CODEX ALIMENTARIUS COMMISSION

Food and Agriculture Organization of the United Nations

World Health Organization

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Agenda Item 13 **CF18/CRD02**

June 2025

ORIGINAL LANGUAGE ONLY

JOINT FAO/WHO FOOD STANDARDS PROGRAMME
CODEX COMMITTEE ON CONTAMINANTS IN FOODS
18th Session

Bangkok, Thailand
23-27 June 2025

REPORT OF THE IN-SESSION WORKING GROUP ON THE DEVELOPMENT OF A CODE OF PRACTICE FOR THE PREVENTION AND REDUCTION OF TROPANE ALKALOIDS IN FOOD AND FEED

(Submitted by China, Chair of the EWG/ISWG)

1. This CRD presents proposed changes to the project document and the draft Code of Practice (CoP) based on the analysis of comments submitted through CL 2025/41-CF and discussions during the in-session working group (ISWG) on 23 June 2025.

2. There was general support in the ISWG to submit a project document after revision to CAC48 for approval to start new work on the development of a code of practice for the prevention and reduction of tropane alkaloids (TAs) in food and feed, as it is necessary to provide global, science-based guidance on TA prevention across the food/feed chain.

3. Nevertheless, the ISWG did not agree to include references to animal health in the project document, noting that it was not the mandate of Codex to address animal health.

4. Changes made to the project document in CX/CF 25/18/14 Appendix II, in response to Members' comments and discussions during the ISWG, are indicated in Appendix I using tracked changes.

5. The revised draft CoP in Appendix II of this CRD is provided only for information.

Recommendation

6. CCCF18 is invited to forward the revised project document (Appendix I) to CAC48 for approval as new work.

APPENDIX I

REVISED PROJECT DOCUMENT FOR THE DEVELOPMENT OF A CODE OF PRACTICE FOR THE PREVENTION AND REDUCTION OF TROPANE ALKALOIDS CONTAMINATION IN FOOD AND FEED

(For consideration by CCCF)

Note: Revisions are shown in tracked changes.

1) Purpose and scope of the project

The purpose of the proposed new work is to develop a code of practice (CoP) *to prevent and reduce tropane alkaloids contamination in food and feed*. The scope of the work is to complete a CoP to prevent and reduce tropane alkaloids (TAs) contamination in food (e.g., cereal grains, dried legumes, herbs and spices, herbal teas, baby foods and leafy green vegetables such as spinach) and feed, particularly derived from *Datura*, for various stakeholders including farmers, food and feed manufacturers, competent authorities, and consumers.

2) Relevance and timeliness

Food aid contaminated with TAs was determined to cause food poisoning outbreaks in the Republic of Uganda and the Republic of South Sudan in 2019. These events affected more than 300 people and even resulted in deaths. The *Joint FAO/WHO expert meeting on tropane alkaloids*[1] (FAO/WHO, 2020) provided expert scientific advice on TAs in processed and unprocessed food products. To develop appropriate risk management measures in the United Nations World Food Programme (WFP) supply chains, it was recognized that limits expressed as physical toxic *Datura stramonium* seed contamination of cereals and grains will be beneficial for screening purposes at the field level. An *FAO/WHO guidance document on physical Datura stramonium seed contamination*[2] was developed and published in 2020 to address this. Since then, global reports of TA contamination and poisoning in plant-based foods have continued to emerge (e.g. Reports of tropane alkaloid poisonings and analytical techniques for their determination in food crops and products from 2013 to 2023[3]).

The 17th Session of the Codex Committee on Contaminants in Foods (CCCF17, 2024) agreed to follow up on the findings of these documents and consider the development of a code of practice and project document for consideration by CCCF18.

3) Main aspects to be covered

This work will address measures for preventing TA contamination in food and feed, including pre-harvest agricultural mitigation strategies related to *Datura* weeds control. It will also address post-harvest measures such as sorting grains and seeds to remove *Datura* seeds, sorting *Datura* plants from leafy green vegetables and extra precautions for processed food (including cereal-based food for infants and young children). Furthermore, since foodborne illnesses caused by TA can also occur at the household level, the CoP would also include some cusumer practices.

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

(a) **Consumer protection from the point of view of health and fraudulent practices**. To protect consumer health, exposure to TAs should be prevented or reduced. A CoP providing recommendations to farmers, food and feed manufacturers, competent authorities, and consumers will help prevent contaminated food and feed from entering the market.

(b) **Diversification of national legislations and apparent resultant or potential impediments to international trade. Currently, best practices and legislations.** Development of a CoP is needed to ensure that information on recommended practices for preventing and reducing TA exposure is available to all member countries. It will also provide the means to enable exporters to minimize risk of TAs and assist in compliance with any MLs that may be established in the future.

(c) **Scope of work and establishment of priorities between the various sections of the work.** The CoP will address all relevant measures for preventing or reducing TAs at the different steps in the food and feed chain.

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[1] https://cdn.who.int/media/docs/default-source/food-safety/jecfa/summary-and-conclusions/tropane-alkaloids-expert-meeting_30-march-3-april-2020_executive-summary.pdf?sfvrsn=f6c51fc1_5;
https://openknowledge.fao.org/server/api/core/bitstreams/6f846395-4481-46ca-850d-8953ae8ccb38/content

[2] https://openknowledge.fao.org/server/api/core/bitstreams/cdcafea7-63dd-4c7c-a767-34b168a3904c/content

[3] Gravador, R. S., Haughey, S., Meneely, J., Greer, B., Nugent, A., Daniel, C. S., & Elliott, C. (2024). Reports of tropane alkaloid poisonings and analytical techniques for their determination in food crops and products from 2013 to 2023. Comprehensive Reviews in Food Science and Food Safety, 23, e70047. https://doi.org/10.1111/1541-4337.70047

(d) **Work already undertaken by other international organizations in this field.** Several bodies and organizations, such as Joint FAO/WHO Expert Committee on Food Additives (JECFA), Food and Agriculture Organization (FAO), World Health Organization (WHO), and World Food Programme (WFP), have undertaken work on TAs and can be consulted in developing a CoP. These organizations have made recommendations but have not offered a CoP.

5) Relevance to Codex Strategic Goals

(a) **Goal 1: Address current, emerging, and critical issues in a timely manner.** Establishing a CoP to prevent or reduce TAs in food and feed will address the current need for guidance to ensure consumers' health.

(b) **Goal 2: Develop standards based on science and Codex risk-analysis principles.** This work will apply risk analysis principles in developing a CoP, using scientific data and recommendations from FAO/WHO and other recognized expert bodies to support a reduction in consumers' and animals' exposure to TAs (to control levels in feed).

(c) **Goal 3: Increase impact through the recognition and use of Codex standards.** The proposed CoP ensures that information on recommended practices to avoid and prevent TAs consists of current best practices and is available to all member countries, especially those with fewer resources to devote to this topic.

(d) **Goal 4: Facilitate the participation of all Codex Members throughout the standard-setting process.** Developing a CoP through the Codex Step process will inform all Codex members and observers about recommended practices to prevent and reduce TAs.

(e) **Goal 5: Enhance work management systems and practices that support the efficient and effective achievement of all strategic plan goals.** A CoP will help develop and implement effective and efficient work management systems and practices by providing basic guidance for countries and producers to keep highly TA-contaminated food out of the marketplace.

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

Standard for certain pulses (CXS 171-1989), *Standard for sorghum grains* (CXS 172-1989), *Standard for maize* (corn) (CXS 153-1985), *Standard for wheat and durum wheat* (CXS 199-1995) and *Standard for oats* (CXS 201-1995) include a provision that the products "shall be free from the following toxic or noxious seeds in amounts which may represent a hazard to human health", including *Datura* species. The weed control measures in the *Code of practice for weed control to prevent and reduce pyrrolizidine alkaloid contamination in food and* feed (CXC 74-2014) are also relevant.

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

The Joint FAO/WHO Expert Meeting (FAO/WHO, 2020) and other risk assessment bodies, such as the European Food Safety Authority (EFSA) (EFSA CONTAM Panel, 2008, 2013, 2016, 2018, and 2022), have already provided expert scientific advice.

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

There is no identified need for additional technical input from external bodies.

9) The proposed timeline for completion of the new work, including the starting date, proposed date for adoption at Step 5, and the proposed date for adoption by the Commission.

Work will commence in 2025 following CCCF18's recommendation and CAC48's approval. Completion is expected by 2028.

APPENDIX II

REVISED PROPOSED CODE OF PRACTICE FOR THE PREVENTION AND REDUCTION OF TROPANE ALKALOIDS CONTAMINATION IN FOOD AND FEED

(For information)

INTRODUCTION

1. Tropane alkaloids (TAs) are natural plant toxins occurring in several plant families, such as Brassicaceae (*B. oleracea*), Solanaceae (*Atropa belladonna L., Datura stramonium L., and Hyoscyamus niger L.*) and Erythroxylaceae (including cocoa). TAs are found in all parts of these plants and are responsible for their toxic effects. TA content varies by plant tissue and species but typically ranges from 0.01% to 3%.

2. The group of TAs comprises more than 200 compounds, and the wide range of compounds occurring especially in the Solanaceae family arises from the esterification of tropine with a variety of acids. The most studied tropane alkaloids are atropine (the racemic mixture of (-)-hyoscyamine and (+)-hyoscyamine) and scopolamine. TAs exert their pharmacological and toxicological effects mainly by acting as competitive antagonists of the muscarinic acetylcholine receptors, in both the central and peripheral nervous systems.

3. While crops grown for human consumption do not naturally contain a significant level of TAs, bulk commercial grains and seeds, such as wheat, rye, soybeans, linseed, and maize, may be contaminated by TAs due to field contamination by TA-containing plants (*Datura spp., Atropa belladonna, Hyoscyamus niger,* etc.). There have been numerous reports of human poisonings, including fatalities, due to accidental and/or deliberate ingestion of *Datura* plant parts. Establishing control strategies to reduce consumer exposure is critical.

4. Although several plant families contain TAs, *Datura spp.* are the most virulent invasive species. Of the 15–25 *Datura spp.* estimated to exist, *D. stramonium L.* is considered one of the world's most widespread weeds. *D. stramonium* is extensively distributed in temperate and tropical areas and is likely to be found in almost any summer crop (reported as a weed in more than 40 crops in almost 100 countries)[4].

5. *Datura spp.* commonly grow in various locations, including crop fields, and produce TAs such as hyoscyamine and scopolamine. These compounds may accidentally contaminate cereals, oilseeds, vegetables, and cereal-based foods at occasionally high levels. Additionally, *Datura spp.* compete with food crops for resources, leading to economic losses.

6. *Datura spp.* may enter the food network at a number of points, including during cereal/oilseed/vegetable cultivation (e.g., from compost containing weed seeds), harvesting (accidentally co-harvested with cereal grains due to mechanical harvesting methods, as well as harvested due to their structural similarity to cereal grains) and processing. Post-harvest, these weeds (seeds) may not be fully removed and may get ground into flour during food production processes.

7. Grazing animals generally avoid consuming *Datura spp.* due to their high TA content, which confers both toxicity and unpalatability. However, accidental ingestion may occur under specific conditions (e.g., forage scarcity or accidental contamination), posing acute health risks to livestock. Fortunately, TAs exhibit a short biological half-life, and observable pharmacological symptoms (e.g., mydriasis, tachycardia) typically manifest before the onset of life-threatening toxicosis, preventing clinically affected animals from entering the food chian[5]. Although trace TA residues in milk were detected under experimental overdose conditions, these levels are low and pose negligible risks to consumers under normal farming practices.Thus, residual TA levels in animal-derived products pose minimal risk to consumers.

8. However, feed and livestock producers should implement the *Code of Practice on Good Animal Feeding* (CXC 54-2004) and maintain vigilance in identifying and eradicating toxic plants (e.g., *Datura spp., Atropa belladonna, Hyoscyamus niger*) to safeguard animal welfare and prevent economic losses.

9. Adequate application of good practices (e.g., good agricultural practices (GAPs), good manufacturing practices (GMP)) and food safety and quality management systems (e.g., hazard analysis and critical control point (HACCP) and ISO 22000), from the start of cereal cultivation through to the final stages of manufacturing of food and feed products can reduce contamination. Farm management based on GAP has become the primary strategy for controlling TA contamination.

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[4] Commonwealth Agricultural Bureaux International (CABI). 2019. Invasive Species Compendium. *Datura stramonium* (jimsonweed). (also available at https://www.cabi.org/ isc/datasheet/18006).

[5] EFSA Panel on Contaminants in the Food Chain. (2008). Tropane alkaloids (from Datura sp.) as undesirable substances in animal feed. EFSA Journal, 691, 1–55. 10.2903/j.efsa.2008.691

SCOPE

~~9.~~10. This document provides guidance on recommended practices to prevent and reduce TA contamination in foods and feeds, particularly derived from *Datura*, for various stakeholders, including farmers, food and feed manufacturers, competent authorities, and consumers.

RECOMMENDED PRACTICES BASED ON GOOD AGRICULTURAL PRACTICES (GAP)

Farmland planning and preparation

11. The main pathways and key factors for the contamination of the human food supply by TAs are the infestations of cereal grains such as wheat and millet, buckwheat, sorghum, corn, and other crops by weeds such as *Datura stramonium*.

~~10.~~12. During the cultivation planning phase, rational spatial arrangement of crop planting areas is essential to avoid creating environments conducive to weed proliferation, particularly for species like *Datura stramonium*. Additionally, implementing sound crop rotation practices, such as alternating susceptible crops (e.g., cereals, legumes) with non-susceptible crops (e.g., root vegetables), can disrupt the life cycle of TA-containing weeds (e.g., *D. stramonium*) while improving soil fertility and structure. Enhanced soil health promotes vigorous crop growth, indirectly suppressing weed competition, thereby increasing overall yield efficiency.

~~11.~~13. In addition to crop rotation, implementing cover crops (e.g., rye, clover, or mustard species) can suppress weed emergence by competing for light, nutrients, and soil space while improving soil structure and fertility. Cover crops can further inhibit *Datura* germination by producing allelopathic compounds that negatively affect weed seed viability. Notably, mustard is a priority allergen, necessitating careful management to prevent its presence in cereal crops.

~~12.~~14. Another key approach is adopting conservation tillage or no-tillage systems, which help maintain soil integrity and reduce the redistribution of weed seeds within the seedbank. Unlike traditional plowing and harrowing, which may inadvertently promote the spread of Datura seeds, minimal soil disturbance techniques help prevent the seeds from being brought to the surface, where they are more likely to germinate. When soil preparation is necessary, shallow tillage or stale seedbed techniques—where weeds are encouraged to germinate and then eliminated before crop planting—can be used to reduce the initial weed burden.

~~13.~~15. Proper field sanitation should also be considered, including cleaning farm equipment and establishing buffer zones around fields to prevent weed encroachment. Using certified weed-free seeds and ensuring that irrigation water sources are not contaminated with *Datura* seeds are additional preventative measures that contribute to long-term weed management. Integrating these strategies into farmland planning will create a more resilient agricultural system that minimizes the risk of TA contamination in food crops.

~~14.~~16. Pasture management must also be done in accordance with GAPs, such as appropriate sowing time and depth, adequate fertility and moisture at sowing, which is important to ensure good weed control.

Seed management

~~15.~~17. Seeds should be carefully selected before sowing to ensure they are free from weed seeds, particularly from invasive species such as *Datura stramonium*. This can be achieved through mechanical and physical separation methods such as sieving, wind-sorting, and water-selecting measures to remove weed seeds, which help remove contaminant seeds based on size, weight, and density. Additionally, during import and export, seed inspection programs by national or local authorities or other accredited inspection agencies should be conducted to verify the purity of seeds to ensure that no weed seeds are included during planting.

~~16.~~18. Besides physical separation and regulatory inspections, certified seeds from accredited suppliers should be prioritized to ensure high genetic purity and minimal weed contamination. Implementing seed treatment methods, such as thermal or chemical disinfection, can further reduce the presence of dormant weed seeds and enhance overall seed health. Farmers should also adopt proper storage practices to prevent cross-contamination with weed seeds during handling and transportation.

Weed control and management

~~17.~~19. A comprehensive weed monitoring plan for weeds such as *D. stramonium* should be developed based on the climate, environmental conditions, soil characteristics, and the specific requirements of cultivated crops. This plan should define monitoring schedules, frequency, and key areas. Regular field inspections should be conducted to monitor the growth of weeds and promptly detect their presence, including the types, quantity, and distribution of weeds. National or local authorities should train and encourage farmers to routinely inspect their fields for TA-containing plants, ensuring early detection and management.

~~18.~~20. Farmers should be encouraged to visually inspect materials before composting them to prevent the inclusion of weed seeds that could later germinate and spread in agricultural fields. Composting practices should prioritize using weed-free plant residues to minimize the risk of reintroducing *Datura* and other harmful species into the soil.

~~19.~~21. Preventing weeds from reaching the flowering and seed production stages is crucial to avoiding further contamination of farmland. Accurate species identification, based on morphological traits and growth patterns, should guide classification and appropriate removal strategies. Datura stramonium, for example, must be controlled early in the season before seedpods develop, as late-stage intervention is significantly less effective in preventing seed dispersal.

22. Chemical control is the most effective method for managing *Datura* infestations during cultivation, but mechanical weeding is also a viable method. The best timing for mechanical weed removal is at the early stages of crop development, as dense crop canopies later suppress weed growth naturally. In cereal crops such as wheat and millet, pre-planting weeding and periodic removal during the first six weeks of growth are recommended. If feasible, a final weeding two weeks before harvest can further minimize contamination by toxic plants. In legume crops, where dense infestations may occur, mechanical or manual weeding might be the only effective option. Special attention should also be given to field borders, as these areas often serve as persistent weed reservoirs.

~~20.~~23. Integrated Weed Management (IWM), a holistic approach combining multiple strategies to minimize weed infestations while reducing reliance on chemical herbicides, is essential for sustainable control of *Datura spp.* and other TA-producing plants. Effective programs incorporate cultural methods (crop rotation, cover cropping with non-allergenic species), mechanical strategies (including early-season removal of *Datura spp.* before seedpod development and targeted tillage), chemical control (used rotationally with different herbicide modes of action where registered to prevent resistance), and biological control (introducing natural predators or allelopathic plants). Implementing this multifaceted strategy ensures long-term weed suppression, promotes soil health and biodiversity, optimizes management of these specific problematic plants.

Removal and Reduction of TA-Containing Plants

Physical methods

~~21.~~24. Hand Weeding: Manual removal of weeds using tools such as hoes, hand weeders, or trowels is an effective method for small-scale infestations or areas where precision is required. This technique ensures complete weed removal by extracting the entire root system, preventing regrowth. Tools such as knives or pruning shears may be used to cut shallow-rooted or fast-growing weeds at the base, ideally before flowering. To prevent reinfestation, all removed plant material should be promptly collected and disposed of outside the field, avoiding composting unless properly treated to eliminate viable seeds.

~~22.~~25. Mechanical Cultivation Weeding: Mechanical cultivation equipment disrupts weed growth by cutting off their roots and burying seedlings. However, mechanical tillage sometimes triggers secondary weed emergence, particularly in species with staggered germination patterns like *Datura stramonium*. Mechanical weeding also aerates and loosens the soil, which is beneficial for crop growth, but it must be done carefully to prevent excessive soil disturbance, erosion, and crop damage. Controlling the depth and frequency of tillage is crucial to maintaining soil integrity and minimizing weed proliferation.

~~23.~~26. Rotary Tillage Weeding: A rotary tiller cuts and mixes weeds into the soil, causing root damage and eventual death. This method is effective for large-scale weed control but requires caution, as excessive tillage can spread weed seeds deeper into the soil profile, prolonging their viability. Additionally, repeated tillage can disrupt soil structure and microbial communities, potentially reducing soil fertility over time.

~~24.~~27. Mulching: Applying organic (e.g., straw, rice husks) or synthetic (e.g., plastic film) mulch to the soil surface helps suppress weed growth by blocking sunlight and restricting oxygen flow to emerging seedlings. Mulching also aids moisture retention, temperature regulation, and soil enrichment as organic materials decompose. However, mulch should be sourced appropriately, fully decomposed, and free of contaminants to prevent inadvertently introducing weed seeds. In no-tillage systems, mulch can play a crucial role in reducing Datura stramonium emergence by limiting seed-to-soil contact.

~~25.~~28. Irrigation Water Filtration: To prevent weed seed dispersal through irrigation, interception devices such as fine-mesh nylon filters (<2 mm pore size) should be installed at water inlets. These filters help prevent Datura stramonium seeds from entering fields via contaminated irrigation sources. Regular maintenance of filtration systems is essential to ensure effectiveness and avoid clogging.

~~26.~~29. Floating Seed Removal: After field irrigation, weed seeds often accumulate in water channels, field corners, or on the surface of irrigation ponds. Collecting and removing these seeds promptly reduces the soil seed bank and

prevents their reintroduction into agricultural areas. Using skimming devices or sedimentation basins can enhance the efficiency of this method.

~~27.~~30. Soil solarization: It is a non-chemical method that uses solar heat to kill weed seeds, including Datura stramonium. This technique involves covering moist soil with a transparent plastic sheet for four to six weeks during the hottest part of the year. The trapped solar energy raises soil temperatures to levels that destroy weed seeds, pathogens, and some soil pests. Solarization is most effective in regions with high temperatures and intense sunlight and is particularly useful in reducing seed viability in the upper soil layers.

31. Flame weeding: Flame weeding, also known as thermal weeding, is a technique that uses directed heat from propane torches to kill young weeds by disrupting their cellular structure. This method effectively manages weeds in organic farming systems or areas where mechanical or chemical control is not desirable. Datura stramonium is particularly susceptible to flame weeding in its early growth stages. However, flame weeding should be used cautiously in dry conditions to avoid fire hazards, and multiple applications may be required for full effectiveness.

~~28.~~32. Disposal of weed seeds and plant parts: To prevent recontamination of food or feed chains, all removed TA-containing plant materials (including seeds, stems, leaves, and roots) must be disposed of appropriately. Burning is recommended as a primary disposal method for weed seeds and plant parts, as high temperatures effectively destroy viable seeds and degrade TA residue s. Alternatively, plant materials can be sent to licensed waste facilities for industrial composting under controlled conditions that ensure seed sterilization (e.g., prolonged high-temperature treatment). Under no circumstances should untreated weed materials be left in fields, used for animal feed, or incorporated into agricultural compost piles, as this may facilitate seed dispersal or residual TA transfer. Farmers and processors must follow local regulations for hazardous waste disposal and maintain records of disposal activities to ensure traceability.

Chemical methods

~~29.~~33. Herbicide Selection and Application: Chemical weed control should begin with the careful selection of appropriate herbicide, taking into account the target weed species, growth stage, and the crop's tolerance to herbicides. Farmers must use only herbicides registered and approved by national or local regulatory authorities, strictly adhering to label instructions to ensure food safety, environmental protection, and crop health. Priority should be given to herbicides that are selective, effective against *Datura stramonium* and other invasive species, and have a short residual period to minimize environmental impact. Highly toxic, persistent, or hazardous herbicides should be avoided whenever possible, particularly those with carcinogenic, teratogenic, or mutagenic properties.

~~30.~~34. Optimal Timing of Herbicide Application: Herbicides should be applied at the most effective stage of weed development to maximize control and minimize the need for repeated applications. Pre-emergent herbicides play a crucial role in preventing the germination of *Datura stramonium* and other invasive weeds by forming a chemical barrier in the soil. These herbicides should be applied before weed seeds germinate, typically before or at the time of crop planting, ensuring early suppression and reducing competition with the main crop. On the other hand, post-emergent herbicides should be applied during the early seedling stage of weeds, as young plants are more susceptible to chemical treatments, requiring lower doses for effective control. Applications during the most vulnerable weed growth stages improve efficiency and reduce the need for repeated treatments. However, care must be taken to avoid herbicide application during crop growth stages that are particularly sensitive to chemical exposure, as this can cause phytotoxicity and yield losses.

~~31.~~35. Farmers should also consider soil texture, moisture levels, and weather conditions when determining herbicide application rates and timing. Many pre-emergent herbicides require adequate soil moisture to activate their chemical properties, while post-emergent applications are most effective when weeds are actively growing under optimal environmental conditions. Proper calibration of herbicide sprayers and adherence to recommended dosages help maximize efficacy and minimize off-target effects.

~~32.~~36. To prevent the development of herbicide-resistant weed populations, farmers should implement a herbicide rotation strategy, alternating active ingredients with different modes of action. This practice helps delay resistance buildup and ensures long-term weed control effectiveness. Additionally, integrating herbicides with non-chemical weed management strategies, such as mechanical weeding and cover cropping, can further reduce reliance on chemical treatments. Proper post-application safety intervals must be observed to ensure that herbicide residues in agricultural products comply with food safety regulations before harvest.

Harvesting and transportation

~~33.~~37. Pre-Harvest Monitoring: Before harvesting, it is essential to monitor adjacent fields and surrounding areas for the presence of *Datura spp.* and other TA-containing plants that could pose a contamination risk. Special attention should be given to fields with a history of *Datura* infestations, as seeds can remain viable in the soil for several years. Early identification and removal of these plants before harvest can significantly reduce contamination risks.

~~34.~~38. Harvesting Considerations: *Datura spp.* tend to germinate and develop later in the season, meaning they may still be in a green, sap-filled stage when cereal crops reach maturity. During harvest, mechanical harvesting equipment can crush *Datura* plants, leading to sap leakage, which may contaminate edible grains. Proper pre-harvest field inspections should be conducted to mitigate this risk, and efforts should be made to remove any Datura plants before harvest begins.

~~35.~~39. Preventing Co-Harvesting of TA-Containing Plants: Strict measures should be implemented to prevent *Datura* and other TA-containing plants from being co-harvested with food crops. This includes thorough pre-harvest inspections, targeted weed removal, and the use of clean, well-calibrated harvesting equipment to minimize plant fragments in the final yield. All harvested material should be screened to ensure that toxic plant seeds, roots, stems, and leaves are not mixed with food crops at any stage of the process.

~~36.~~40. Equipment Cleaning and Sanitation: To prevent contamination and the spread of *Datura* seeds, all agricultural machinery, including combines, conveyors, and transport vehicles, should be thoroughly cleaned before and after harvesting operations. Equipment sanitation protocols should be strictly followed, especially when moving between fields to avoid transferring weed seeds to uncontaminated areas.

~~37.~~41. Farmers should ensure harvested crops meet local, regional, or national standards for noxious weed contamination in cereal grains. As part of a Good Agricultural Practices screening program for cereal grains and legumes, for small-scale operations, size exclusion and visual inspection of screenings could be implemented at an early-stage post-harvest to ensure the final product meets the generic Codex standard[6] of being free from noxious weed seeds (e.g. *Datura* seeds) in amounts that would represent a hazard to human health, or national/local government quality/safety requirements for the products.

Staff Training

~~38.~~42. Weed Identification and Control Training: National and local authorities and agricultural extension services should provide specialized training programs for personnel involved in field management to enhance their weed identification and control skills. Training should include identifying TA-containing plants, such as those shown in Annex I, enabling field managers to recognize and effectively manage toxic weeds. Particular attention should be given to sectors utilizing mechanical harvesting and sorting technologies, as these systems may not always detect toxic plant fragments, depending on the crop and processing method. Additionally, incorporating digital training tools, such as mobile applications and online platforms featuring AI-based weed identification, can facilitate real-time recognition and support decision-making in the field.

43. Proper Removal and Disposal of TA-Containing Plants: Farmers should receive comprehensive training on the safe and effective removal of TA-containing plants, emphasizing methods such as digging, cutting, or hand hoeing. Once removed, these plants must be collected in designated, properly marked bags for safe disposal. National and local authorities should provide clear guidelines on disposal procedures, ensuring that toxic weeds are not left at field edges or repurposed for composting, as this may contribute to further contamination. Regular field inspections should be conducted to identify and promptly eliminate toxic weeds in compliance with national/local regulations, where available.

RECOMMENDED PRACTICES BASED ON GOOD MANUFACTURING PRACTICES (GMP)

~~39.~~44. Raw materials for processing: Food/feed processors should implement control measures to monitor incoming ingredients and verify that suppliers provide materials free from *Datura spp.* weeds and their seeds. This is particularly critical for ingredients potentially contaminated with TAs, including cereal grains such as buckwheat, millet, maize, and rye; legumes and oilseeds such as soybeans, linseed, sunflower seeds, and hempseed; herbs and spices like fennel seeds, cumin seeds, and anise seeds; and herbal teas. Given the heightened vulnerability of infants and young children, manufacturers of processed cereal-based foods for infant and young children should consider to implement stricter TA control on raw materials if supplier quality control cannot guarantee safety. As a preventative measure, referencing the FAO/WHO intervention level for super cereals (30 µg/kg) to

[6] *Standard for certain pulses* (CXS 171-1989); *Standard for sorghum grains* (CXS 172-1989); *Standard for maize* (Corn) (CXS 153-1985); *Standard for wheat and durum wheat* (CXS 199-1995); *Standard for oats* (CXS 201-1995).

establish stricter acceptance criteria for raw materials is recommended to ensure product safety.

45. Feed producers should implement GAP-aligned protocols to prevent TA-containing plants (*Datura spp.*, *Atropa belladonna*, *Hyoscyamus niger*, etc.) contamination, referencing CXC 54-2004 for good animal feeding practices.

46. For food and feed producers, the most effective control measure for TAs is the timely identification and removal of leaves or seeds from TA-containing plants before processing. Once mixed into food or feed, these contaminants are difficult to remove. Moreover, final product testing is less effective and more costly than early-stage identification.

47. Food/feed processing and Equipment Sanitation: During processing, raw materials must be carefully screened and inspected to prevent the entry of *Datura spp.* weeds or their seeds into the production line. High standards of cleanliness for processing equipment and pipelines are essential to avoid cross-contamination and to halt the spread of *Datura* seeds during production, thereby ensuring the overall safety of the food production process.

~~40.~~48. Employee Training: The food/feed industry where contamination of *Datura* plants may occur must ensure that all personnel involved in production receive comprehensive training on food/feed safety, including the correct identification of *Datura spp.* in both dried and fresh states—covering roots, stems, leaves, flowers, and seeds. In particular, adherence to GMP/HACCP procedures is crucial during raw material handling and equipment operation to thoroughly remove contaminants and prevent the introduction of TAs into the production chain.

~~41.~~49. Product Traceability: Establishing an effective product traceability system is essential. This system should enable the rapid identification and recall of affected products in the event of TA contamination, ensuring that any potential risks are addressed swiftly and efficiently.

50. Food/feed processors could also consider occasional testing of finished products for TAs to verify that their control measures are functioning effectively. Although Codex has not established MLs for TAs, manufacturers could consider intervention levels for TAs in food (e.g., 30 µg/kg for super cereal, 10 µg/kg for super cereal plus and lipid-based nutrient supplements) as recommended by the *Joint FAO/WHO expert meeting on tropane alkaloids*[7] (FAO/WHO, 2020).

~~42.~~51. Analytical methods: LC-MS/MS and LC-HRMS are the most reliable and widely adopted methods for TA analysis in food/feed due to their sensitivity, specificity, and ability to handle complex matrices. GC-MS aids in rapid intoxication screening but faces limitations in food analysis. Sample preparation via QuEChERS or SPE, coupled with chromatographic separation and MS detection, ensures reliable quantification and identification, even at trace levels.

CONSUMER PRACTICES

~~43.~~52. National or local competent authorities should educate consumers about the potential risks of consuming TA-contaminated grains, vegetables, the symptoms associated with TA ingestion and common TA-containing plants. Educational materials should highlight specific plant parts that are often mistaken for edible portions, as detailed in Annex II.

~~44.~~53. Consumers should choose reputable sources when purchasing and consuming grains, vegetables(e.g., spinach), herbs and spices, herbal teas, and other foods. They should carefully review food labels and instructions and avoid products of unknown or suspicious origin, especially wild-harvested foods, to prevent accidental consumption of toxic plant parts such as those from *Datura spp.*, Mandrake(*Atropa Mandragora*), Henbane(*Hyoscyamus niger*), or Belladonna(*Atropa belladonna*) .

~~45.~~54. Given that plant extracts containing TAs have long been used in human medicine, it is strongly recommended that consumers adhere to medical guidance. Proper storage practices must be maintained by keeping food and medical products strictly separated to prevent accidental cross-contamination.

[7] https://cdn.who.int/media/docs/default-source/food-safety/jecfa/summary-and-conclusions/tropane-alkaloids-expert-meeting_30-march-3-april-2020_executive-summary.pdf?sfvrsn=f6c51fc1_5
https://openknowledge.fao.org/server/api/core/bitstreams/6f846395-4481-46ca-850d-8953ae8ccb38/content

Annex I

Pic 1 *Datura stramonium* leaf

Pic 2 *Datura stramonium* flower

Pic 3 *Datura stramonium* seeds

Annex II

Table 1: Pictures of some *Datura* plants and some similar-looking vegetables (still collecting)

Datura innoxia

Spinach

Datura stramonium

Datura stramonium

Datura stramonium

Datura Metel

Fruit and seeds of Datura stramonium

Brown Rice(Oryza sativa), Millet(Setaria italica), Buckwheat(Fagopyrum esculentum),Broomcorn Millet(Panicum miliaceum)