

# CODEx ALIMENTARIUS COMMISSION



Food and Agriculture  
Organization of the  
United Nations



World Health  
Organization

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**Agenda Item 12**

**CX/CF 26/19/12**

**August 2026**

## JOINT FAO/WHO FOOD STANDARDS PROGRAMME CODEX COMMITTEE ON CONTAMINANTS IN FOODS

**Nineteenth Session**

**19-23 October 2026**

**Cairo, Egypt**

### DISCUSSION PAPER

### DEVELOPMENT OF A CODE OF PRACTICE FOR THE PREVENTION AND REDUCTION OF OCHRATOXIN A CONTAMINATION IN DRIED FRUITS

(Prepared by the Electronic Working Group chaired by Türkiye, co-chaired by the United Kingdom)

Codex Members and Observers wishing to submit comments on the recommendations for the development of a code of practice for the prevention and reduction of ochratoxin A contamination in dried fruits should do so as instructed in paragraphs 13-14 and CL 2026/58-CF, available on the Codex webpage<sup>1</sup>

#### BACKGROUND

1. At the 18th session of the Codex Committee on Contaminants in Foods (CCCF18, 2025), Türkiye requested that the Committee consider submitting the project document to the Codex Alimentarius Commission (CAC) for approval as new work, highlighting that Codex maximum Levels (MLs) and codes of practice (CoPs) for the prevention and reduction of Ochratoxin A (OTA) contamination already existed for various food groups, and that scientific literature on the prevention and reduction of OTA in dried fruits was available. The Chairperson proposed that the discussion paper and project document be further revised in line with current CCCF approaches for new work proposals, for consideration at CCCF19. CCCF18 agreed to<sup>2</sup>:
  - (i) establish an electronic working group (EWG), chaired by Türkiye and co-chaired by the United Kingdom, working in English; and
  - (ii) refine the discussion paper and project document for the development of a Code of practice (CoP) for the prevention and reduction of OTA contamination in dried fruits, for consideration by CCCF19.

#### WORK PROCESS

2. CCCF18 agreed to establish the electronic working group (EWG), chaired by Türkiye and co-chaired by the United Kingdom, to refine the discussion paper and the project document for the development of a Code of practice for the prevention and reduction of OTA contamination in dried fruits for consideration by CCCF19.
3. Following the establishment of the EWG in December 2025, a timetable for the work was circulated to the EWG and they were invited to suggest dried fruits for possible inclusion in the scope of the work and to provide relevant supporting information, including trade volumes, OTA-related risk assessments, scientific publications, and applicable regional or national CoPs. Members were also requested to provide supplementary information and data relevant to the topics identified in the discussion paper to support the further refinement of the discussion paper and project document. In addition, with a view to facilitating the preparation of a proposed CoP, should the work progress to that stage, members were invited to provide information on recommended practices applicable to the pre-planting, planting, pre-harvest, harvest, post-harvest, storage, packaging, and transportation stages that have been demonstrated to reduce or prevent OTA contamination, together with supporting scientific publications, studies, and relevant regional or national guidance documents.

<sup>1</sup> Codex webpage/Circular Letters:

<http://www.fao.org/fao-who-codexalimentarius/resources/circular-letters/en/>

Codex webpage/CCCF/Circular Letters:

<http://www.fao.org/fao-who-codexalimentarius/committees/committee/related-circular-letters/en/?committee=CCCF>

<sup>2</sup> [REP25/CF18](#), para.192.

4. In response to the welcome message and the circulation of the timetable, Brazil, Cabo Verde, Ghana, and the International Nut and Dried Fruit Council (INC) provided useful information and scientific data relevant to the development of the discussion paper and project document. The information and data received informed the further refinement of the discussion paper and project document.
5. To refine the discussion paper and the project document for the development of a CoP for the prevention and reduction of OTA contamination in dried fruits, a meeting was held in Türkiye in February 2026 with experts from the Ministry of Agriculture and Forestry, Provincial Directorates, Exporters' Associations, primary producers, food business operators, as well as academia and experts from relevant institutes, and the draft document was further elaborated in line with the outcomes of these consultations.
6. The first draft of the discussion paper, project document, and CoP was circulated to the EWG members in March 2026 for comments and suggestions. Comments and suggestions were received from Argentina, Brazil, Cabo Verde, Canada, Indonesia, Japan, the United States of America, and INC.
7. The comments and suggestions proposed by members for the first draft of the discussion paper and project document are summarised below.
  - Two Members proposed removing references to risk assessments conducted by organizations other than JECFA from the discussion paper, noting that JECFA is the risk assessment body that provides scientific advice to CCCF.
  - Two Members considered that the sections on Methods of Analysis and Sampling, as well as references to performance criteria, sampling plans and MLs, were outside the current scope of work agreed by CCCF18, which is limited to the discussion paper and project document.
  - Three Members emphasized that the discussion paper should remain focused on supporting the development of the CoP and recommended removing or relocating information more relevant to future work on MLs or other Codex activities.
  - Two Members noted that some mitigation or decontamination methods are subject to national regulatory frameworks and should not be presented as generally applicable Codex recommendations.
  - One Member considered that the section on trade volume was outside the scope of the CoP.
  - Two Members recommended strengthening the justification for the development of the CoP by better explaining the specific characteristics of dried fruits and the added value of a commodity-specific Codex text.
  - Two Members suggested broadening the scope of the proposed CoP by considering the inclusion of additional dried fruits, such as dried mango, dried pineapple and dried banana, where relevant.
  - One Member suggested aligning the project document with the Codex Strategic Plan 2026–2031, including the relevant Strategic Goals and timeline for the proposed new work.
8. To support the determination of the scope of the proposed CoP, the GEMS/Food Contaminants Database was reviewed to assess the availability of OTA occurrence data for different dried fruits. The information obtained, together with the available scientific literature, was taken into consideration when selecting the dried fruits covered by the proposed CoP.
9. Although CCCF18 agreed only to further develop the discussion paper and the project document, a preliminary CoP was also prepared to facilitate discussion and obtain early technical input from Members and Observers. The main comments for the first draft of the CoP received are summarized below:
  - Several members welcomed the proposed CoP and considered it a good technical basis, while recommending further streamlining to avoid repetition and improve its structure.
  - Several members suggested strengthening the practical and commodity-specific recommendations, with greater emphasis on preventive measures throughout the production chain and clearer operational guidance for stakeholders.
  - Several members provided technical and editorial comments to improve clarity, scientific accuracy, scope, definitions, and the presentation of the proposed CoP.
10. The second draft of the discussion paper, project document, and proposed CoP was circulated to the EWG members in May 2026 for comments and suggestions. Comments and suggestions were received from Argentina, Canada, Ghana, Indonesia, Iran, Japan, the United States of America, and INC. The comments and suggestions proposed by members for the second draft of the discussion paper, project document, and CoP are summarised below:
  - Two Members suggested giving greater emphasis to JECFA as the scientific risk assessment body for CCCF and reconsidering the inclusion of regional risk assessments or information not directly supporting the development of the CoP.

- Two Members suggested removing information related to wine or other content not directly relevant to the proposed CoP for dried fruits.
- One Member suggested better explaining the relationship between the proposed CoP and existing Codex texts, while reflecting both common and commodity-specific preventive approaches.
- Two Members recommended strengthening the description of preventive measures throughout the production chain, particularly during post-harvest handling, drying, storage and processing.
- One Member suggested that only mitigation measures demonstrated to be effective at commercial scale should be included in the future CoP, while experimental approaches should remain in the discussion paper.
- Two Members requested further clarification of the scope of the proposed CoP, particularly regarding the commodities covered and the rationale for focusing on specific dried fruits.
- One Member questioned the exclusion of additional dried fruits, such as dried mango and dried pineapple, and requested clarification of the selection criteria.
- One Member suggested strengthening the justification for the proposed new work by highlighting its contribution to harmonized international management of OTA in dried fruits.
- One Member proposed strengthening recommendations on representative sampling and commodity-specific drying practices.
- Several Members recommended improving the scientific accuracy, structure, and clarity of the document by revising terminology and reducing repetition.
- Several Members suggested improving the overall structure and logical flow of the discussion paper by strengthening the links between sections and reducing repetition. In response, the discussion paper was reorganized to improve coherence, readability, and the presentation of preventive measures throughout the production chain.

#### **SUMMARY OF KEY POINTS OF DISCUSSION**

11. Several members suggested expanding the scope of the proposed Code of practice to include additional dried fruits, such as dried mango, dried pineapple, and dried banana. The EWG notes that the initial scope focused primarily on dried fruits predominantly produced using traditional sun-drying practices, where OTA contamination presents a greater challenge and where greater experience is available with commodity-specific prevention and reduction measures. In response to members' comments, the EWG is prepared to include these additional commodities within the scope of the proposed CoP. To support the development of scientifically sound and practical commodity-specific recommendations, members, particularly major producing countries, are invited to provide occurrence data, information on production and drying practices, commodity-specific OTA risk factors, critical control points, and effective prevention and reduction measures applicable to these commodities.

#### **CONCLUSION**

12. The revised discussion paper and project document, taking into account the comments received from members, are submitted for consideration by CCCF. The detailed comments received on the proposed CoP demonstrate the value of continuing to develop this work.

#### **RECOMMENDATIONS**

13. CCCF19 is invited to:
  - i. consider whether the data/information provided in the discussion paper (Appendix I) is sufficient to support new work on a Code of practice for the prevention and reduction of ochratoxin A contamination in dried fruits, and in the affirmative, to consider the points below.
  - ii. consider the project document in Appendix II and make any necessary adjustments to ensure a robust rationale for the development of the Code of practice (CoP) for the prevention and reduction of OTA contamination in dried fruits, with a view to forwarding it to CAC50 (2027) for approval as new work.
  - iii. review the outline for the proposed CoP as presented in Appendix III to guide an electronic working group (EWG) in developing the CoP following approval of new work by CAC50, in particular as to whether the structure and general content are reasonable and if further improvements could be made, e.g. addition of new sections, further development of current sections.
  - iv. establish an electronic working group to develop the CoP, for consideration by CCCF20 (2027).
14. If the discussion paper needs further development, CCCF19 is invited to identify gaps and data/information in Appendix I that should be further developed for consideration of a revised discussion paper by CCCF20 (2027).

## APPENDIX I

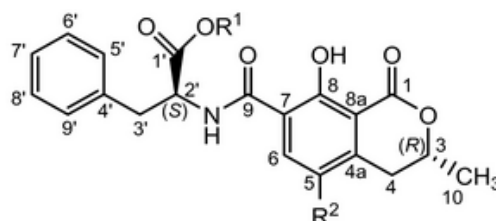
## DISCUSSION PAPER ON OCHRATOXIN A IN DRIED FRUITS

(For information)

## BACKGROUND

## Ochratoxin A

- Ochratoxins are mycotoxins produced by several species of the genera *Aspergillus* and *Penicillium*, including *A. ochraceus*, *A. carbonarius*, and *P. verrucosum*. Structurally, ochratoxins consist of the amino acid L-phenylalanine linked via an amide bond to a substituted dihydroisocoumarin moiety.



| Ochratoxin | Substituents                                                         | Molecular formula                                 | Molar mass (g · mol <sup>-1</sup> ) | CAS number |
|------------|----------------------------------------------------------------------|---------------------------------------------------|-------------------------------------|------------|
| OTA        | R <sup>1</sup> = H; R <sup>2</sup> = Cl                              | C <sub>20</sub> H <sub>18</sub> ClNO <sub>6</sub> | 403.8                               | 303-47-9   |
| OTB        | R <sup>1</sup> = H; R <sup>2</sup> = H                               | C <sub>20</sub> H <sub>19</sub> NO <sub>6</sub>   | 369.4                               | 4825-86-9  |
| OTC        | R <sup>1</sup> = C <sub>2</sub> H <sub>5</sub> ; R <sup>2</sup> = Cl | C <sub>22</sub> H <sub>22</sub> ClNO <sub>6</sub> | 431.9                               | 4865-85-4  |

Figure 1. Chemical structure of ochratoxin A, B, and C

- Ochratoxin A (OTA) is the most prevalent and toxic member of the ochratoxin group. OTA has been reported to remain stable at temperatures up to 250°C. It is classified by the International Agency for Research on Cancer (IARC) as a possible human carcinogen (group 2B).
- The fungal species associated with OTA contamination in dried fruits vary according to the commodity and environmental conditions. In dried figs, grapes, and other vine fruits, *A. carbonarius* and *A. niger* aggregates are frequently reported, whereas *A. ochraceus* and *A. westerdijkiae* are mainly associated with dried prunes. In dates, OTA contamination during storage has primarily been linked to *A. niger*, although *A. ochraceus* has also been reported in some studies. In dried apricots, *A. niger* is the most commonly identified species associated with OTA contamination. Information on the fungal species associated with OTA contamination in other dried fruits proposed for inclusion in the scope, such as dried mango, dried pineapple and dried banana, remains limited and further data are needed to support commodity-specific recommendations.
- The public health significance of OTA has been evaluated by the Joint FAO/WHO Expert Committee on Food Additives (JECFA), the scientific risk assessment body supporting Codex work on food additives and contaminants. In its most recent risk assessment (2007), JECFA concluded that the available scientific evidence did not warrant revision of its previous assessment and retained the provisional tolerable weekly intake (PTWI) of 100 ng/kg body weight.
- Codex has established Codes of practice (CoPs)<sup>1</sup> on OTA for cereals<sup>2</sup>, wine<sup>3</sup>, coffee<sup>4</sup>, cocoa<sup>5</sup>, and spices<sup>6</sup>. These CoPs provide guidance on preventing and reducing OTA contamination in their respective commodities. The proposed CoP for dried fruits would build on existing Codex texts while providing guidance on practices related to primary production, drying, processing, storage, and transportation.
- There is currently no CoP or maximum level for OTA in dried fruits in the General Standard for Contaminants and Toxins in Food and Feed (CXS 193-1995)<sup>7</sup>. Maximum levels for OTA have been established in CXS193 for wheat, barley, rye, chili pepper, paprika and nutmeg.

<sup>1</sup> Available at:  
<https://www.fao.org/fao-who-codexalimentarius/committees/committee/related-standards/en/?committee=CCCF>

<sup>2</sup> CXC 51-2003

<sup>3</sup> CXC 63-2007

<sup>4</sup> CXC 69-2009

<sup>5</sup> CXC 72-2013

<sup>6</sup> CXC 78-2017

<sup>7</sup> CXS 193-1995

7. The dried fruits discussed in this paper were selected based on available scientific evidence on OTA occurrence, information from official monitoring programmes and published literature, together with their relevance in international production and trade. Additional dried fruits may be considered where relevant scientific information becomes available.

#### **RISK EVALUATION**

8. JECFA has conducted<sup>8</sup> risk assessments of OTA in 1991, 1995, 2001 and 2007. In 1991, JECFA established a PTWI of 112 ng/kg body weight per week, based on a lowest observed effect level (LOEL) of 8 µg/kg body weight per day for deterioration of renal function in pigs and the application of an uncertainty factor (UF) of 500. This uncertainty factor was applied because no no-observed-effect level (NOEL) had been identified for OTA and adverse renal effects were observed after only a small proportion of the pigs' lifespan.
9. In 1995, the PTWI was rounded to 100 ng/kg body weight per week and was retained in the subsequent risk assessment conducted in 2001.
10. In its most recent risk assessment (2007), JECFA reviewed additional scientific evidence, including data on the mode of action of OTA in the kidney, and concluded that the new information did not warrant revision of its previous risk assessment. Consequently, the Committee retained the PTWI of 100 ng/kg body weight per week. Dietary exposure estimates, based mainly on European occurrence data, ranged from 8 to 17 ng/kg body weight per week, which were below the PTWI.

#### **PREVENTION AND REDUCTION OF OTA CONTAMINATION**

11. Preventing and reducing OTA contamination in dried fruits requires effective control measures throughout the production chain. Fungal growth and subsequent OTA formation may occur during both pre-harvest and post-harvest stages, including crop production, harvest, drying, storage and transportation<sup>9</sup>. Species within the *Aspergillus* genus, including *A. carbonarius* and other species within *Aspergillus* section *Nigri* and *Aspergillus* section *Circumdati*, may infect fruits before harvest and continue to develop during post-harvest handling.

##### **Pre-harvest and Harvest**

12. Preventing fungal infection during primary production is one of the most effective measures for reducing OTA contamination. The implementation of good agricultural practices (GAP) may help reduce the risk of OTA contamination. Appropriate soil cultivation, crop rotation, efficient irrigation under drought conditions, proper use of fungicides and fertilizers, adoption of fungus-resistant crop varieties, and timely harvesting may help reduce fungal growth and risk of OTA contamination. Inadequate pre-harvest practices may increase the risk of fungal growth and subsequent OTA accumulation during storage.
13. Appropriate harvesting practices may contribute to reducing fungal infection and subsequent OTA contamination. Maintaining product quality during harvest, including minimizing mechanical damage to fruits, avoiding contact with soil, using clean, dry harvesting containers, and promptly removing visibly damaged or mouldy fruits, may further reduce the risk of fungal growth.

##### **Drying**

14. Drying practices are important for reducing fungal growth and OTA formation in dried fruits. For example, control of OTA formation in dried vine fruits may be particularly challenging because any pre-harvest infection with *A. carbonarius* may continue to develop during the early stages of drying. In addition, damage to grapes during harvest and the initial stages of drying may lead to new *A. carbonarius* infections. Although the high temperatures and intense sunlight that typically occur during drying are generally not favourable for the growth of *A. carbonarius*, this fungus is less inhibited than many other fungal species because of its dark hyphae and spores, which provide a competitive advantage. Consequently, OTA production may continue until the water activity of the drying grapes has been substantially reduced.

##### **Storage and Transportation**

15. Appropriate storage and transportation practices, together with adherence to good manufacturing practices, may contribute to preventing fungal growth and reducing OTA contamination after drying. Maintaining cleanliness, regularly inspecting and cleaning storage areas and equipment, and following proper hygiene practices are important for minimizing the risk of contamination. In addition, appropriate control of moisture content, water activity, temperature, and humidity; prevention of rewetting; adequate ventilation; suitable packaging and storage conditions; hygienic transportation; sorting; and the removal of damaged or fungus-infected fruits may help minimize fungal growth and OTA formation. Although these practices may reduce the risk of fungal growth and OTA contamination, the presence of fungus-infected fruits does not necessarily indicate the presence of OTA, since toxin production depends on several interacting factors, including nutrient availability, temperature, oxygen availability, moisture, and time.

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<sup>8</sup> Available at: <https://apps.who.int/food-additives-contaminants-jecfa-database/Home/Chemical/1905>

<sup>9</sup> Available at: <https://www.sciencedirect.com/science/article/pii/S2405844024153443>

### Additional Mitigation Approaches

16. In addition to preventive measures implemented throughout the production chain, various physical, chemical, and biological approaches have been investigated for reducing OTA contamination in food commodities. The applicability of these methods, particularly chemical decontamination and biological approaches, depends on national regulations, as their use may be restricted or prohibited in some countries. Physical approaches include cleaning, sorting, monitoring, decontamination, and detoxification practices. Various chemical agents, including organic acids (e.g. citric acid), alkaline substances (e.g. sodium bicarbonate) and oxidizing agents (e.g. hydrogen peroxide), as well as biological control strategies, including the use of selected antagonistic microorganisms such as specific yeasts or bacteria, have also been investigated for their potential to inhibit fungal growth and reduce OTA contamination. Any method used to reduce or eliminate OTA contamination should preserve the nutritional quality and organoleptic characteristics of the food and ensure its suitability for human consumption<sup>10</sup>.
17. Although manual sorting techniques are used in some dried fruits to reduce mycotoxin contamination, practical separation methods specifically targeting OTA-contaminated fruits are not yet widely established or routinely applied. For example, in dried figs, aflatoxin-contaminated fruits can be manually separated using the Bright Greenish Yellow Fluorescence (BGYF) method under ultraviolet (UV) light; however, no comparable routine method is currently available for OTA.

### Experimental and emerging approaches

18. In a study published in 2024<sup>11</sup> evaluated the potential of several chemical washing treatments, as well as ultrasound (US) and high-intensity pulsed light (HIPL) technologies, for reducing OTA contamination in raisins. Several treatments showed promising OTA reduction; however, some chemical washing treatments adversely affected product quality by causing undesirable odours.
19. A recent review published in 2024<sup>12</sup> highlighted the effects of thermal and non-thermal food processing methods on OTA reduction. The review concluded that the effectiveness of OTA mitigation strategies should be evaluated not only by their ability to reduce OTA levels, but also by the safety of the degradation products formed during processing. It also discussed additional mitigation strategies investigated in the literature, including the use of food additives such as baking soda and sugar.
20. A review published in 2024<sup>13</sup> examined innovative decontamination approaches for OTA, including irradiation, cold plasma (CP), adsorbents, ozone (O<sub>3</sub>), and bacterial and fungal treatments. The review highlighted that these approaches may have potential to reduce OTA contamination; however, their effectiveness should be evaluated alongside their impact on food safety, nutritional quality, sensory attributes, and consumer acceptance to support the development of safe, sustainable, and scalable mitigation strategies.
21. The applicability and regulatory acceptance of the experimental and emerging approaches presented in this section may vary according to national regulatory frameworks.

### NATIONAL AND REGIONAL MAXIMUM LEVELS AND OCCURRENCE DATA

22. National and regional maximum levels, together with occurrence data, provide important information to support the development of a Code of practice for the prevention and reduction of OTA contamination in dried fruits. These data help identify commodities and stages of production where OTA contamination may occur, facilitate evaluation of existing risk management measures, and support the identification of preventive practices that may help reduce OTA contamination.
23. Examples of national and regional maximum levels for OTA in dried fruits are presented in Table 2. These examples illustrate the range of existing regulatory approaches and may provide useful background information for developing the proposed CoP. In addition to regulatory limits, occurrence data provide valuable information on the actual distribution of OTA contamination in dried fruits.

<sup>10</sup> Available at: <https://www.mdpi.com/2304-8158/13/8/1184>

<sup>11</sup> Available at: <https://academic.oup.com/ijfst/article/59/12/9170/7932941>

<sup>12</sup> Available at: <https://pubmed.ncbi.nlm.nih.gov/38276534/>

<sup>13</sup> Available at: <https://www.preprints.org/manuscript/202412.2214/v1>

**Table 2.** Example of regulatory limits for the presence of OTA in Dried Fruits

| Region/ Country | Food commodities                                                  | OTA levels (µg/kg) |
|-----------------|-------------------------------------------------------------------|--------------------|
| EU              | Dried vine fruits (currants, raisins and sultanas) and dried figs | 8                  |
|                 | Other dried fruits                                                | 2                  |
| Türkiye         | Dried fruits                                                      | 10                 |
| Brazil          | Dried fruits                                                      | 10                 |
| Egypt           | Dried fruits                                                      | 10                 |
| Vietnam         | Currants, raisins and sultanas                                    | 10                 |

24. Occurrence data from official monitoring programmes and published studies provide valuable information on the distribution of OTA contamination in dried fruits and complement the available regulatory information. Examples of occurrence data from official controls in Türkiye, the EFSA (2020) risk assessment, and published studies from different countries are presented below in Tables 3, 4, 5, and 6.

**Table 3.** Occurrence data for OTA in dried figs from official controls in Türkiye

| Years     | N   | LOQ (µg/kg) | <LOQ (N) | Mean LB (µg/kg) | Mean UB (µg/kg) | P95   | > 8 µg/kg (N) | > 10 µg/kg (N) |
|-----------|-----|-------------|----------|-----------------|-----------------|-------|---------------|----------------|
| 2019-2021 | 153 | 0.50        | 126      | 2.35            | 2.76            | 8.32  | 8             | 5              |
| 2022      | 307 | 0.50        | 197      | 2.50            | 2.82            | 11.44 | 32            | 22             |
| 2023      | 169 | 0.50        | 100      | 2.27            | 2.56            | 10.27 | 17            | 13             |
| 2024      | 348 | 0,50        | 268      | 2.73            | 3,12            | 14.85 | 20            | 19             |

25. Similar occurrence patterns have also been observed in Türkiye for dried mulberries, where the P95 value exceeded 10 µg/kg. In addition, the P95 value for commercially traded sulphur-free dried apricots exceeded 2 µg/kg.

**Table 4.** Occurrence data for OTA in dried fruits from the EFSA (2020) risk assessment

| Foods                                              | N    | <LOQ (N) | Mean LB (µg/kg) | Mean UB (µg/kg) | P95 LB | P95 UB |
|----------------------------------------------------|------|----------|-----------------|-----------------|--------|--------|
| Dried figs                                         | 1936 | 1448     | 3.63            | 4.12            | 8.5    | 8.9    |
| Dried apricot                                      | 319  | 300      | 0.28            | 1.12            | 0.3    | 2      |
| Dried vine fruits (currants, raisins and sultanas) | 4070 | 2206     | 1.86            | 2.44            | 8.6    | 8.6    |
| Dried dates                                        | 347  | 335      | 1.83            | 2.27            | 0      | 2      |
| Dried mulberry                                     | 0    |          |                 |                 |        |        |
| Dried prunes                                       | 253  | 248      | 0.02            | 0.71            | 0      | 2      |

**Table 5.** Examples of published occurrence data for OTA in dried dates<sup>14</sup>

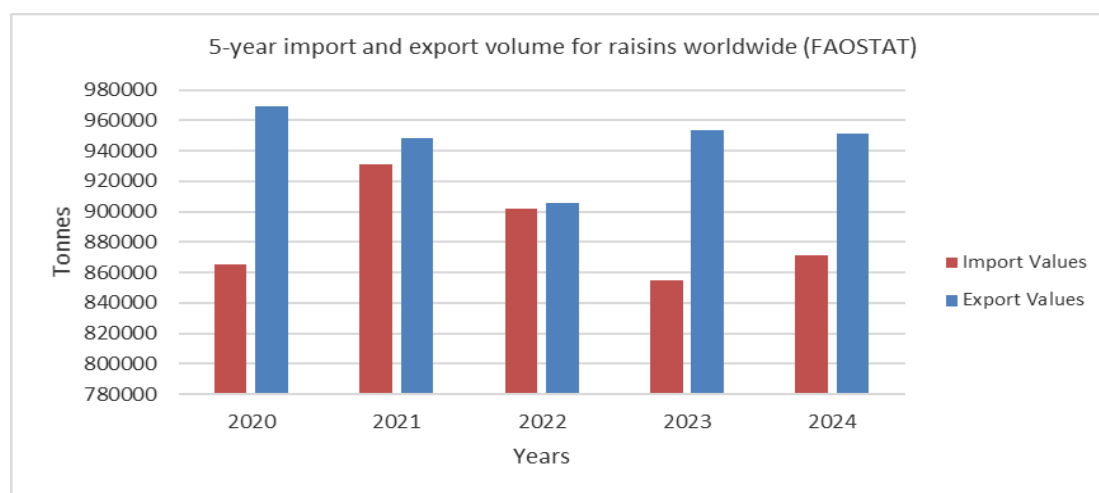
| Country | N  | <LOQ (N) | Mean (µg/kg) | Range (µg/kg) |
|---------|----|----------|--------------|---------------|
| Brazil  | 10 | 8        | -            | 0.1-5         |
| China   | 40 | 31       | -            | LOD-61.4      |
| Egypt   | 28 | 25       | -            | 1.48-6070     |
| Iran    | 10 | 8        | 2.5          | 1.4-3.6       |
| Iran    | 22 | 17       | 1.2          | 0.5-2.1       |
| Tunisia | 48 | 30       | 1.26         | 0.57-3.34     |

**Table 6.** Examples of published occurrence data for OTA in dried vine fruits<sup>15</sup>

| Country        | N    | <LOQ (N) | Mean (µg/kg) | Range (µg/kg) |
|----------------|------|----------|--------------|---------------|
| Argentina      | 50   | 13       | -            | 1.4-14        |
| Brazil         | 43   | 14       | -            | 0.1-33.9      |
| Canada         | 153  | 45       | 2.74         | 0.1-26.6      |
| China          | 56   | 22       | 0.99         | 0.07-12.83    |
| Cyprus         | 43   | 13       | 2.2          | 0.2-13.7      |
| Czech Republic | 48   | 30       | 11.5         | 1.6-63.6      |
| Czech Republic | 12   | 7        | 0.46         | 0.1-2.17      |
| Greece         | 81   | 21       | 2.6          | 0.6-13.8      |
| Greece         | 41   | 11       | -            | 0.1-98.2      |
| Greece         | 26   | 0        | 47.2         | 2.8-138.3     |
| Iran           | 66   | 27       | 2.98         | 0.16-8.4      |
| Iran           | 38   | 19       | 7.0          | 2.9-18.2      |
| Italy          | 35   | 17       | 2.6          | 0.05-12.61    |
| Pakistan       | 17   | 13       | 5.6          | 0.18-18.5     |
| Sweden         | 118  | 22       | -            | 0.1-34.6      |
| Türkiye        | 1885 | 172      | 1.36         | 0.3-100       |
| United Kingdom | 60   | 7        | 6.4          | 0.3-53.6      |
| United States  | 109  | 61       | 2.26         | 0.28-15.34    |

### TRADE VOLUME OF DRIED FRUITS

26. This section provides background information on the global production and trade of dried fruits potentially covered by the proposed CoP. The data illustrate the economic importance and international trade of these commodities and provide context for the potential impact of OTA contamination on food safety and international trade. Given the substantial international trade in dried fruits, OTA contamination may result in economic losses through increased compliance costs and reduced market access where products do not comply with applicable food safety requirements. This information may help identify priority commodities for the proposed CoP.
27. FAOSTAT<sup>16</sup> provides global export and import data for raisins, dates, dried apricots, dried figs, dried prunes and other dried fruits. The corresponding data are presented in Figures 2–7.

**Figure 2.** Global import and exports of raisins, 2020–2024 (FAOSTAT)

<sup>15</sup> Available at: <https://pmc.ncbi.nlm.nih.gov/articles/PMC10537527/>

<sup>16</sup> Available at: <https://www.fao.org/faostat/en/#home>



Figure 3. Global import and exports of dates, 2020–2024 (FAOSTAT)

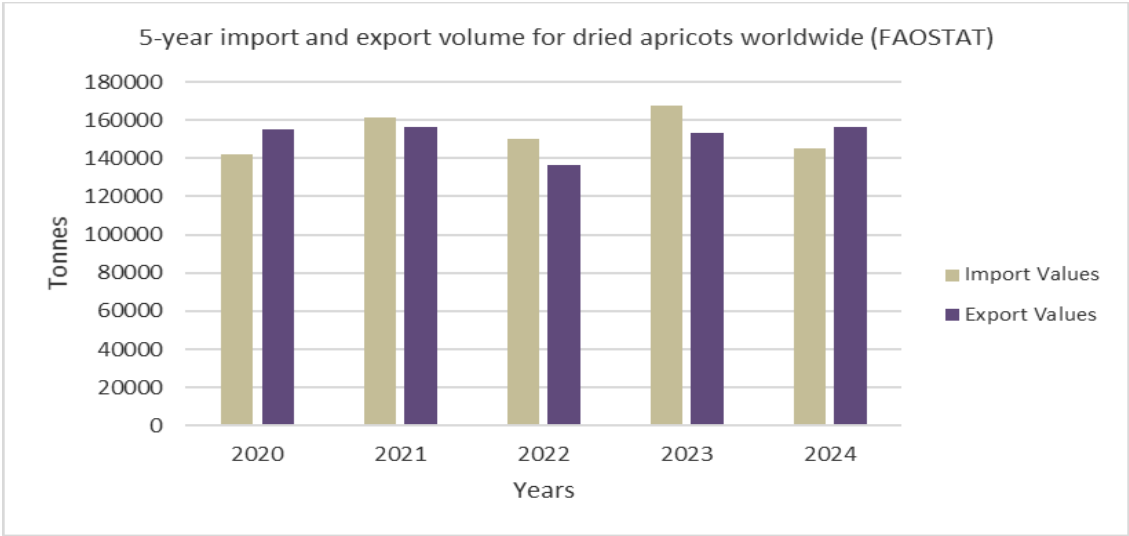


Figure 4. Global import and exports of dried apricots, 2020–2024 (FAOSTAT)

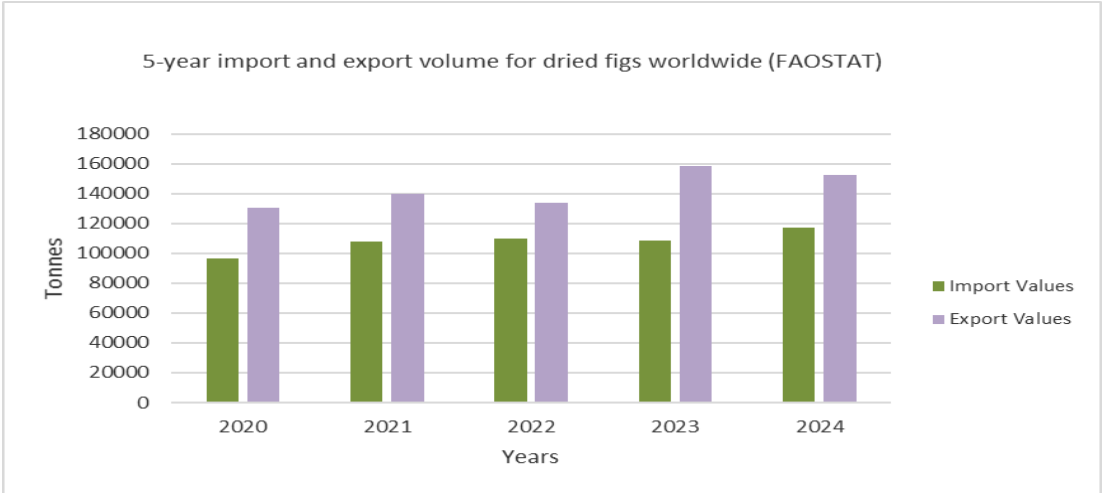


Figure 5. Global imports and exports of dried figs, 2020–2024 (FAOSTAT)

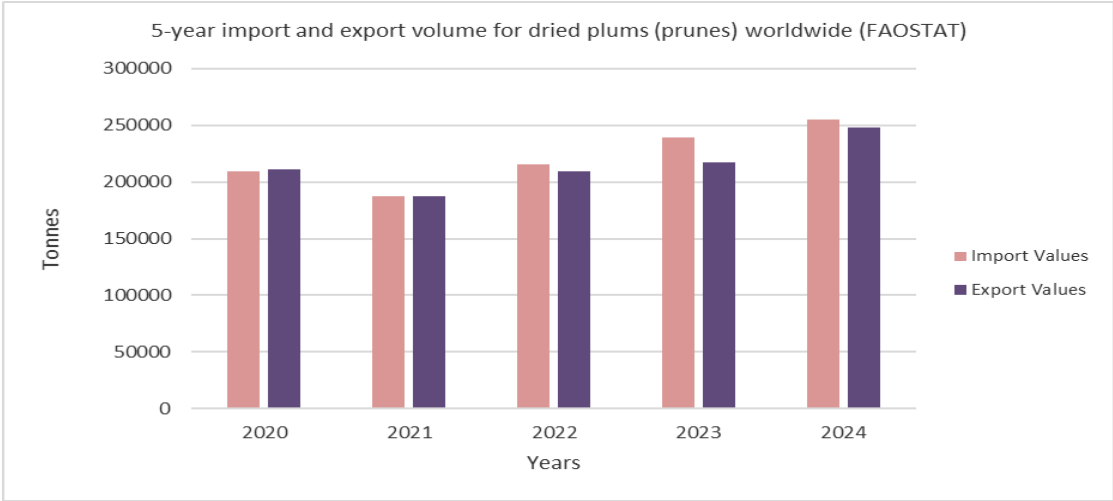


Figure 6. Global imports and exports of dried prunes, 2020–2024 (FAOSTAT)



\*Tropical and not elsewhere classified dried fruit

Figure 7. Global imports and exports of other dried fruits, 2020–2024 (FAOSTAT)

28. The figures for dried cranberries and dried prunes provided by The International Nut and Dried Fruit Council (INC) to the EWG are shown below.

World Dried Cranberry Production. Metric Tons  
Source: International Nut and Dried Fruit Council (INC)

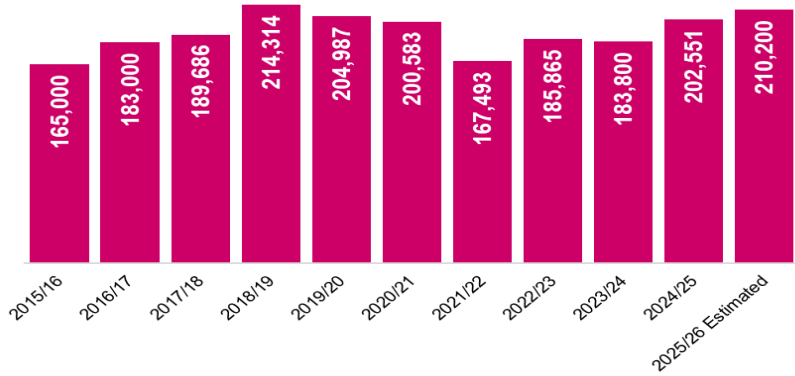
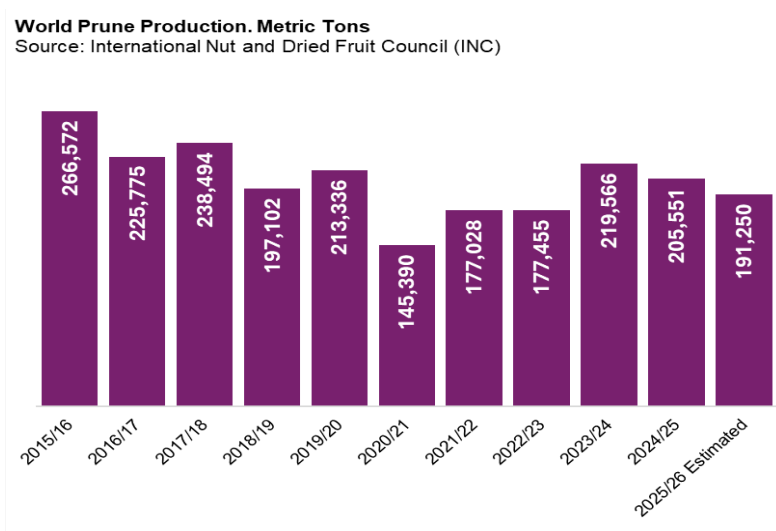


Figure 8. Global dried cranberry production (2015-2026) and top exporters (2020–2024) (INC)



**Figure 9.** Global dried prune production (2015-2026) and top exporters (2020–2024) (INC)

**APPENDIX II**

**PROPOSAL FOR NEW WORK ON THE DEVELOPMENT OF A  
CODE OF PRACTICE FOR THE PREVENTION AND REDUCTION OF OCHRATOXIN A CONTAMINATION IN DRIED FRUITS  
PROJECT DOCUMENT  
(For consideration by CCCF)**

**1) Purpose and scope of the project**

The purpose of this proposed new work is to develop a Code of practice (CoP) for the prevention and reduction of Ochratoxin A (OTA) contamination in dried fruits. The proposed CoP will provide risk-based, practical guidance addressing factors that significantly influence OTA formation in dried fruit production systems, particularly during pre- and post-harvest stages.

This work aims to support preventive risk management measures, protect consumer health, and promote fair practices in the international trade of dried fruits. The proposed CoP will complement relevant Codex texts, including the *General Principles of food hygiene* (CXC 1-1969), by addressing OTA-specific risk factors relevant to dried fruit production systems that are not covered in detail in existing Codex texts.

The scope of this work is to provide recommendations covering primary production (including planting and harvesting), drying (both sun-drying and mechanical drying), storage, processing, distribution, and other stages of the food supply chain. The aim is to guide producers and the food industry in preventing and reducing OTA contamination in dried fruits. The proposed work covers whole and cut dried fruits intended for human consumption and international trade, with particular reference to raisins, dried figs, dried apricots, dates, dried prunes, dried mulberries, dried cranberries, and other dried fruits with comparable production and storage characteristics, for which available scientific evidence indicates that OTA contamination may be of concern. These commodities were selected based on available scientific evidence, including occurrence data from GEMS/Food, national monitoring programmes, and the published literature, as well as information on international production and trade. These data indicate that the selected commodities are among the dried fruits most consistently associated with OTA occurrence and are of significant commercial importance. Additional dried fruits may be considered during the development of the Code of practice, provided that members provide relevant scientific information, including occurrence data and commodity-specific information on OTA risk and preventive measures.

**2) Relevance and timeliness**

OTA is a mycotoxin of public health concern due to its nephrotoxic properties and potential long-term health effects associated with chronic dietary exposure. The Joint FAO/WHO Expert Committee on Food Additives (JECFA) has evaluated OTA on several occasions. In its most recent evaluation<sup>1</sup> JECFA reconfirmed the provisional tolerable weekly intake (PTWI) of 100 ng OTA/kg bw, taking into account newly available data.

The contamination of foods and animal feeds with OTA is a global problem. In the *General Standard for contaminants and toxins in foods and feeds* (CXS 193-1995), maximum levels (MLs) for OTA have been established for wheat, barley, rye, chilli pepper, paprika and nutmeg. CoPs have been developed to support the prevention and reduction of OTA contamination in these commodities<sup>2</sup>. However, no comparable CoP is currently available for dried fruits.

Human exposure to OTA may result from its presence in a wide variety of foodstuffs, including cereals, coffee, wine, spices, nuts, and dried fruits. In addition, OTA is a stable compound and cannot be removed completely once it is present in foodstuffs. Therefore, preventive measures are essential to keep OTA contamination as low as reasonably achievable (ALARA).

Emerging challenges, including climatic variability, fluctuations in temperature and relative humidity, and the continued use of traditional sun-drying systems in many producing regions, may influence the risk of OTA contamination in dried fruits. In this context, the development of a specific, risk-based CoP for dried fruits remains timely to support preventive measures, enhance the effectiveness of existing food hygiene frameworks, and protect consumer health.

The development of a CoP for dried fruits would complement existing Codex texts by providing commodity-specific guidance on preventing and reducing OTA contamination in dried fruits and supporting a more harmonized approach to managing OTA risks in international trade.

<sup>1</sup> Available at: <https://apps.who.int/food-additives-contaminants-jecfa-database/Home/Chemical/1905>

<sup>2</sup> Available at: [https://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FStandards%252FCXS%2B193-1995%252FCXS\\_193e.pdf](https://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FStandards%252FCXS%2B193-1995%252FCXS_193e.pdf)

### 3) Main aspects to be covered

The proposed work will focus on best practices for preventing or reducing OTA contamination in dried fruits across primary production, processing, storage, and transportation. The CoP will address Good Agricultural Practices (GAP), Good Manufacturing Practices (GMP), and Good Storage Practices (GSP), recognizing that OTA contamination may occur at different stages of the production chain.

The main aspects to be covered include:

- Conditions influencing fungal contamination and OTA formation during pre- and post-harvest;
- Good practices for harvesting, handling and sorting to minimize OTA contamination;
- Drying practices, including general considerations for moisture and temperature management;
- Measures to prevent rewetting and other conditions favourable to fungal growth;
- Storage, packaging and transportation conditions relevant to OTA risk management;
- General approaches to monitoring and verification in support of preventive control.

The CoP will provide guidance applicable to both small-scale traditional production systems and industrial operations under different climatic regions.

### 4) Assessment against the criteria for the establishment of work priorities

- (a) **Consumer protection from the point of view of health and fraudulent practices.** The proposed CoP will provide additional guidance to help countries prevent and reduce OTA contamination in dried fruits, thereby reducing consumers' dietary exposure to OTA. By promoting consistent preventive measures throughout the production chain, the CoP will also support transparency and integrity in trade practices and may reduce incentives for non-compliant practices linked to contaminated consignments.
- (b) **Diversification of national legislations and apparent resultant or potential impediments to international trade. Currently, best practices and legislation vary.** Regulatory approaches and preventive practices related to OTA contamination in dried fruits may vary among countries. Differences in risk management measures and their implementation can contribute to trade disruptions, particularly where consignments exceed established regulatory limits. The proposed CoP would provide internationally recognized scientific and technical guidance, promote greater harmonization of preventive practices, and facilitate fair practices in the international trade of dried fruits.
- (c) **Scope of work and establishment of priorities between the various sections of the work.** The proposed CoP will outline measures to prevent and reduce OTA contamination at all relevant stages of the dried fruit supply chain, including primary production, harvesting, processing, storage, and distribution.
- (d) **Work already undertaken by other international organizations in this field.** While scientific publications and technical studies describe various approaches for preventing or reducing OTA contamination, there is currently no internationally agreed, commodity-specific CoP addressing OTA in dried fruits. The proposed work would therefore fill an identified gap by providing harmonized guidance at the international level.

### 5) Relevance to Codex Strategic Goals

- (a) **Strategic Goal 1: Respond to Members' needs for protecting the health of consumers and ensuring fair practices in the food trade in an evolving global landscape by developing science-based standards and related texts.** The proposed CoP for the prevention and reduction of OTA in dried fruits will provide science-based guidance to protect consumer health and facilitate fair practices in the international trade of dried fruits.
- (b) **Strategic Goal 2: Enhance Codex work management systems and practices that support the effective and efficient development of standards and related texts.** The proposed work will be undertaken through an electronic working group (EWG), enabling broad participation by Members and Observers, facilitating the collection and consideration of scientific and technical information, and supporting the efficient development of a consensus-based Codex text.
- (c) **Strategic Goal 3: Strengthen relationships with relevant international organizations, promoting a coordinated approach to address global challenges.** The development of the proposed CoP will support collaboration with FAO, WHO, and other relevant international organizations by considering internationally available scientific information, including data on OTA occurrence, risk assessment, and prevention measures, as appropriate.

- (d) **Strategic Goal 4: Maximize the impact of Codex by increasing the visibility and use of standards.** The proposed CoP will support the effective implementation of Codex standards by providing practical guidance for producers, food business operators and competent authorities to prevent and reduce OTA contamination throughout the dried fruit supply chain.

**6) Information on the relationship between the proposal and other existing Codex documents**

The proposed CoP is intended to complement existing Codex texts relevant to dried fruits and food hygiene. These include the *General Standard for dried fruits* (CXS 360-2020), the *Code of hygienic practice for dried fruits* (CXC 3-1969), and, where relevant, the *Code of hygienic practice for dehydrated fruits and vegetables including edible fungi* (CXC 5-1971).

**7) Identification of any requirement for any availability of expert scientific advice**

JECFA has evaluated OTA on several occasions (1991, 1996, 2001 and 2007), providing the scientific basis for risk management measures. At this stage, no additional expert scientific advice has been identified as necessary for the development of the proposed CoP.

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

No specific need for additional technical input from external bodies has been identified. The proposed work will be based on existing scientific knowledge, relevant Codex texts and information provided by Members and Observers during the development process.

**9) Timeline for completion of the new work**

The proposed work is expected to commence following recommendation by CCCF in 2026 and approval as new work by CAC in 2027. Subject to the progress of the work, completion is anticipated by 2030.

**APPENDIX III****PROPOSED CODE OF PRACTICE FOR THE PREVENTION AND REDUCTION OF  
OCHRATOXIN A CONTAMINATION IN DRIED FRUITS****(For information)****1. Introduction**

- Ochratoxin A (OTA) is a widely distributed foodborne mycotoxin produced as a secondary metabolite by multiple toxigenic species within the genera *Aspergillus* and *Penicillium*.
- OTA poses food safety concerns because of its nephrotoxic, immunosuppressive, and carcinogenic effects. The Joint FAO/WHO Expert Committee on Food Additives (JECFA) has conducted several evaluations of OTA. In the most recent evaluation, JECFA reconfirmed the PTWI of 100 ng OTA/kg bw.
- OTA is characterized by relatively high stability under acidic conditions and during thermal processing, which may significantly limit the effectiveness of post-contamination mitigation measures. However, OTA can be partially degraded under certain processing conditions. OTA is generally only partially degraded under normal cooking conditions and remains relatively stable during high-pressure steam sterilization at 121°C for up to three hours. In addition, OTA has been reported to remain stable up to 250°C.
- OTA-producing fungi occur under a wide range of climatic conditions, from dry and arid environments to cooler temperate zones. Ochratoxigenic *Aspergillus* spp. are well adapted to warm climates and substrates with reduced water activity and are therefore frequently associated with fruits intended for drying, including raisins, dried figs, dried apricots, dried prunes, dried mulberries, and dates.
- OTA contamination may begin during the pre-harvest stage, while the fruit is still attached to the plant, and may occur at any point along the chain from the orchard to the final consumer, including during drying, cross, processing, storage, and distribution if suitable conditions prevail for OTA formation.
- OTA formation in suitable substrates may be influenced by various factors in addition to the presence of ochratoxigenic fungi, such as temperature, relative humidity, and water activity. During dried fruit production, mature fruit composition constitutes a suitable substrate for the growth of ochratoxigenic fungi and for toxin formation. Inadequate or extended drying, moisture migration, mechanical damage, pest activity, and improper storage conditions may promote fungal growth and trigger OTA formation. Preventive measures implemented throughout the entire production and processing chain are therefore essential to minimize the risk of contamination.
- OTA contamination in dried fruits is associated with different fungal species; however, it varies according to the substrate and climatic conditions. *Aspergillus* spp. is dominant in milder climates where sun-drying is practiced. According to literature reports, major OTA-producing *Aspergillus* spp. associated with dried fruits are given in Table 1. These findings support that OTA-producing species may differ according to the commodity and ecological conditions, and that the risk of contamination should therefore be assessed on a product- and location-specific basis.

**Table 1.** OTA-producing species associated with some of the dried fruits

| <b>Dried Fruits</b>          | <b>Responsible species for OTA contamination</b>                                                     |
|------------------------------|------------------------------------------------------------------------------------------------------|
| Dried figs                   | <i>Aspergillus carbonarius</i><br><i>Aspergillus niger</i> aggregate<br><i>Aspergillus alliaceus</i> |
| Dried grapes and vine fruits | <i>Aspergillus carbonarius</i><br><i>Aspergillus niger</i>                                           |
| Dried prunes                 | <i>Aspergillus ochraceus</i><br><i>Aspergillus westerdijkiae</i>                                     |
| Dates                        | <i>Aspergillus niger</i><br><i>Aspergillus ochraceus</i>                                             |
| Dried apricots               | <i>Aspergillus niger</i>                                                                             |

## 2. Scope

8. This CoP applies to the prevention and reduction of OTA contamination in dried fruits intended for human consumption, including the stages of primary production, harvesting, processing (including drying), storage, packaging, and distribution. Dried fruits and products containing dried fruits should be prepared and handled in accordance with the *General Principles of food hygiene* (CXC 1-1969), which apply to all foods intended for human consumption, as well as the *Code of hygienic practice for dried fruits* (CXC 3-1969), and the *Code of hygienic practice for dehydrated fruits and vegetables including edible fungi* (CXC 5-1971). These Codex texts provide the general hygiene framework to be applied, as appropriate, together with the commodity-specific measures set out in this CoP for the prevention and reduction of OTA contamination in dried fruits.
9. This CoP applies to dried fruits intended for human consumption. While many of the recommended practices may also be applicable to other fruits intended for drying, this CoP focuses in particular on dried apricots, dates, dried figs, dried mulberries, dried cranberries, dried prunes, and raisins.

## 3. Related Codex Texts

- *General Principles of food hygiene* (CXC 1-1969);
- *General Standard for contaminants and toxins in food and feed* (CXS 193-1995);
- *Recommended Methods of analysis and sampling* (CXS 234-1999);
- *General Standard for dried fruits* (CXS 360-2020);
- *Code of hygienic practice for dried fruits* (CXC 3-1969);
- *Code of hygienic practice for dehydrated fruits and vegetables including edible fungi* (CXC 5-1971);
- *Code of practice for the prevention and reduction of Ochratoxin A contamination in wine* (CXC 63-2007);
- *Code of practice for the prevention and reduction of Ochratoxin A contamination in coffee* (CXC 69-2009); and
- *Code of practice for the prevention and reduction of Ochratoxin A contamination in cocoa* (CXC 72-2013).

## 4. Definitions

**Apricot** is the fruit of *Prunus armeniaca*, a stone fruit tree belonging to the Rosaceae family.

**Blueberry** is the fruit of plants belonging to *Vaccinium corymbosum* in the Ericaceae family.

**Caprifig** (*Ficus carica* var. *caprificus*) is a male fig tree or its fruit that produces pollen and is used in the pollination of female fig fruits of varieties that require fertilization for fruit set.

**Caprification** is the process by which male figs are placed near female fig fruits to allow fig wasps (*Blastophaga psenes*) living in male fig fruits to transfer to female fruit for pollination, thereby carrying pollen from the male fruits to the female fruits on their bodies.

**Cranberry (American cranberry)** is the fruit of plants belonging to *Vaccinium macrocarpon* in the Ericaceae family.

**Date** is the fruit of *Phoenix dactylifera*, a plant species belonging to the palm family Arecaceae.

**Dried fruit\*** is the intermediate-moisture fruit from which part of its water content has been removed by natural means, such as sun-drying.

**Dehydrated fruit\*** is the low-moisture fruit from which much of its water content has been removed by artificial means (e.g., oven, freeze dryer).

**Fig** is the edible fruit of *Ficus carica*, a perennial species belonging to the Moraceae family.

**Grape** is the fruit of the deciduous woody vine *Vitis vinifera*, belonging to the Vitaceae family.

**Mulberry** is the edible fruit of trees belonging to the genus *Morus*, a group of flowering plants in the family Moraceae.

**Plum** is the common name for the edible fruits of stone fruit tree species in the genus *Prunus*, belonging to the Rosaceae family.

**Prune** is the fruit of prune plum varieties.

**Raisin** is dried from of the grape fruit.

**Vine training** is the practice of managing grapevine growth and canopy architecture to maximize sunlight exposure, improve air circulation, and support grape production and quality.

**Trellis training system** is the infrastructure system of wires and posts used to support and direct the canopy of a grapevine.

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\* For the purposes of this document, the term “dried fruit” will be used to cover both types of processes.

## **5. General Recommendations**

10. Maintain complete records of product information, harvesting, drying, storage and transport conditions, including relevant parameters such as temperature, relative humidity, moisture content, water activity, lot identification, harvest seasons and pre-treatments if any, to ensure traceability and to support the identification of factors and root causes contributing to fungal growth and OTA contamination. Consider these internal and external factors in an integrated manner.
11. Due to the high chemical stability of OTA, do not rely solely on conventional processing techniques for its removal from contaminated food commodities, as this is generally impracticable. Focus on a holistic approach to risk management measures for preventing contamination at both the pre-harvest and post-harvest stages of the supply chain.
12. Implement Good Hygiene Practices (GHP), Good Agricultural Practices (GAP) and Good Manufacturing Practices (GMP) throughout the production chain.
13. Minimize delays between harvest, drying and storage to preserve product quality and safety and focus on enhancing moisture loss to achieve safer water activity levels within short periods.
14. Ensure that all equipment, containers, vehicles and storage facilities are clean, free of prior contamination, dry and properly maintained, and designed to prevent further contamination from dust, pests, water ingress, and condensation.
15. Minimize mechanical damage to products at all stages of handling, as physical injuries increase susceptibility to fungal infection and OTA formation.
16. Apply effective sorting, grading, and segregation procedures to remove visibly moldy, damaged, or defective fruits and prevent contamination of sound lots. Recognize that, while sorting is an important control measure, its effectiveness for OTA control is limited, as contamination is not always visually detectable and cannot be reliably identified by simple visual or optical methods; therefore, use sorting in combination with other preventive control measures. Control moisture and environmental conditions throughout the chain; ensure a proper drying rate to maintain safe water activity levels during drying, storage, and transport; and prevent condensation of water droplets in packages.
17. Prevent rewetting of dried products from night dew or rain throughout the production chain, as it may re-enable fungal activity in previously stabilised products and increase the risk of OTA formation.
18. Use approved agricultural inputs and pest management measures in accordance with competent authority guidance and integrated pest management (IPM) principles.
19. Develop an operational plan based on critical parameters and points, implement monitoring of critical parameters and verify the effectiveness of control measures, including OTA testing where appropriate.
20. Ensure adequate training of all personnel involved in production, harvesting, processing and storage on hygiene practices, OTA contamination risks, and impact on health; corrective actions to be applied when necessary.

## **6. Recommended Practices**

21. The likelihood of ochratoxigenic fungal growth and OTA formation is influenced by commodity-specific factors, including fruit species, cultivar, agronomic practices, pre-treatments, environmental conditions, and post-harvest handling.

### **6.1. Pre-harvest**

#### **6.1.1. Site Selection and Orchard Establishment**

22. When selecting sites for orchards and vineyards intended for dried fruit production, operators should evaluate climatic suitability, field slope and aspect, sun exposure, drainage capacity, and soil characteristics, with particular attention to conditions that may increase humidity, reduce air circulation, favour fungal development or increase stress. Where applicable on sloping land, appropriate measures such as terracing, reduced tillage, or mulching should be implemented to prevent soil erosion, nitrogen leaching, and surface runoff and to create resilient systems.
23. Dense canopies may retain moisture within the canopy or in-between rows and increase surface wetness duration on fruits, thereby promoting fungal infection. High planting density may increase competition for water and nutrients, thereby increasing plant stress.
24. During orchard or vineyard establishment, adequate row and plant spacing should be implemented at the initial stage to ensure air circulation, light penetration, and access for crop management operations, thereby reducing canopy humidity and the duration of surface wetness on fruits, taking into account the expected canopy development at maturity, the characteristics of the fruit species and variety, and the production/vine training (e.g., high density, trellis) system, where applicable.

**6.1.2. Selection of Cultivars and Planting Material**

25. Cultivars intended for drying should be selected, where feasible, based on characteristics such as high dry matter/low moisture content and resistance to fruit cracking, splitting, insect damage, and fungal infection, as these characteristics may influence susceptibility to OTA contamination.
26. Planting material used for dried fruit production should be certified and true to type, ensuring conformity with the declared cultivar and, where applicable, rootstock characteristics (e.g. dwarf, semi-dwarf, or standard rootstock). Prior to planting, planting material should be visually inspected, and, where appropriate, any dried, diseased, or damaged roots, rhizomes, or other vegetative tissues should be removed to promote healthy orchard establishment and minimize the introduction of plant health risks.
27. When grafted material is used, properly grafted plants should be selected, and the graft union should be well healed, with no signs of incompatibility observed between the scion and the rootstock. The graft area should be intact and structurally sound.
28. Planting material should be free from pests and diseases and should show no visible signs of infestation or infection in order to prevent the introduction of phytosanitary hazards at the orchard establishment stage. It should also not exhibit physical damage, such as wounds, cracks, deep scratches, bark stripping, or breakage, which may serve as entry points for fungal pathogens.
29. The root system should be well developed according to the root architecture of the species or variety, with an adequate number of fibrous roots to support healthy establishment and growth of the tree.
30. The stem of the planting material should be straight, well-developed, and healthy.

**6.1.3. Orchard and Vineyard Management Practices: Pruning, Irrigation, Fertilization and Tillage**

31. Orchard and vineyard management should be designed to produce fruit suitable for drying while minimizing conditions that favour the growth of ochratoxigenic fungi and OTA formation.
32. At planting, only well-matured (composted) farmyard manure should be used in sites where organic soil amendments are applied. The use of undecomposed manure should be avoided, as it may serve as a source of pests, plant pathogens, and weed seeds, thereby increasing the risk of contamination in the orchard or plantation environment.
33. Nutrient deficiencies or imbalances during fruit growth may increase the susceptibility of fruits either by causing physical damage, such as cracking or by altering fruit physiology and creating conditions that may favour fungal colonization and OTA formation. For example, nitrogen deficiency may induce stress in both the plant and the fungi, while excessive nitrogen accumulation in the fruit may increase its water content and create conditions favourable to fungal development. To mitigate these risks and stress and support balanced vegetative growth, proper fruit set, and development, macro- and micronutrients should be supplied to ensure overall productivity in orchards and vineyards. Fertilization practices should be based on soil analysis and, where appropriate, plant tissue analysis, and implemented in accordance with expert recommendations and national or regional regulations, with appropriate nutrient management planning designed to avoid excessive vegetative growth, fruit cracking, delayed drying, and other conditions that may trigger increased susceptibility to fungal contamination.
34. Vine training and pruning should be carried out regularly, as appropriate to the species, cultivar, and planting system, to improve air circulation and light penetration, reduce localized canopy humidity, and remove infected tissues that may serve as sources of inoculum. In trellis training systems applied in vineyards, measures should be taken to prevent direct contact between grape clusters and the soil. As plant pathogens may infect not only fruits but also other plant tissues, infected branches and tissues should be pruned and removed from the site to reduce inoculum sources in the production environment and prevent further spread of infection.
35. Orchard and vineyard sanitation plays a key role in controlling spoilage organisms, which can proliferate in cankers, dead branches, and rotten or fallen fruits. Infected plant material, rotten fruits, and fruit debris should be removed promptly and disposed of appropriately to reduce fungal inoculum pressure in the orchard environment. Fungal inoculum sources, including weeds, crop residues, and contaminated or unclean farming equipment and tools (e.g., harvest containers, bins, etc.) should be minimized or removed to reduce the risk of contamination.
36. Irrigation should be carefully managed to avoid both water stress and accumulation of excess moisture. Over-irrigation, particularly close to harvest, may increase fruit turgor pressure and lead to fruit cracking and splitting and extend the drying period, while water stress may weaken fruit skin integrity and prevalence of drought-resistant ochratoxigenic fungi; both conditions result in increasing OTA risk.

37. Water used for irrigation, washing, or any other operation involving direct or indirect contact with fruits should be of a quality appropriate to its intended use and should not contribute to fungal contamination or increased moisture conditions favourable to OTA formation. Where washing is applied, fruits should be dried promptly and handled in a manner that prevents re-wetting or prolonged surface moisture.
38. Cultural practices that reduce humidity in the orchard or vineyard, such as weed control and appropriate plant spacing, should be implemented where relevant, as high humidity favours fungal growth. In addition, the dissemination of dust through soil disturbance is one of the principal factors contributing to the spread of OTA-producing fungi; soil cultivation should be kept to a minimum; weeds should be controlled by mowing, or suitable cover crops should be established, and soil tillage practices should be terminated at least one month prior to fruit maturity and first harvest.
39. Where relevant, protective measures such as windbreaks, hedgerows, or other physical protections should be used to reduce spreading of dust and any fruit damage caused by wind, hail, or other environmental stressors that may predispose fruits to fungal infection.

#### **6.1.4. Pests, Plant Diseases and Wildlife Management**

40. Integrated Pest Management (IPM) strategies, including pest monitoring, should be implemented. Where appropriate, biological control methods may also be applied.
41. Within orchard management practices, fungicides should be applied only after appropriate identification of the pathogen and expert recommendation, as certain active substances have been reported to reduce overall fungal populations while potentially stimulating OTA production. Therefore, the selection and use of fungicides should be managed using a risk-based approach and applied only in accordance with approved uses and expert recommendations, and aligned with local, national, and, in the case of exportation, international legislation.
42. Plant diseases causing fruit rot, skin lesions or tissue breakdown should be promptly managed, as diseased fruits and fruits with damaged skin integrity are highly susceptible to colonization by OTA-producing fungi.
43. In fig production regions producing varieties requiring caprification for fruit set, only clean and sound caprifigs should be used for this purpose. Materials used for placing caprifigs should be clean and maintained in a hygienic condition to prevent fungal contamination and the subsequent risk of OTA formation.
44. The fig wasp involved in pollen transfer may also act as a vector for fungal spores, including *Aspergillus* spp. Improper caprification practices may therefore contribute to fungal contamination of figs and increase the risk of fungal growth and mycotoxin contamination at later stages of fruit maturation and drying. Caprification practices should therefore be carefully managed, and unnecessary caprification practices should be avoided.
45. Caprifigs that have completed their pollination function may serve as reservoirs for insects and fungal pathogens and can act as a source of inoculum within the fig orchard. Caprifigs remaining on trees after completion of fig wasp emergence should therefore be removed from the orchard and properly destroyed. Their timely removal contributes to reducing fungal pressure and minimizing the risk of subsequent contamination.
46. Insect pests may cause direct damage to fruits and create entry points for fungal spores, while also acting as vectors for fungal dissemination. Effective pest control, based on an integrated pest management programme, is therefore an essential preventive measure.
47. Wildlife, including birds and other animals, that may damage fruit should be managed, where appropriate, as fruit injury may facilitate fungal invasion and increase the risk of mycotoxin contamination. Measures such as visual and acoustic deterrents (e.g. noisemakers and reflective devices), netting, and physical barriers (e.g. fencing), where appropriate and in accordance with national and local legislation, may be used to reduce wildlife-related fruit damage.

### **6.2. Harvest**

#### **6.2.1. Harvesting Time and Conditions**

48. Weather conditions should be monitored regularly to support timely harvest decisions, as temperature, surface moisture, and fruit turgidity at the time of harvest may affect fruit integrity, drying behaviour, and susceptibility to fungal contamination.
49. Harvesting fruit too early may result in insufficient dry matter accumulation, prolong the drying period, and increase susceptibility to fungal growth and OTA formation. Conversely, unnecessary delays in harvest should be avoided, as delayed harvest may result in over-ripening, characterized by increasing sugar content and progressive softening of fruit tissues. Such conditions may also increase fruit exposure to insect damage and to variable environmental conditions (e.g., rainfall, dew, and temperature fluctuations). These changes may enhance susceptibility to fungal colonization and create more favourable conditions for the growth of ochratoxigenic fungi, thereby increasing the potential risk of OTA contamination.

50. Harvesting should therefore be conducted at the optimum maturity stage, which varies according to the species/varieties, and pre-treatments to be applied. In grapes, delays in harvest may result in the formation of openings at the stem–berry junction, thereby creating favourable conditions for fungal contamination and further OTA formation.
51. This pattern does not necessarily apply to sun-dried figs, which in many producing regions are allowed to overripen on the tree, lose moisture, shrivel, and fall as partially dried fruit before collection. In such cases, additional preventive measures should be taken to reduce dust dissemination from soil disturbance and soil contact, thereby minimizing fungal growth and contamination during ground collection and subsequent drying.

### **6.2.2. Harvesting Practices**

52. Mechanical damage to fruits (e.g. cracking, bruising, or puncturing) should be minimized during harvesting, handling and transport to the drying area, as such damage may increase fruit susceptibility to fungal colonization and subsequent mycotoxin contamination.
53. Harvesting should be carried out under dry weather conditions, since accumulated moisture may trigger fungal growth on the fruit surface. Harvest containers should be clean, and designed, maintained, and handled to avoid mechanical damage and prevent transfer of soil, plant debris, or fungal contamination to the fruit. Harvested fruits should therefore be placed in clean and dry containers and stored under conditions that prevent contamination. Fruits should be handled carefully, and harvesting operations should minimize bruising, crushing, skin rupture, and punctures, which can create entry points for fungal invasion.
54. Only sound and mature fruits should be harvested and carried onward for drying. Fruits exhibiting visible mould, skin breaks, bruising, overripeness, fermentation, physical damage, or contact with soil should be removed from sound ones at all stages, including harvest, sorting, and grading, to minimize fungal growth and OTA contamination. Rejected fruits should be segregated from sound lots from the earliest stage of handling, stored separately, and should not come into contact with fruit intended for drying or further processing.
55. As dust is one of the major sources of spreading of toxigenic fungi, field traffic during harvesting should be managed to minimize dust generation, including, where feasible, avoiding operations during windy conditions and limiting unnecessary movement of vehicles or equipment.
56. Where applicable, for fruits collected from the ground as part of traditional production techniques, the use of harvesting nets or similar coverings placed beneath the trees is recommended to prevent direct contact of the fruit with the soil. When nets are used, they should be installed to avoid contact with the ground and kept free of any potential fungal load. To minimize fungal growth and pest damage, fruits such as figs that are harvested after they have partially dried and fallen from the tree should be picked up from the ground at frequent intervals, and the soil surface should be kept intact and clean.
57. Good sanitation practices should be maintained throughout harvesting and post-harvest handling to minimize fungal contamination of fruit-contact surfaces. Mechanical harvesters, field containers such as baskets or lug boxes used for fruit picking, and packinghouse equipment should be cleaned and sanitized regularly in accordance with applicable standards. For soft fruits, shallow containers should be used during harvesting and handling to minimize bruising and mechanical damage resulting from pressure.

## **6.3. Drying**

### **6.3.1. Drying Methods**

58. Drying procedures should be designed to achieve rapid and uniform moisture reduction, considering the fruit properties (species, variety, whole, cut, sliced, cubed or halved), drying method, load density, air flow, and environmental conditions. Appropriate measures should be applied to protect fruits from rain, dew, dust, insects, rodents, and other contamination sources that may favour fungal growth and OTA formation during drying.
59. The choice of drying method should consider the characteristics of the fruit including its physical and chemical properties, prevailing local environmental conditions (including ambient humidity and temperature), and the need to achieve rapid and uniform drying to lower water activity levels that do not support fungal growth and toxin formation. In regions or seasons with high relative humidity or limited solar efficiency, mechanical or hybrid drying methods with controlled airflow and temperature may be considered to ensure a sufficiently rapid and uniform reduction in moisture to safer water activity levels.
60. Drying systems and practices should also be designed and operated to prevent any re-wetting, condensation, and uneven drying, as these conditions may prolong drying and favour fungal growth and mycotoxin formation.

61. Where feasible and appropriate to the fruit type, climatic conditions, and availability of energy sources, the use of controlled or assisted drying systems, such as forced-convection solar dryers, heat pump dryers, greenhouse-type dryers, cabinet dryers, tunnel dryers, or hybrid solar dryers (with forced air circulation and/or supplemental heat), may be considered to improve control of drying conditions. These systems may provide enhanced air circulation and better control of temperature and relative humidity, allowing faster and more uniform moisture removal than open sun-drying under field conditions.

### 6.3.2. Drying Process

62. Efficiency in drying represents a critical factor for the prevention of OTA contamination, as drying conditions and the physical form of the fruit may influence the rate and uniformity of moisture removal and, consequently, under certain conditions, the potential for fungal growth. Fruits may be dried in different physical forms, including whole, halved, pitted, or sliced, depending on the fruit type and processing practices. In some cases, fruits may also be cut or chopped after drying. Drying operations should therefore be monitored closely so that the product reaches and maintains a moisture content and/or water activity consistent with the relevant product standard and sufficiently low to prevent fungal growth during subsequent storage and transportation.
63. To minimize conditions favourable to fungal growth, the drying process should be started as soon as possible after harvest and should be carried out within appropriate timeframes and under conditions suitable for the fruit type. If drying cannot begin immediately after harvest, the fruit should be held under conditions that preserve integrity and minimize fungal growth, such as cooling or other suitable short-term storage conditions appropriate to the commodity. Safe moisture and water activity levels should be reached after drying, in accordance with established standards, before the product is placed in storage to reduce the risk of mycotoxin formation. The final residual moisture content of dried fruits may vary according to the fruit species and the process used. The maximum levels allowed in the product and appropriate moisture contents are specified in relevant market standards.
64. Sun-drying of fruits is commonly carried out on farms, in orchards or in vineyards. Where open-air drying is used, measures should be implemented to prevent direct contact between fruits and soil or vegetal material that could be a source of inoculum. To this end, fruits should be dried on clean, raised surfaces or on suitable drying tools/devices, such as mesh trays, concrete surfaces, sheets, rather than being placed directly on the soil surface.
65. Where drying is carried out in open-air environments, drying sites should be located away from roads, pathways used by wheeled vehicles, and areas with frequent human or animal traffic, in order to prevent dust exposure and other sources of contamination that may result in contaminated dried fruit and indirectly increase the risk of contamination by toxigenic fungi.
66. Drying operations should be managed under clean and appropriately controlled environmental conditions in a manner that promotes continuous and uniform drying. The formation of piles during the drying of fruits should be avoided. Where drying in layers cannot be avoided, the fruits should, where necessary, be turned or gently mixed in a manner that does not cause damage to enhance ventilation, allow rapid and homogeneous moisture loss, and limit the growth and development of ochratoxigenic fungi.
67. During drying, fruits should be protected from rain, dew formation, and night-time increases in relative humidity, which may lead to moisture reabsorption and create favourable conditions for fungal growth and OTA production. Where drying is carried out in the open air, appropriate protective measures should be implemented, such as movable covers, protective sheets, or transfer to sheltered drying areas during rainfall or overnight periods.
68. For suitable fruits, drying under plastic or solar tunnels/solar dryers may be used, where appropriate. These drying systems can provide more controlled drying, protect against adverse climatic conditions such as dew, rain, extremely hot winds, dust, or insects, and improve hygienic conditions, thereby limiting fungal growth. Drying tunnels should be located with due regard to the prevailing wind direction and maximum sunlight interception. They should be designed to allow adequate air intake from the sides to maintain release of humidity, and any ventilation openings should be covered with insect-proof mesh to prevent pest entry. In addition, tunnel height and roof structure should be sufficient to ensure adequate air circulation, enhance moisture removal, and prevent condensation. When drying parameters are appropriately controlled, solar tunnel drying may achieve shorter, more uniform drying than open sun drying.
69. After completion of drying, sound and intact fruits should be separated from damaged or defective ones and promptly transferred to appropriate on-farm storage facilities, to protect the product from any further re-wetting, pest infestation, and fungal growth.
70. Fruits with visible mould, abnormal moisture, fermentation, insect damage, severe bruising, or other defects associated with increased risk of fungal contamination should be segregated without delay and excluded from lots intended for drying, storage, or further processing. Discarded dried fruits should be disposed of using appropriate methods such as controlled disposal in designated waste areas, deep burial away from production sites, conditions or incineration where permitted, in order to prevent any further source of inoculum or cross-contamination.

### 6.3.3. Fruit-specific Drying Practices and Pre-treatments

71. In grape drying, some practices permitted by national or international standards involve dipping grapes into an alkaline solution to increase skin permeability and promote water loss. This pre-treatment may increase surface pH, create less favourable conditions for fungal growth, facilitate the removal of fungal spores from the grape surface, and consequently reduce the risk of OTA contamination. Similar alkaline pre-treatments may also be applied to prunes, where appropriate and in accordance with national or international standards.
72. After drying, raisins are commonly winnowed to separate stems and unripe or underdeveloped berries. This process may help reduce OTA contamination by removing materials more likely to be associated with fungal contamination. Where mechanical equipment is used, it should be operated and maintained to minimize berry damage and prevent cross-contamination.
73. In certain dried fruits like grapes and apricots, sulphur dioxide (SO<sub>2</sub>) may be applied, within permitted limits, to preserve the product, prevent browning, preserve quality and suppress fungal growth during drying and storage. The application of SO<sub>2</sub> should be carried out using approved methods and doses; uniform distribution should be ensured by treating fruit of homogeneous maturity, and compliance with national or regional regulatory limits should be maintained. The use of sulphur dioxide should be integrated with good drying and storage practices and should not be used as a substitute for adequate hygiene, appropriate harvest timing, effective drying, or proper storage moisture control. Excessive or improper application should be avoided, as it may result in uneven treatment, quality defects, or non-compliance with regulatory limits.
74. In pitted dried fruits from which stones are removed, the destoning operation carried out during the drying process should be completed within the shortest possible time. During this stage, prolonged holding of partially dried fruits, excessive mechanical damage, and contact with unclean equipment or surfaces should be avoided, as these conditions may favour fungal contamination or growth. Once the destoning process is complete, drying of the fruits should resume promptly.

### 6.4. Packaging

75. Depending on the production system, dried fruits may be packaged immediately after drying or after a period of temporary storage. Where temporary storage is applied prior to packaging, the recommendations in Section 6.5.1 should also be followed.
76. Packaging should provide an effective barrier against moisture, and prevent re-wetting of the dried fruits through absorption of external moisture or in-package condensation of water vapor, as moisture uptake may favour fungal growth and subsequent mycotoxin formation.
77. Packaging should only be carried out after the product has reached moisture content and/or water activity levels suitable to prevent fungal growth during storage and distribution. Dried fruit pieces with smaller particle size or higher surface area should receive particular attention, as they are more susceptible to moisture uptake and quality deterioration during storage. Where appropriate, dried fruits should be cooled to ambient temperature before packing to prevent condensation of moisture inside the package. Similarly, if dried fruits are deep-frozen and kept at very low temperatures (e.g., -36-40 °C) as a strategy for storage pest management, especially in organic certified products, the increase in temperature to ambient conditions should be gradual to prevent condensation.
78. Packaging materials and systems should be selected and managed to protect the product against water vapor, oxygen exposure, light, foreign odours, physical damage, bruising, impurities, and insect infestation that may reduce quality. Appropriate storage practices should be applied both before and after packaging to maintain product quality and minimize the risk of moisture uptake and fungal growth.

### 6.5. Storage and Transportation

#### 6.5.1. Storage conditions

79. High ambient temperatures and elevated relative humidity create conditions conducive to the growth of toxigenic fungi and consequently increase the risk of mycotoxin contamination in dried fruits. Storage facilities should therefore be designed, maintained, and operated so that they remain dry (RH 60-65%), cool, clean, and adequately ventilated, thereby preventing condensation on products, walls, and ceilings.
80. Dried fruits should be stored under controlled conditions, in well-ventilated, cool, and dry environments, to minimize fungal growth and OTA formation. The suitability and effectiveness of storage conditions should be evaluated in relation to local climatic conditions and supported by practical monitoring of temperature, relative humidity, and product condition appropriate to the scale of operation, as high ambient relative humidity and elevated temperatures may compromise the effectiveness of conventional uncontrolled storage conditions and increase the risk of moisture absorption and fungal growth.

81. Particular attention should be given to the prevention of localized “hot spots” within storage areas due to inadequate spacing, or in storage containers, e.g., due to intense pest infestation or presence of dried fruit clumps where increases in temperature and moisture may occur, as such conditions may lead to secondary fungal growth and subsequent OTA production. For this reason, potential sources of moisture ingress or condensation, including leaks, inadequate ventilation, wet floors, damaged packaging, and direct contact with walls or floors, should be identified and corrected. To further reduce the risk of moisture uptake and condensation, direct contact between dried fruit containers and floors or walls should be avoided by using pallets or other suitable separators. Where appropriate, hermetic storage as part of a dry-chain approach may be considered to limit moisture ingress and reduce the risk of fungal growth during storage, thereby reducing food losses and minimizing the risk of mycotoxin contamination.
82. Low storage temperatures may slow fungal growth and ochratoxin formation but do not eliminate the risk of fungal growth in inadequately dried products. In addition, high relative humidity in cold-storage facilities may cause dried fruit to absorb moisture, elevating water activity and promoting fungal growth and OTA formation. If products are transferred from very low temperatures and subsequently exposed to higher temperatures during handling, packaging, or transport, moisture condenses. Nevertheless, where appropriate, refrigerated storage may be considered for certain dried fruits, such as dried figs (<10°C), as it has been reported to reduce the risk of mycotoxin formation compared with ambient storage conditions.
83. Pests, including insects and rodents, may cause physical damage to dried fruits, create entry points, or generate hot spots that facilitate fungal contamination during storage. In addition, certain pests may act as vectors, carrying fungal spores on their bodies and thereby increasing the risk of mycotoxin contamination. Documented pest control programmes should include preventive exclusion measures, routine inspections, monitoring, corrective actions, and verification of effectiveness, without posing risks to product safety.
84. Good Manufacturing and Good Storage Practices should be implemented, including maintaining cleanliness and ventilation, regularly inspecting and cleaning storage facilities and equipment, and applying appropriate hygiene practices, in order to prevent cross-contamination and minimize the risk of mycotoxin development.
85. Where products dried using traditional drying methods are not promptly packaged after drying, they may be temporarily stored in food-grade crates. Crates should be stacked in a manner that prevents damage to the product, allows adequate air circulation, and avoids localized moisture accumulation or poorly ventilated hot spots that may favour fungal growth. Dried fruits with differing moisture levels, whether of the same or different species or varieties, as well as dried fruits produced in different harvest seasons or using different pre-treatments or drying methods, should be identified and stored as separate lots. Separate storage areas should also be provided to prevent moisture transfer and cross-contamination.

#### **6.5.2. Transportation**

86. Transport vehicles and containers should be clean, dry and temperature-controlled, where feasible. During transport to processing establishments and import destinations, operators should control, or, where direct control is not feasible, verify, conditions related to moisture, cleanliness, pest protection, high-temperature fluctuations, package integrity, mechanical damage, and conformity with good storage principles. In countries with extended transport routes or multi-modal distribution systems, particular attention should also be given to maintaining lot traceability, package integrity, and appropriate environmental conditions throughout the distribution chain.
87. For transportation by sea, particular attention should be given to moisture control, prevention of insect and rodent access, and avoidance of unnecessary delays during transportation. Containers used for transportation should be used exclusively for food transport and should be free from residues or other materials that may promote fungal growth and toxin formation. Transport units and ship holds should maintain appropriate moisture conditions, be kept clean, and protected against the entry of rodents and insects. If possible, containers should not be exposed to direct sunlight or high temperatures for extended periods to avoid temperature fluctuations and condensation. The same protective conditions should be maintained when containers are held at destination for sampling, inspection, or analytical testing.
88. Dried fruit packages should be placed away from container walls and raised off the floor on pallets or other suitable supports to prevent rewetting and localized moisture accumulation.

#### **6.6. Monitoring and corrective actions**

89. Environmental conditions and relevant critical parameters should be monitored and documented, as appropriate to the stage of the supply chain, including drying time, product moisture and/or water activity, storage temperature and relative humidity, pest status, integrity of packaging, and OTA results where testing is performed. If the individual fruit moisture levels are not homogeneous in the lot and show high variation, the lot should be kept under controlled environmental conditions for a while prior to packaging and processing to allow them to equilibrate.

90. Monitoring programmes should include, as appropriate, documented sampling procedures, defined monitoring frequency based on risk, and criteria for investigation when unsatisfactory results or abnormal trends are observed.
91. Periodic sampling and analysis for OTA should be conducted using sampling plans and analytical methods tested and recommended for a specific dried fruit in order to verify the effectiveness of implemented control measures. Sampling plans should be designed to obtain representative and reliable analytical results, considering the heterogeneous distribution of OTA within and between lots of different dried fruits. Representative sampling of the entire lot should be ensured and, where appropriate, larger lots may be subdivided into multiple laboratory samples in accordance with established sampling approaches.
92. Training programmes should be documented and regularly updated for farmers, harvesters, drying operators, processors, storage personnel, and inspectors. Training should include recognition of risk factors for OTA contamination, identification and segregation of defective fruits, hygienic handling practices, control of drying and storage conditions, lot segregation, record-keeping, and corrective actions. Where available, existing local mechanisms, such as farmer groups, cooperatives and extension services, may be used to facilitate the wider dissemination and uptake of training, particularly among small-scale operators.
93. In the event of deviations from established drying, storage, hygiene, or product acceptance conditions, operators should implement documented corrective actions. These should include segregation of affected lots, investigation of root causes, evaluation of product disposition, correction of process deficiencies, and measures to prevent recurrence. Effective implementation of corrective actions should be supported by appropriate sampling, testing, and record-keeping systems to facilitate the identification of affected lots, the investigation of root causes, and the verification of corrective measures.

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