejections data. Spices were ranked based on median values of both total aflatoxins (Table 12) and ochratoxin A (Table 13). Median values of aflatoxin B_1 in spices of List 1 were also shown in Table 14. The overall rank for each of the spices was calculated based on the sum of ranks for total aflatoxins and ochratoxin A in spices and shown in Table 15. Because chillies and paprika belong to same genus Capsicum and have the same botanical name as *Capsicum annuum* L., they were given the same rank. Ginger and pepper have the same sum of rank (Table 15). However, because the median values of total aflatoxins and aflatoxin B_1 in ginger are higher (Table 12 and 14), ginger was given higher priority than pepper.

18. As data for Spices in List 2 (Table 11) is presently less, they were not prioritized. But, median values of mycotoxins present in those spices were calculated for understanding (Table 16). Spices with ample data (List 1) were prioritized and listed in Annex V (Table 17). Spices such as dried or dehydrated forms of chilli, nutmeg, turmeric, pepper and ginger included in Annex V are traded predominantly in the international market (Annex I).

19. A lack of spice-specific food consumption data hinders the estimation of dietary exposure; however, the differences in maximum levels (MLs) between different countries still present difficulties in trade. In the interests of harmonization, in the absence of more spice consumption data, MLs could be considered based on achievability.

VI. Eighty-third meeting of JECFA (November 2016) "Summary and Conclusions"

20. The Eighty-third meeting of JECFA (http://www.fao.org/3/a-bq821e.pdf) evaluated Aflatoxins and noted that there were limited contamination data from developing countries, which hindered a more comprehensive and global evaluation of aflatoxin occurrence and may have resulted in an underestimate of dietary exposure in these countries.

21. The Committee stated that only five food commodities (maize, peanuts, rice, sorghum and wheat) each contributed more than 10% to international dietary exposure estimates for more than one Global Environment Monitoring System – Food Contamination Monitoring and Assessment Programme (GEMS/Food) cluster diets, for either total aflatoxins or aflatoxin B_1.

22. The Committee also noted that although overall concentrations of aflatoxins in rice and wheat are lower than concentrations in maize and peanuts (a traditional focus of aflatoxin risk management), the high consumption of rice and wheat in some countries means that these cereals may account for up to 80% of dietary aflatoxin exposure for those GEMS/Food cluster diets.

23. In the impact assessment of different MLs for ready-to-eat peanuts, the Committee concluded that enforcing a maximum level (ML) of 10, 8 or 4 µg/kg for ready-to-eat peanuts would have little further impact on dietary exposure to total aflatoxins for the general population, compared with setting an ML of 15 µg/kg. At an ML of 4 µg/kg, the proportion of the world market of ready-to-eat peanuts rejected would be approximately double the proportion rejected at an ML of 15 µg/kg (about 20% versus 10%).

Annex I

Table 3: Worldwide Export data of Spices						
Spice	**Export Quantity (In Tonnes)**					**Average Export Quantity (in Tonnes)**
	2010	**2011**	**2012**	**2013**	**2014**	
Garlic	22,557,355	23,088,184	23,411,764	24188693	24939965	23,637,192.20
Chillies and Peppers, dry *	3,148,238	3,350,947	3,452,334	3618392	3818768	3,477,735.80
Ginger	244,668	295,018	646,874	2423324	2156453	1,153,267.40
Pepper	343,075	330,857	350,356	436949	462955	384,838.40
Nutmeg	20,417	23,770	14,711	21,359	22,680	20,587.40
Turmeric	151,347.0	124,007	119,050	108,058	109,224	122,337.20
Cloves	127,456	101,342	126,956	137010	152968	129,146.40

* Red and cayenne pepper, paprika, chillies (*Capsicum frutescens; C. annuum*); allspice, Jamaica pepper (*Pimenta officinalis*)

Source: FAOSTAT, ITC

Annex II

Table 4: Worldwide Occurrence data including Rejections of spices due to aflatoxins – 2009 to 2015			
Spice	**Mycotoxins Type**	**Range of the mycotoxins present (min to max) µg/kg**	**Total number of samples analyzed**
Dried chilli (whole & ground)	Aflatoxin B_1	0.0169 – 1462.4	20081
	Total aflatoxins	0.0169–1489.9	
Turmeric (whole & ground)	Aflatoxin B_1	0.22 – 305.7	855
	Total aflatoxins	0.02 - 336.6	
Dried ginger	Aflatoxin B_1	0.029 – 51.8	256
	Total aflatoxins	0.029–362.9	
Nutmeg	Aflatoxin B_1	0.0203 – 1026.8	385
	Total aflatoxins	0.0241-1200	
Pepper	Aflatoxin B_1	0.02 – 33.7	71
	Total aflatoxins	0.02 – 40.1	
Dried paprika (whole & ground)	Aflatoxin B_1	0.055 – 349.8	107
	Total aflatoxins	0.055 - 358.6	
Clove	Total aflatoxins	29	1
Dried garlic (ground)	Aflatoxin B_1	0.7	1
	Total Aflatoxins	0.7	
Coriander seed	Aflatoxin B_1	0.5 – 0.7	3
	Total aflatoxins	0.5 – 0.7	
Fenugreek	Aflatoxin B_1	1.6	1
	Total aflatoxins	1.6	
Caraway	Aflatoxin B_1	0.5 – 2.3	2
	Total aflatoxins	0.5 – 2.3	

Source: Austria, Canada, India, Indonesia, European Union, Singapore, UK, USA

Table 5: Worldwide Occurrence data including rejections of spices due to Ochratoxin A – 2009 to 2015		
Spice	**Range of the toxin present (min to max) µg/kg**	**Total number of samples analyzed**
Dried chilli (whole & ground)	0.05 – 724	439
Turmeric (whole & ground)	0.01 – 15.41	169
Dried ginger	0.01 – 44.4	85
Nutmeg	0.116 – 355	56
Pepper	0.044 – 24.2	87
Dried paprika (whole & ground)	0.2 – 2150	132
Dried garlic (ground)	0.0480 – 145	7
Celery Seed	0.215 – 0.73	2
Coriander seed	0.277 – 1.86	6

Source: Austria, Canada, India, Indonesia, European Union, Singapore, UK, USA

Table 6: Total Aflatoxins in spices in Occurrence data including rejections (2009 to 2015)				
Spice	**Percentage (%) of samples exceeding the concentration of**			
	> 10 µg/kg	**> 15 µg/kg**	**> 20 µg/kg**	**> 30 µg/kg**
Nutmeg	66.49	53.25	45.71	33.77
Paprika	13.08	8.41	7.48	7.48
Chilli	25.11	17.96	13.88	8.62
Ginger	10.55	7.81	3.51	1.56
Pepper (Piper spp.)	5.63	5.63	4.22	1.41
Turmeric	4.91	2.57	2.22	1.63

Graph 1

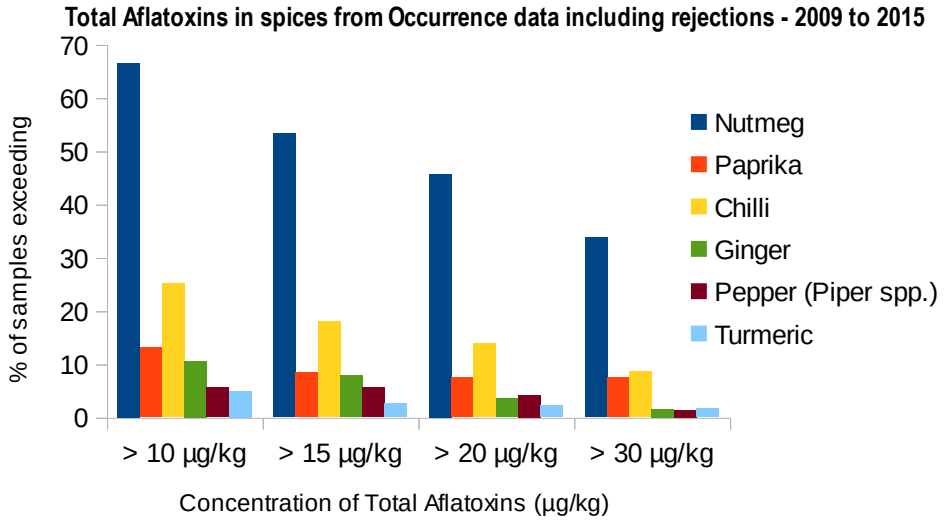
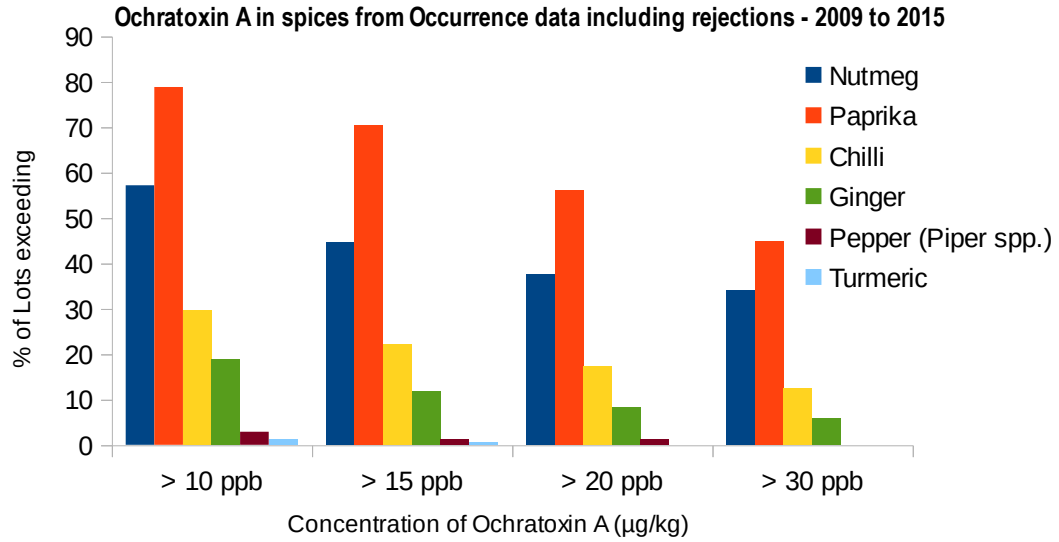


Table 7: Ochratoxin A in spices in occurrence data including rejections (2009 to 2015)				
Spice	**Percentage (%) of samples exceeding the concentration of**			
	> 10 µg/kg	**> 15 µg/kg**	**> 20 µg/kg**	**> 30 µg/kg**
Nutmeg	57.14	44.64	37.5	33.92
Paprika	78.78	70.45	56.06	44.69
Chilli	29.61	22.09	17.31	12.52
Ginger	18.82	11.76	8.23	5.88
Pepper	2.873	1.149	1.149	0
Turmeric	1.18	0.59	0	0

Graph 2



Annex III

Table 8: Estimated per capita daily consumption of spices and herbs, using data on daily amounts of spices and herbs available per resident, as a proxy[a, b]

Spice/ Herb	Imports (In Tonnes)*	Production (In Tonnes)*	Total (In Tonnes)*	Consumption[b] (gram per capita/day)
Anise seed, caraway seed, and Fennel seed	10,315	0	10,315	0.09
Cassia (includes cinnamon)	23,743.58	0	23,743.58	0.21
Celery seed	1,265.788	0	1,265.788	0.01
Clove	1,743.056	0	1,743.056	0.02
Coriander seed	4,253.313	0	4,253.313	0.04
Ginger root	56,068.26	0	56,068.26	0.49
Mace	531.426	0	531.426	0
Nutmeg	2,101.44	0	2,101.44	0.02
Paprika	28,861.98	0	28,861.98	0.25
Pepper, black and white	62,445.51	0	62,445.51	0.54
Pepper, capsicum, dried	89,987.67	0	89,987.67	0.79
Pepper, chili, dried	0	36,616.05	36,616.05	0.32
Turmeric	4,035.14	0	4,035.14	0.04
Other spices[c]	14,2462.5	0	14,2462.5	1.24

** The source data obtained in 1000 pounds was converted to tonnes with the conversion factor of 0.453592.*

[a] **Source:** USDA, Economic Research Service. Spices: Supply and Disappearance. Downloaded from http://ers.usda.gov/data-products/food-availability-(per-capita)-data-system.aspx#2794; per capita daily availability calculations are based on a 2012 USA population of 314,267,867, as provided in ERS documentation.

[b] Estimated consumption based on per capita availability data; may be over-estimates, since they are not corrected for small amounts exported to Puerto Rico and to other countries.

[c] Includes basil, cardamom seeds, capers, curry and curry powder products, dill, fenugreek seeds, oregano, parsley, rosemary, savory, thyme, mixed spices, and other spices and spice seeds (ground and unground) not individually reported.

Table 9: Consumption (g/day) of treenuts, peanut, total spices in each GEMS/Food Cluster Diet (2006)

Cluster Diet (g/day)	A	B	C	D	E (EU)	F	G	H	I	J	K	L	M (USA)
Tree nuts	4.2	21.5	3.9	3	5.5	10.2	16.3	15.7	9.7	1.9	19.1	29	5.6
Peanuts in shell	7.6	4.3	3	1	5.6	2	10.6	2.9	6.6	30.5	1.3	1	9.7
Peanuts shelled	5.2	3.1	2.1	0.7	4	1.4	7.6	2.1	4.7	21.8	0.9	0.7	6.9
Total Spices	2.7	1.1	2.4	0.9	1.8	1.1	2.3	1.9	1.4	1.3	0.4	0.6	1.7

Table 10: Average Consumption (g/day) of treenuts, peanut, total spices in different cluster groups in GEMS/Food Cluster Diet (2006)

Commodity	Average Consumption (g/day) in different cluster groups
Peanuts in shell	6.6
Peanuts shelled	4.7
Total Spices	1.5

Annex IV

Table 11	
List 1: Spices (ample data collected)	**List 2: Spices (less data)**
Chilli Ginger Nutmeg Paprika Pepper Turmeric	Caraway Celery seed Cloves Coriander seed Fenugreek Garlic

Prioritization of spices based on median concentration of mycotoxins

List 1:

Table 12: Total aflatoxins in spices

Spice	Median conc. (µg/kg)	Rank
Nutmeg	16.60	1
Chilli	3.40	2
Paprika	1.40	3
Ginger	1.40	4
Turmeric	1.10	5
Pepper	0.92	6

Table 13: Ochratoxin A in spices

Spice	Median conc. (µg/kg)	Rank
Paprika	26.10	1
Nutmeg	14.25	2
Pepper	12.12	3
Chilli	5.78	4
Ginger	1.90	5
Turmeric	1.19	6

Table 14: Aflatoxin B_1 in spices

Spice	Median (µg/kg)
Nutmeg	14.60
Chilli	3.40
Paprika	1.64
Ginger	1.10
Turmeric	1.00
Pepper	0.38

Table 15: Ranking of spices in List 1		
Spice	**Sum of the Ranks**	**Overall rank in Priority list**
Nutmeg	3	1
Paprika	4	2
Chilli	6	2[a]
Ginger	9	3[b]
Pepper	9	4
Turmeric	11	5

a - Chilli and Paprika were merged

b - Ginger was given more priority based on median value of Aflatoxin B_1

Table 16: Median conc. of mycotoxins in spices in List 2		
Spice	**Mycotoxins**	**Median Conc. of mycotoxin present (µg/kg)**
Cloves	Total aflatoxins	29
Fenugreek	Aflatoxin B_1	1.6
Caraway	Aflatoxin B_1	1.4
Garlic	Aflatoxin B_1	0.7
Coriander seed	Aflatoxin B_1	0.6
Celery seed	Ochratoxin A	0.47
Garlic	Ochratoxin A	0.15

Annex V

Table 17: Priority list of spices (from List 1 of Annex IV)		
Spice	**Scientific name**	**Mycotoxins for which MLs will be established**
1) Nutmeg (dried/dehydrated)	*Myristica fragrans* L.	Aflatoxin B_1, Total aflatoxins, Ochratoxin A
2) Chilli and Paprika (dried/dehydrated)	*Capsicum annuum* L.	
3) Ginger (dried//dehydrated)	*Zingiber officinale*	
4) Pepper (dried/dehydrated)	*Piper nigrum* L.	
5) Turmeric (dried/dehydrated)	*Curcuma longa* L.	

APPENDIX II

PROJECT DOCUMENT

PROPOSAL FOR NEW WORK ON ESTABLISHMENT OF MAXIMUM LEVELS FOR MYCOTOXINS IN DRIED OR DEHYDRATED FORMS OF NUTMEG, CHILI AND PAPRIKA, GINGER, PEPPER, AND TURMERIC

1. Purpose and Scope

- The purpose of the work is to ensure fair practices in international food trade and to protect public health by harmonizing the levels of mycotoxins in dried/dehydrated forms of nutmeg, chili and paprika, ginger, pepper, and turmeric.
- The scope of the work is to establish Codex maximum levels (MLs) of mycotoxins (Aflatoxin B_1, total aflatoxins and ochratoxin A) in dried/dehydrated forms of nutmeg, chili and paprika, ginger, pepper, and turmeric.

2. Relevance and Timeliness

Nutmeg (Binomial name: *Myristica fragrans.*), chilli and paprika (Binomial name: *Capsicum annuum* L.), ginger (Binomial name: *Zingiber officinale*), pepper (Binomial name: *Piper nigrum* L.), and turmeric (Binomial name: *Curcuma longa* L.) in dried or dehydrated forms are spices prominently produced and traded globally. They are traded in both whole and ground forms. These spices are reported to have higher susceptibility towards mycotoxin contamination.

Aflatoxins (AFs) were evaluated by the JECFA at its thirty-first, forty-sixth, forty-ninth and fifty-sixth meetings. Ochratoxin A (OTA) was evaluated by the JECFA at its thirty-seventh, forty-fourth and fifty-sixth meetings. The Provisional tolerable weekly intake (PTWI) of 100 ng/kg body weight is maintained for OTA at the latest (JECFA, 2007).

The hazardous nature of mycotoxins to humans and animals has necessitated the need for establishment of control measures and tolerance levels by national and international authorities. Many countries in the world have MLs for Aflatoxin B_1, total aflatoxins and ochratoxin A in spices. But different regulations (MLs) for mycotoxins in various countries are a potential impediment to the international trade.

3. Main aspects to be covered

- Establishment of MLs for aflatoxins (for aflatoxin B_1, total aflatoxins) and for ochratoxin A in dried or dehydrated nutmeg, chili and paprika, ginger, pepper, and turmeric.

4. Assessment against the Criteria for the establishment of work priorities

This proposal complies with the following criteria for establishing priorities of work:

a) Diversification of national legislation and apparent resultant or potential impediments to international trade.

Spices are commodities worldwide traded. About 41 countries and the European Union have different MLs for mycotoxins in spices/foods. Diversification of national and regional legislations has the potential to create technical barriers to trade, therefore there is a need to harmonize measures at international level.

b) Work already undertaken by other organizations in this field

The risk assessment has been already done for aflatoxins and ochratoxin A by JECFA.

5. Relevance to the Codex Strategic Objectives

The proposed work has relevance with Codex Strategic Goals 1 and 2.

Goal 1: Establish international food standards that address current and emerging food issues

- Mycotoxins are potential contaminants in various spices. Therefore, establishment of MLs for mycotoxins in dried or dehydrated nutmeg, chili and paprika, ginger, pepper, and turmeric is necessary to ensure consumers' health and to promote fair practices in trade.

Goal 2: Ensure the application of risk analysis principles in the development of Codex standards

The establishment of MLs based on exposure assessment by JECFA is proposed.

6. Information on the relation between the proposal and other existing Codex documents

There are no Codex maximum levels for mycotoxins in spices set by the Codex Alimentarius Commission.

7. Identification of any requirement for and availability of expert scientific advice

Exposure assessment for health impact on proposed MLs for spice(s)/mycotoxin(s) combinations might be required.

8. Identification of any need for technical input to the standard from external bodies

Not anticipated at this stage.

9. Proposed time-line for completion of the work

Subject to approval by the Codex Alimentarius Commission, the proposed new work to establish maximum levels for mycotoxins in dried or dehydrated forms of nutmeg, chili and paprika, ginger, pepper, and turmeric will be considered by CCCF11 with a view to its adoption in 2019, depending upon the availability of scientific advice.

APPENDIX III

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