CODEX ALIMENTARIUS COMMISSION

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World Health Organization

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Agenda item 17 **CX/CF 25/18/18**

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JOINT FAO/WHO FOOD STANDARDS PROGRAMME

CODEX COMMITTEE ON CONTAMINANTS IN FOODS

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ANALYSIS OF THE OCCURRENCE DATA OF LEAD IN SPICE MIXTURES

(Prepared by the FAO/WHO JECFA Secretariat)

BACKGROUND

1. Noting the absence of maximum levels (MLs) for lead in spice mixtures in the *General standard for contaminants in food and feed* (CXS 193-1995) (GSCFF), the 17th Session of the Codex Committee on Contaminants in Foods (CCCF17, 20224) considered a discussion paper prepared by Brazil, as Chair of the Electronic Working Group (EWG), on maximum levels (MLs) for lead in certain food categories, including spices.

2. CCCF17 noted that the EWG and the virtual meeting of the WG that took place before CCCF17 (VWG) had not proposed ML(s) for a spice mixture, as CXS 193 did not establish levels for multi-ingredient products. It was possible to obtain MLs considering the percentage of specific ingredients in the mixture. Additionally, the contamination profiles varied between spice mixtures, depending on the ingredients. This discussion became more evident when the Committee considered an ML of 0.9 mg/kg for spices, dried seeds, excluding dried celery seeds.[1]

3. CCCF17 noted that the Codex Secretariat could issue a circular letter (CL) requesting comments on the necessity and content of further guidance for multi-ingredient products. The CL would include a sample calculation reflecting the proposal to include ingredients without Codex ML and a mixture where the proportion of ingredients is unknown. Following this recommendation, the Codex Secretariat issued CL 2024/03-CF[2] requesting comments on the application of MLs to multi-ingredient products. The replies to this CL have been compiled in CX/CF 25/18/17[3].

4. CCCF17 also agreed to request the Secretariat of the Joint FAO/WHO Expert Committee on Food Additives (JECFA) to review the data in the GEMS/Food database already available on products labelled as spice mixtures and present an analysis of the data for discussion at CCCF18. Such an analysis would determine the concentration range of lead in spice mixtures and enable further understanding of such mixtures.[4]

5. The 47th Session of the Codex Alimentarius Commission (CAC47, 2024) adopted several MLs for spices, including dried seeds (excluding celery seeds) as proposed by CCCF17.[5]

OCCURRENCE DATA

Data retrieved from the Global Environment Monitoring System - Food Contamination Monitoring and Assessment Programme (GEMS/Food database)

6. The JECFA Secretariat retrieved through the GEMS/Food database, 14,805 results from declared randomly collected samples from the broad food category ‘herbs, spices, and condiments, covering 45 distinct food items. To avoid introducing confounding bias in data interpretation, this discussion paper focuses on six food categories, potentially including spice mixtures due to the lack of specificity in the GEMS/Food naming system. These categories represent a total of 5,250 data points, listed below in order of frequency:

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1 REP14/CF17, paras. 28-31, Appendix II
2 https://www.fao.org/fao-who-codexalimentarius/resources/circular-letters/en/
https://www.fao.org/fao-who-codexalimentarius/committees/committee/related-circular-letters/en/?committee=CCCF
3 https://www.fao.org/fao-who-codexalimentarius/meetings/detail/hu/?meeting=CCCF&session=18
4 REP24/CF, paras. 28 and 30
5 REP24/CAC47, paras. 63-67, Appendix II

- HERBS (n = 1,925)
- Herb, spice or condiment NES (n = 1,348)
- SPICES (n = 1,293)
- Spices, Fruits and Berries (n = 498)
- Spices, Roots and Rhizomes (n = 169)
- Spices, Seeds (n = 17)

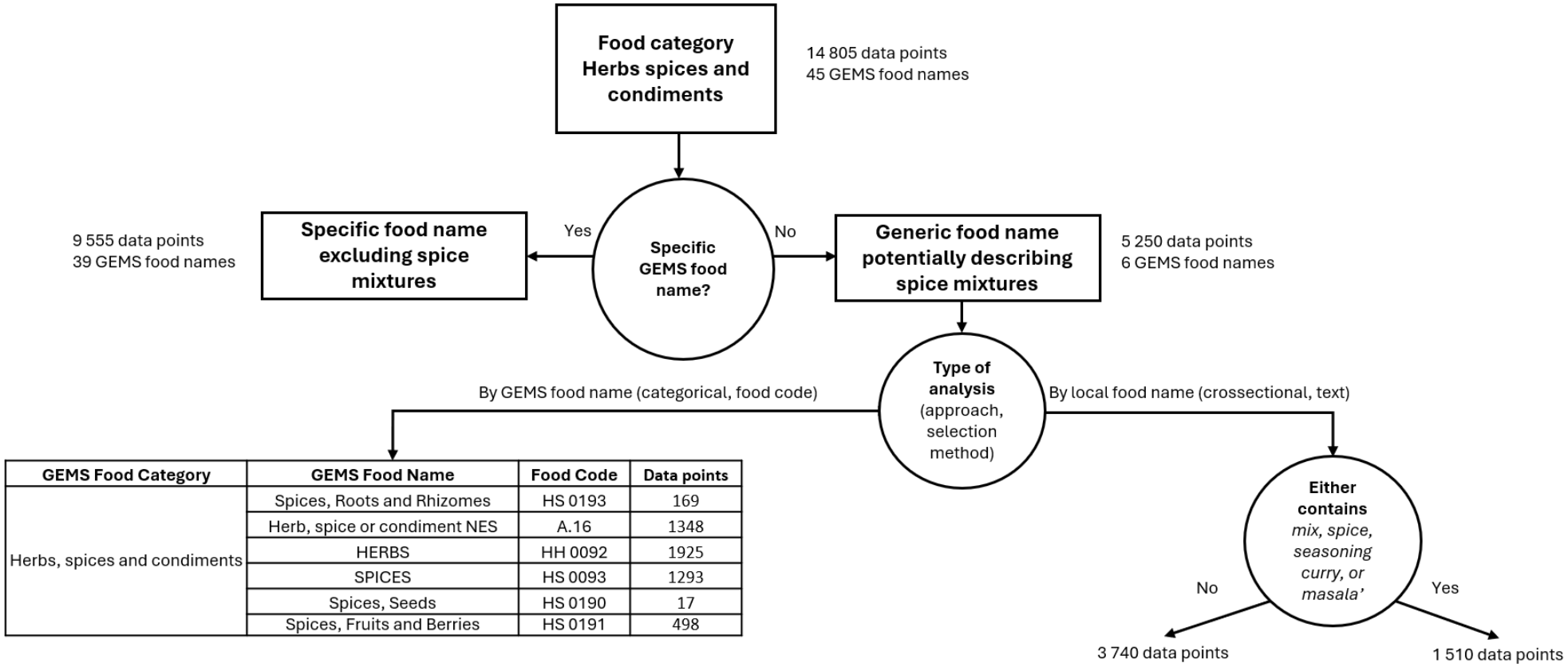
Summary statistics on the remaining 9,555 data points (reflecting 39 GEMS/Food names that were clearly identified as individual spices and, therefore, do not represent spice mixtures) are also presented for information and comparison purposes only.

7. The sampling period ranged from 2014 to 2024. Lead occurrence data were submitted by the following countries, listed by number of data points:

- European Union (n = 2,637)
- India (n = 643)
- China (n = 405)
- USA (n = 362)
- Canada (n = 339)
- Thailand (n = 245)
- Singapore (n = 205)
- Saudi Arabia (n = 132)
- Indonesia (n = 92)
- Brazil (n = 91)
- New Zealand (n = 33)
- Türkiye (n = 18)
- United Kingdom (n = 12)
- An additional 36 analytical results were provided by 14 other countries, each contributing fewer than 10 data points.

8. The limit of detection (LOD) and the limit of quantification (LOQ) ranged from 0.001 to 0.100 mg/kg and from 0.0003 to 0.401 mg/kg, respectively. In 22% of the samples, lead was non-detected (ND).

9. The distribution of the lead contamination was assessed according to two approaches, as described in **Figure 1**. The first approach consists of assessing the distribution of the lead concentration by GEM/Food name, whereas the second approach consists of assessing the distribution of the lead concentration of data points based on texts in the local food name indicated by data submitters. The text search aimed at identifying 5 likely descriptors of spice mixture and included ‘mix’, ‘spice’, ‘seasoning’, ‘curry’, and ‘masala’.



GEMS Food Category	GEMS Food Name	Food Code	Data points
Herbs, spices and condiments	Spices, Roots and Rhizomes	HS 0193	169
	Herb, spice or condiment NES	A.16	1348
	HERBS	HH 0092	1925
	SPICES	HS 0093	1293
	Spices, Seeds	HS 0190	17
	Spices, Fruits and Berries	HS 0191	498

Figure 1: Description of the analysis methodology

10. **Table 1** provides the distribution of lead concentrations in spices following the first approach described in **Figure 1**, by GEMS/Food name. The distributions of lead concentrations in spices are all dissymmetric l (mean> median or 50th percentile). Table 1 shows different mean concentrations; for example, the mean lead concentration in HERBS (0.86 mg/kg) is double that of SPICES (0.42 mg/kg), whereas Herbs, spices, or condiments NES stand in between (0.56 mg/kg). The distribution of lead concentrations in samples within a GEMS/Food group with limited data points (e.g., below 500) should be interpreted cautiously.

11. **Table 2** provides the distribution of lead concentrations in spices following the second approach described in Figure 1: a text search in the local food name. The distributions of lead concentrations in spices are all dissymmetric (mean>median or 50th percentile). Table 2 shows no major differences in contamination patterns among the general GEMS/Food groups, whether we consider the text marker of spice mixtures. However, specific GEMS/Food names (individual spices) have a mean lead concentration of 0.24 mg/kg, half that of generic food names (0.60 mg/kg).

Table 1: Distribution of lead concentration in spices, potentially identified as spice mixtures, by GEMS /Food name

GEMS Food Name	GEMS Food Code	Data points	Non Detected (%)	Lead concentration 5th Percentile (mg/kg)	Lead concentration 50th Percentile (mg/kg)	Mean lead concentration (mg/kg)	Lead concentration 75th Percentile (mg/kg)	Lead concentration 95th Percentile (mg/kg)	Lead concentration 97.5th Percentile (mg/kg)	Maximum lead concentration (mg/kg)
Spices, Roots and Rhizomes	HS 0193	169	5	0.01	0.20	0.59	0.36	2.18	5.98	11.20
Herb, spice or condiment NES	A.16	1348	71	0.00	0.02	0.56	0.08	0.32	0.52	543.00
HERBS	HH 0092	1925	17	0.01	0.11	0.86	0.26	1.31	1.78	350.00
SPICES	HS 0093	1293	20	0.03	0.21	0.42	0.39	1.50	2.50	11.00
Spices, Seeds	HS 0190	17	59	0.01	0.02	0.06	0.02	0.15	0.20	0.25
Spices, Fruits and Berries	HS 0191	498	11	0.02	0.24	0.26	0.38	0.58	0.60	2.58
Selection of Herbs, spices and condiments	6 codes above	5250	31	0.00	0.11	0.60	0.29	1.03	1.67	543.00

Table 2: Distribution of lead concentration in spices, with and without specific text marker in local food name

Food selection criterion	GEMS Food Code	Data points	Non Detected (%)	Lead concentration 5th Percentile (mg/kg)	Lead concentration 50th Percentile (mg/kg)	Mean lead concentration (mg/kg)	Lead concentration 75th Percentile (mg/kg)	Lead concentration 95th Percentile (mg/kg)	Lead concentration 97.5th Percentile (mg/kg)	Maximum lead concentration (mg/kg)
Local food name text includes either '*spice, mix, seasoning, curry or masala*'	6 generic food codes	1510	52	0.00	0.07	0.68	0.23	1.00	1.92	543.00
Local food name text excludes all of '*spice, mix, seasoning, curry or masala*'	6 generic food codes	3740	22	0.01	0.13	0.58	0.30	1.05	1.61	350.00
Selection of herbs, spices and condiments potentially including spice mixtures	6 generic food codes	5250	31	0.00	0.11	0.60	0.29	1.03	1.67	543.00
Selection of herbs, spices and condiments excluding spice mixtures	39 specific food codes	9555	17	0.01	0.08	0.24	0.23	0.80	1.30	135.67
Herbs, spices and condiments category	All 45 codes	14 805	31	0.00	0.09	0.37	0.25	0.88	1.46	543.00

12. The proportion of rejected samples based on proposed MLs of 1 and 2 mg/kg was estimated and provided for CCCF discussion. Table 3 reflects the number of samples that do not comply with a certain ML. An ML of 1 mg/kg would imply a rejection rate of 5.1%, whereas a rejection of 1.9% would be observed if an ML of 2 mg/kg were applied.

Table 3: Projection of rejection rates based on ML scenarios

ML Scenario	Data points	Mean lead concentration (mg/kg)	Lead concentration 95th Percentile (mg/kg)	Rejection rate (%)
No ML	5250	0.60	1.03	0
ML: 2 mg/kg	5148	0.21	0.78	1.9
ML: 1 mg/kg	4982	0.17	0.57	5.1

CONSUMPTION DATA

Consumption data of spices from the GEMS/Food cluster diet

13. Spices and condiments represent a food availability of 2.6 g/day per capita across clusters, spanning from 0.5 g/d for cluster G16 up to 7.0 g/d in cluster G14. It is understood that this broad category is not specific to spice mixtures and includes individual and specific spices.

FAO/Stat Food Supply Utilization Accounts

14. Two countries (Saint Vincent and the Grenadines and Yemen) have reported food availability of 'Other stimulants, spices and aromatic crops, n.e.c.' exceeding 10 g/capita/day and average 15.8 g/capita/day and 18.0 g/capita/day, respectively, in 2022. Similar to the cluster diet, the fact that this food category is broad means that spice mixtures only represent a fraction of it.

Consumption data of spice mixture from the FAO/WHO Chronic Individual Food Consumption database (CIFOCOss)

15. A limited number of countries (14) have reported 'mixed herbs and spices' consumption in the CIFOCOss database. Most countries reported daily consumption below 1g, except Cyprus, the Netherlands, Sweden, and Brazil. Only the data from the Netherlands had enough subjects (>60 individuals) to come up with a reliable 95th percentile. The mean and high consumption (high 95th percentile) of mixed herbs and spices was mean: 3.8 g/day, P95: 10.4 g/day in children (20 kg) and mean: 5.3 g, P95: 11.0 g/day in adults (84 kg).

DIETARY EXPOSURE ESTIMATES

16. Mean lead concentration values in spices associated with generic GEMS/Food names, which include spice mixtures and were reported in Table 3, are combined with the consumption data of mean and high consumers of mixed spices and herbs in the FAO/WHO CIFOCOss individual food consumption data. In the absence of ML, the resulting contribution to dietary exposure estimates to lead of adult consumers was estimated at 0.04 µg/kg bw/day in mean and at 0.08 µg/kg bw/day at the P95 (**Table 5).** For children, the mean consumption was estimated at 0.11 µg/kg bw/day and 0.31 µg/kg bw/day at the P95 (**Table 6**).

Table 5: Impact of different ML scenarios on dietary exposure to lead and risk characterization from the consumption of mixed herbs and spices in adults (JECFA quantitative risk assessment).

ML Scenario Applied to adults PoD: 1.3 µg/kg bw/d **JECFA 73** 1 mm Hg increase in blood pressure	**Mean lead concentration** (mg/kg)	**Mean mixed spice and herbs consumption** (g/d)	**High P95 mixed spice and herbs consumption** (g/d)	**Mean exposure to lead from mixed herbs and spices** (µg/kg bw/d)	**High exposure to lead from mixed herbs and spices** (µg/kg bw/d)	**Risk characterization of lead from mixed herbs and spices:** (Mean % PoD)	**Risk characterization of lead from mixed herbs and spices:** (High % PoD)
No ML	0.60	5.3 g/d	11.0 g/d	0.04	0.08	3%	6%
ML: 2 mg/kg	0.21			0.01	0.03	1%	2%
ML: 1 mg/kg	0.17			0.01	0.02	1%	2%

Table 6: Impact of different ML scenarios on dietary exposure to lead and risk characterization from the consumption of mixed herbs and spices in children (JECFA quantitative risk assessment).

ML Scenario Applied to children PoD: 0.6 µg/kg bw/d **JECFA 73** 1 IQ point loss	**Mean lead concentration** (mg/kg)	**Mean mixed spice and herbs consumption** (g/d)	**High P95 mixed spice and herbs consumption** (g/d)	**Mean exposure to lead from mixed herbs and spices** (µg/kg bw/d)	**High exposure to lead from mixed herbs and spices** (µg/kg bw/d)	**Risk characterization of lead from mixed herbs and spices:** (Mean % PoD)	**Risk characterization of lead from mixed herbs and spices:** (High % PoD)
No ML	0.60	3.8 g/d	10.4 g/d	0.11	0.31	19%	52%
ML: 2 mg/kg	0.21			0.04	0.11	7%	18%
ML: 1 mg/kg	0.17			0.03	0.09	5%	15%

17. The last JECFA assessment (JECFA73, 2011) has established for lead a point of departure (PoD) of 0.6 µg/kg/d for loss of intelligence quotient of 1 IQ point in children and of 1.3 µg/kg bw/d for 1 mmHg increase in blood pressure in adults. The overall dietary exposure to lead was estimated by JECFA73 to be: Adults: 0.02-3 µg/kg bw/d (mean), 0.06-2.43 µg/kg bw/d (90th to 97.5th percentile). Children: 0.03 to 9 µg/kg bw/d (mean), 0.2 to 8.2 µg/kg bw/d (90th to 97.5th percentile). The contribution to lead dietary exposure from the consumption of mixed herbs and spices could represent at the P95 up to 6% of the PoD in adults and 52% in children.

18. Moreover, **Table 5** and **Table 6** show that enforcing an ML of 2 mg/kg for spice mixtures would impact dietary exposure to lead for the general population, compared with the current situation with no Codex ML. With an ML of 2 mg/kg for lead in spice mixtures, Children's exposure would decrease from 52% to 18% of the PoD associated with a 1-point IQ loss. Enforcing an ML of 1 mg/kg for lead in spice mixtures would further reduce the exposure, though the additional gain would be limited, bringing the exposure down to 15% of the PoD. As shown in **Table 3,** the proportion of spice mixtures exceeding the ML would be approximately 2% for an ML of 2 mg/kg and around 5% for 1 mg/kg.

CONCLUSIONS

19. The JECFA Secretariat has arrived at the following conclusions:

    (i) Applying a maximum level (ML) of 2 mg/kg for lead in spice mixtures would reduce dietary lead exposure in the general population by approximately 15% compared to the current situation with no Codex ML. Enforcing an ML of 1 mg/kg is estimated to achieve an 18% reduction in exposure. However, this measure would also increase the proportion of rejected spice mixtures from 1.9% to 5.1%.

    (ii) In neurodevelopmental toxicity, applying maximum levels (MLs) at 1 or 2 mg/kg for lead in spice mixtures is expected to reduce dietary exposure from this specific source. However, the potential health risk in children cannot be fully excluded based on current exposure estimates and the absence of an identified threshold for lead-induced neurodevelopmental effects. This reflects the contribution of other dietary and environmental lead sources to total exposure, supporting the need to consider cumulative exposure.

RECOMMENDATIONS

20. Besides the specific case of spice mixtures described in this paper, and the possibility to establish an ML for spice mixtures as indicated in the conclusions, Codex members and observers should read this paper jointly with the information provided, and considerations made, about the application of MLs to multi-ingredient products (Agenda item 16) to have a consistent approach when considering food mixtures vis-à-vis the possibility of establishing single MLs for such mixtures or when considering single MLs within such mixtures. This would enable the joint consideration of both the technical (JECFA Secretariat) and procedural (Codex Secretariat) aspects associated with the establishment of MLs for spice mixtures and food mixtures in general.

21. CCCF is invited to consider the conclusions in paragraph 19 (i) and (ii) while taking into account the considerations made about the application of MLs for multi-ingredient foods in CL 2024/03-CL[2] and comments provided by countries in this regard (CX/CF 25/18/17)[2].