Food and Agriculture Organization of the United Nations
World Health Organization
CODEX ALIMENTARIUS
INTERNATIONAL FOOD STANDARDS

CODEX ALIMENTARIUS
CODE OF PRACTICE

CODE OF PRACTICE FOR THE PREVENTION AND REDUCTION OF AFLATOXIN CONTAMINATION IN PEANUTS

CXC 55-2004

ADOPTED 2004
REVISED 2025

CXC 55-2004

History of the code of practice

2025 Revisions

Revisions adopted at the Forty-eighth Session of the Codex Alimentarius Commission.

This publication was redesigned and published in 2025.

Adopted in 2004.

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1 Introduction

Research has demonstrated that aflatoxins (AF) are among the most potent liver carcinogens. This classification was established by the Joint FAO/WHO Expert Committee on Food Additives (JECFA) at its forty-ninth meeting, and reaffirmed at its eighty-third meeting, based on studies in test species and human epidemiological studies. In addition to their carcinogenic properties, aflatoxins exhibit acute and chronic toxicity and genotoxic, carcinogenic, and immunosuppressive effects. Aflatoxins can be found in several food commodities, including peanuts, tree nuts, dried figs, cereals, spices, and derived products.

Several species of the *Aspergillus* section *Flavi* are known to produce aflatoxins, with *Aspergillus flavus, A. parasiticus,* and related species commonly isolated from peanuts. These fungi are usually found in soils where peanuts grow and can infect them under favourable conditions. The interaction of the host plants, the fungus, and the environment determines the infection of the peanut and the subsequent aflatoxin production. Preharvest conditions such as drought stress, elevated temperatures, and humidity during seed filling and plant development, are among the most important factors that influence aflatoxigenic fungal infection and aflatoxin production.

After harvest, peanuts are cured, often sun-dried, stored, and traded. To prevent aflatoxigenic species growth and toxin formation, the water activity and/or moisture content of peanuts can be monitored and maintained. Colour sorting, blanching and roasting are processing techniques that are used for aflatoxin reduction in peanuts.

2 Scope

This document is intended to provide guidance for all parties involved in producing/processing, and handling of peanuts intended for food and feed. Peanuts and peanut products should be prepared and handled in accordance with the *General principles of food hygiene* (CXC 1-1969),[1] which apply to all foods prepared for human consumption, and the *Code of hygienic practice for groundnuts (peanuts)* (CXC 22-1979).[2] These outline the measures that should be implemented by those responsible for ensuring that food is safe and suitable for consumption.

3 Related Codex texts

- *General standard for contaminants and toxins in food and feed* (CXS 193-1995);[3]
- *Recommended methods of analysis and sampling* (CXS 234-1999);[4]
- *General principles of food hygiene* (CXC 1-1969);
- *Code of hygienic practice for groundnuts (peanuts)* (CXC 22-1979);
- *Standard for peanuts* (CXS 200-1995);[5] and
- *Code of practice for the reduction of aflatoxin B1 in raw materials and supplemental feeding stuffs for milk-producing animals* (CXC 45-1997).[6]

4 Definitions

- **Blows (pops)**: in-shell peanuts, which are unusually light in weight due to extensive damage from physiological, mould, insect, or other causes and which can be removed, for example, by an air-separation process.
- **Curing**: drying of the in-shell peanuts to a safe moisture level.
- **Density flotation**: a physical separation process used to remove damaged, immature, or potentially aflatoxin-contaminated peanut kernels based on differences in their density.
- **Farmers' stock peanuts**: in-shell peanuts as they come from farms.
- **Loose-shelled kernels:** peanut kernels or any portion of kernels completely free from shells when found in farmers' stock peanuts.
- **Moisture content**: total amount of water present in a product.
- **Peg**: an ovary stalk that goes underground and from where the pods originate.
- **Water activity (a_w)**: a measure of free moisture in a product.
- **Winnowing**: a physical separation process that removes lighter materials such as husks, shells, or dust from edible kernels by using airflow or mechanical agitation.
- **Xerophilic fungi**: fungi that can grow at low water activity, below 0.85, under at least one set of environmental conditions.

5 General recommendations

Document the harvesting, drying, cleaning, and storage procedures and conditions (e.g. temperature, moisture, humidity) in each season to help identify causes of fungal growth and prevent future occurrences. Validated predictive models can be useful in helping make management decisions.

Ensure all vehicles (e.g. wagons, trucks), equipment, and materials used for planting, harvesting, transporting, drying, cleaning and storage are:

- Cleaned of potential sources of contamination (e.g. crop residues, dust, insects, fungal growth, broken glass, animal excrement) and dried. Use approved cleaners and disinfectants that do not cause offodours, flavour, or contaminate the crop.
- Intact and able to provide protection from water (e.g. precipitation, groundwater seepage, condensation) as well as rodents, birds and insects that can contaminate the crop and cause physical damage, making it more susceptible to mould infection. Use registered fumigants or insecticides as needed.

Ensure all equipment and materials used for planting, harvesting, transporting, drying, cleaning, and storage are in good working order and calibrated to relevant conditions (e.g. moisture sensors), where applicable. Have spare parts available to minimize time loss for equipment repairs.

Aim to minimize mechanical damage to crops during cultivation, irrigation, pest management practices, harvest, and cleaning.

Contact product or equipment manufacturers, competent authorities, and/or extension services for supplementary information about the practices noted in this code of practice.

Extension services can advise about aflatoxin mitigation measures relevant to regional conditions and situations.

Products used in the production of food and animal feed that may indirectly prevent or control aflatoxinproducing species (e.g. insecticides, additives used to support fermentation, biofungicides, and biopesticides) or directly reduce aflatoxin levels post-harvest (e.g. additives and mycotoxin detoxifying agents (MDAs)) should be approved/registered and used within the parameters set by competent authorities. In approving /registering the use of *Aspergillus* strains as biopesticides, competent authorities should take into account that research has shown that *A. flavus* can undergo sexual recombination, generating new, aflatoxinproducing genotypes.

Aflatoxin concentrations in food and feed may be heterogeneous. Therefore, it is important that any sampling and testing follow Codex sampling plans or those of competent authorities to provide accurate and representative results. The sampling plan for total aflatoxins in peanuts is established in the *General standard for contaminants and toxins in food and feed* (CXS 193-1995).

6 Recommended practices based on good agricultural practices (GAPs)

6.1 Pre-planting preparation and planting

For effective pre-harvest control of aflatoxin contamination in peanuts, it is essential to consider all the environmental and agronomical factors that influence pod and seed infection by the aflatoxigenic fungi and aflatoxin production. These factors can vary considerably from one location to another and between seasons in the same location. Some conditions may be particularly favourable to fungal infection and subsequent aflatoxin contamination of peanuts. In these circumstances, appropriate planning and agricultural practices should be employed to reduce aflatoxin contamination in peanuts.

The cultivation of peanuts on the same land for several cycles may lead to a build-up of high populations of aflatoxigenic fungi, particularly *A. flavus* and/or *A. parasiticus,* in the soil, increasing the probability of infection and aflatoxin contamination. Some studies have been carried out on the effect of crop rotation on aflatoxin contamination. In semi-arid environments, populations of aflatoxigenic fungi may be very high, and crop rotations have little influence on the activity of these species. Cropping systems in some regions involve diverse cultivation and fertilizer practices that, individually or taken together, may affect the survival or buildup of populations of the aflatoxigenic fungi. There is evidence that peanuts grown in different soil types may have significantly different infection levels by the fungi. Light sandy soils, for example, favour rapid proliferation of the fungi, particularly under dry conditions. In contrast, heavier soils have a higher water-holding capacity and, therefore, there is less likelihood of drought stress, which may partly explain the lower-than-average levels of aflatoxin contamination in peanuts grown on such soils.

Use soil test results to determine if fertilizer and/or soil conditioners are needed to maintain appropriate soil pH and plant nutrition. This helps to prevent plant stress, especially during seed development, when peanuts are more susceptible to fungal infection. Utilizing soil amendments such as composting manure and gypsum/lime at sowing time is shown to reduce *A. flavus* seed infection and aflatoxin formation. Lime and gypsum are sources of calcium that enhance cell thickness and pod filling and decrease fungal infection while also altering soil pH.

Organic supplements, such as composting manure and non-contaminated crop residues, improve the soil's water-holding capacity, minimizing the effect of drought during plant development and reducing fungal infection and aflatoxin accumulation in the peanut seeds.

The choice of peanut variety is important, so before planting, farmers should consult with the national or relevant competent authorities or extension services to identify the cultivars most suitable for their region. They should also consider the availability of varieties resistant to various factors, such as insect infestation and fungal and other microbial infections, which can affect the safety and quality of the peanuts. A cultivar that is suitable for a particular growing season and matures at the end of the rainy season should be selected, allowing post-harvest field drying under favourable conditions. It is undesirable that a variety suffers from drought stress during pod maturation; therefore, some adjustments may have to be implemented to avoid such stress. Cultivation strategies may be considered that maximize harvest during dry conditions while preventing drought stress as much as possible (e.g. the use of early ripening cultivars that mature before the rainy season has ended).

It is essential to prevent the overcrowding of plants by adhering to the recommended spacing between rows and within plants for the specific species or varieties being cultivated. Establishing optimal plant populations is crucial, as excessively high densities can result in drought stress, particularly in seasons where rainfall is not at ideal levels needed for growth.

6.2 Pre-harvest

When necessary, irrigation may be used as a strategy to mitigate the impact of heat and drought stress. Water stress affects plants in three ways: first, by wilting the plant and reducing its metabolic activity, which inhibits the plant's natural defences against fungal infection; second, by lowering the water activity in the soil, which reduces growth and activity of competing microorganisms; and third, by promoting the growth of *A. flavus* or *A. parasiticus*, which are xerophilic fungi.

Irrigation to ensure adequate soil moisture during the pod/seed filling and before harvest should minimize preharvest aflatoxin contamination of peanuts. This may be achieved by growing a thoroughly irrigated crop or applying supplementary irrigation to a rainfed crop. If irrigation is used, ensure that it is applied evenly and that all plants in the plot have an adequate water supply.

Excessive weed growth may affect available soil moisture. Effective weed control through the use of registered herbicides or cultivation is therefore advisable. During weed cultivation, care should be taken to avoid damaging pegs and pods.

Cultivation and crop protection practices that lower the incidence of soil insects, mites and nematodes can help reduce aflatoxin contamination. Minimizing insect damage and fungal infection in the vicinity of the crop can be achieved by the proper use of registered insecticides, insect-resistant cultivars, fungicides, and other appropriate practices within an integrated pest management programme. Growers should consult local or national authorities and extension services to identify the insects and pests commonly found in their region that may attack peanuts, making them more susceptible to fungal infections and aflatoxin production.

No fungicide, combinations of fungicides, or other chemical treatments appear to have been widely adopted for the practical control of infection and subsequent aflatoxin contamination of peanuts pre-harvest. The results of studies on the application of fungicides on freshly harvested or windrowed peanuts are equivocal.

Biological methods could be used, like biofungicides and biopesticides. For example, the deliberate introduction of competitive, non-aflatoxigenic *A. flavus* and *A. parasiticus* into the agricultural environment can suppress the natural occurrence of the aflatoxigenic fungi.

6.3 Harvest

Local and national authorities, as well as trade associations, should take the lead in informing growers of the hazards associated with aflatoxin contamination of peanuts and how they may practise safe harvesting procedures to reduce the risk of contamination.

Peanuts must be harvested at full maturity (R8, as shown in Table 1) unless there are chances of extreme heat, rainfall, or drought conditions. It is very important to harvest the crop at optimal maturity, as excessive numbers of over-mature pods at harvest can be reflected in high levels of aflatoxin in the product, and immature pods are more likely to be contaminated by aflatoxins due to lower phytoalexin levels, which give natural resistance to fungal infection. Delayed harvest of peanuts may cause a significant increase in the aflatoxin content of infected plants (or peanuts). Monitoring crop maturity, precipitation, and soil temperature, as well as the use of predictive models, if available, may be very useful in helping target optimal harvest periods.

Table 1 represents the stages of peanut reproductive growth. The following stages correspond to the beginning of pod formation (R3), pod expansion (R4), and seed formation (R5). Once it reaches the ground, the peg with its swollen ovary doubles its width, and the expansion of the pod begins. With the pod fully expanded, the growth of the seed's cotyledon begins. Seed formation begins approximately 60 days after planting. When the pod cavity is completely filled with seed, the plant reaches the R6 stage around 74 days after planting. When 50 percent of the plants have at least one pod that shows colour on the inner part of the pericarp, the plantation reaches the R7 stage, indicating the beginning of maturation. Complete maturation (R8), indicating the moment of harvest, occurs when 70 percent to 75 percent of the pods are placed in the inner part of the pericarp. Stages R7 and R8 occur approximately in the last 30 days of the peanut planting cycle. Maturation can be observed by the colour of the cotyledons, which varies from white (immature kernels) to pink (more mature kernels).

Table 1: Stages of peanut reproductive growth

Stage	Reproductive stages	Description	Figure
R1	Beginning bloom	One open flower at any node on the plant.	
R2	Beginning peg	One elongated peg (gynophore).	
R3	Beginning pod	One peg in the soil with turned swollen ovary at least twice the width of the peg.	
R4	Full pod	One fully expanded pod to dimensions characteristic of the cultivar.	
R5	Beginning seed	One fully expanded pod in which seed cotyledon growth is visible when the fruit is cut in cross-section.	
R6	Full seed	One pod with cavity apparently filled by the seeds when fresh.	
R7	Beginning maturity	One pod sharing visible natural colouration or blotching of inner pericarp or testa.	
R8	Harvest maturity	66–75% of all developed pods have testa or pericarp colouration.	
R9	Over-mature pod	One undamaged pod showing orangetan colouration of the testa and/or natural peg deterioration.	

Individual plants that die due to damage from pests, pathogens, such as *Sclerotium rolfsii* or *Fusarium* spp., and diseases like rosette virus, or insects such as termites, earwigs, and false wireworms that cause damage to the pods, should be harvested separately, if possible, as peanuts from these plants are likely to be contaminated with aflatoxins.

If irrigation systems are used, care should be taken to harvest peanuts beyond the reach of irrigation systems separately to avoid mixing peanuts from irrigated sections with those from unirrigated sections.

Damage to peanut pods at the time of harvest should be avoided as much as possible since this can lead to rapid invasion of the pods by aflatoxigenic fungi.

After harvest, peanut pods should be exposed to the sun and wind for maximum drying rate. This may be accomplished by turning the plants to leave the pods uppermost, away from the ground, and exposed to sun and wind. Curing should be completed as soon as possible to a safe water activity to prevent the growth of microorganisms, particularly aflatoxigenic fungi. However, curing too rapidly may cause skin slippage and offflavours of the peanut kernels. When curing by supplemental heat, excessive heat should be avoided since this impairs the general quality of the peanuts, e.g. causing the splitting of kernels after shelling. Close checks of the moisture content/water activity of lots of farmers' stock peanuts should be maintained.

Peanuts should be dried so that damage to the peanuts is minimized and moisture levels are lower than those required to support fungal growth during storage. The ideal combination of moisture level and maximum allowed drying period will vary with peanut variety and agricultural zone. It is envisaged that the preliminary windrow drying should achieve a moisture level of <12 percent, whereas the second drying phase, on a flat surface or by other suitable methods, should attain a moisture level of <10 percent for peanuts in-pod and <9 percent for peanut kernels. Lower moisture levels may be required for certain destinations in relation to the climate, duration of transport, and storage.

Once the windrow drying is done, the separation of the pods from the pegs must be carried out. This can be done manually or mechanically, being careful not to damage the fruit with rough handling and the use of poorly adjusted machinery, which would allow moisture to enter the pod and increase the risk of fungal contamination and spoilage of the seed.

Peanuts should be cleaned and sorted to remove damaged peanuts and other foreign matter. Cleaning procedures, such as density separators or air legs to remove light pods and slotted screens to eliminate preshelled kernels, may remove some infected peanuts.

7 Recommended practices based on good manufacturing practice (GMP)

7.1 Transport to processing facilities

Harvest peanuts (farmers' stock peanuts) should be transported to a suitable storage facility or the processing area for processing as soon as possible after harvesting or drying.

Consignments of farmers' stock peanuts should be protected from additional moisture by using covered or airtight containers or tarpaulins but remove them promptly after transportation to avoid moisture trapping, which could make the consignment more conducive to mould growth and aflatoxin contamination. Avoid temperature fluctuations that may cause condensation on the farmers' stock peanuts, which could lead to local moisture build-up and consequent fungal growth and aflatoxin formation.

Avoid insect, bird, and rodent infestation during transportation, using pest-proof containers or insect and rodentrepellent chemical treatments if they are approved for the intended use.

7.2 Segregation of aflatoxin-contaminated lots

Farmers' stock peanuts should be screened for aflatoxin contamination using appropriate sampling and analytical techniques to segregate peanut loads for proper storage. Aflatoxin-free loads should be segregated from loads with low levels of aflatoxin contamination, loads destined for subsequent processing and clean-up, and loads that are highly contaminated.

Research results indicate that quality sorting removes a large part of the aflatoxins present at harvest.

7.3 Storage of in-shell peanuts

The post-harvest storage phase is crucial for controlling aflatoxin contamination in peanuts.

A properly ventilated warehouse with a roof of suitable material and a concrete floor is required to prevent the rewetting of peanuts and mould development. Ensure that the storage facilities include dry, well-ventilated structures that protect from rain, allow water to drain away from the facility, protect from entry of insects, rodents, and birds, and minimize temperature fluctuations. Also, the following are examples of warehouse improvements proven to be effective: (1) to reduce solar heat load, warehouse roofs with white paint can be used instead of conventional galvanized roof material; and (2) the double roofing concept of installing a new roof over a defective, existing roof, with an air space in-between the two roofs, has proven effective in controlling warehouse condensation.

Storage temperature and relative humidity should be carefully monitored during storage. Storage temperature and relative humidity should not be above 30 °C and 85 percent, respectively. Ideally, relative humidity below 70 percent and temperatures between 0 °C and 10 °C are optimal for minimizing spoilage and fungal growth during long-time storage.

Uniform loading in the warehouse allows excessive heat and moisture to escape and reduces areas favourable for insect infestation. Stockpiling of peanuts can cause heat build-up and moisture accumulation, causing mould growth and aflatoxin contamination.

The increase in aflatoxin contamination during storage and transportation depends on water activity and moisture content, the temperature in the environment, and the hygienic conditions. Aflatoxigenic fungi such as *A. flavus* and *A. parasiticus* cannot grow or produce aflatoxins at water activities less than 0.7 and moisture content less than 9 percent.

Store at the lowest temperature possible, consistent with ambient conditions, but avoid near-freezing temperatures. Where possible, aerate the peanuts by circulating air through the storage area to maintain proper and uniform temperature levels throughout the storage area.

When necessary, aflatoxin levels in farmers' stock peanuts coming into and out of storage should be monitored for aflatoxins using appropriate sampling and screening techniques, such as rapid tests that report acceptable/not acceptable results.

For bagged peanuts, ensure that the bags are clean and dry and stacked on pallets, or incorporate a waterimpermeable layer between the bags and the floor. When low-temperature storage is not available, the use of hermetic storage bags is recommended. These bags create airtight and moisture-proof conditions, reducing aflatoxin contamination during long-term storage. To further improve their effectiveness, hermetic storage can be combined with oxygen absorbers or CO_2 injection, particularly to prevent fungal growth during the critical early phase of storage.

Measure the temperature, when possible, of the stored peanuts at scheduled intervals during storage. Increasing temperature is likely a good indicator of microbial growth as well as insect infestation. Visually check peanuts for evidence of mould growth and insect damage. Separate the apparently infected peanuts and send samples for analysis if possible. When separated, lower the temperature of the remaining peanuts and aerate. Avoid using visually infected peanuts for food or feed production.

Use good housekeeping procedures to minimize the levels of insects and fungi in storage facilities. This may include the use of suitable traps, registered insecticides, fungicides, and fumigants.

Record the harvesting and storage procedures employed each season and document measurements of temperature, moisture levels, water activity, and humidity, along with any deviations or alterations from conventional practices. This information may be very useful for explaining the causes of fungal growth and aflatoxin contamination during a particular crop year and help to avoid similar issues in the future.

7.4 Receiving and shelling

A buyer for a shelling plant, whether located at the plant or an outlying buying point, should monitor the quality of peanuts. Buyers should encourage farmers' stock peanuts suppliers to follow GAPs as described herein, including application and documentation of GAPs, quality assurance, and qualitycontrol measures.

Farmers' stock peanuts received at the shelling plant should be inspected on arrival. It is advisable to know the origin and history of each lot of peanuts. The transport vehicle should be examined. If the vehicle is not fully enclosed, it should have a covering such as tarpaulin to keep out rain or other forms of water. The general appearance of the peanuts should be observed during the process of unloading. If the peanuts are wet to the touch, they should not be mixed with peanuts in a bulk warehouse. The vehicle that contains the peanuts should be set aside until a decision is made for their disposal. If possible, remove a sample from each lot, separate the loose-shelled kernels, and shell the remainder for peanutgrade observation before an acceptance decision is made.

Specifications for the purchase of peanuts intended for further processing should include a maximum level for aflatoxins based on appropriate sampling and analysis methods.

Peanuts showing signs of insect damage or mould growth must be rejected because of the higher risk of aflatoxin contamination. Aflatoxin test results should be known before allowing lots of raw peanuts to be processed. Any lot of raw peanuts with unacceptable levels of aflatoxins, which cannot be reduced to permitted levels by the available sorting equipment, should not be accepted.

Suppliers of shelled peanuts should comply with the processor requirements to ensure that the finished product meets all specifications, including the maximum limit for aflatoxins.

Examine all loose-shelled, damaged "blows" and undersized kernels for possible presence of mould. If no external mould is visible, split the kernels to disclose possible hidden mould growth. Excessive mould or the presence of mould resembling aflatoxigenic fungi, such as *A. flavus*, warrants a chemical test for aflatoxin or rejection of the lot.

7.5 Sorting

Several peanut processing procedures, such as sorting, density flotation, blanching, and roasting, have been shown to reduce aflatoxin levels by up to 99 percent. Aflatoxins can be reduced at any stage of production by removing defective peanuts and foreign matter by sorting (electronically or manually), winnowing, separating by gravity, or other methods. Sorting is the final step for removing defective kernels.

In electronic or laser sorting, each shelled peanut is inspected, and discoloured peanuts are removed, as discolouration often indicates fungal growth and potential aflatoxin contamination. Sorting can reduce up to 70 percent of aflatoxin. Utilizing equipment that can remove kernels with internal defects through differences in near-infrared transmittance has been shown to be an effective method for reducing aflatoxin levels.

In the case of manual sorting, belts should be well-lit, with peanuts passing through no more than one layer deep and operated at a speed that enables hand sorters to ensure effective removal of foreign material and defective kernels. Sorting machines should be adjusted as often as practicable against standards to ensure the removal of all defective kernels. Adjustments should be checked frequently and regularly.

To remove mould-contaminated peanuts effectively, sorting should be performed before and after blanching and roasting. Where splitting is part of the processing operation, kernels that resist splitting should be removed. The effectiveness of sorting techniques should be checked by regular aflatoxin analyses of the sorted peanuts, or in the finished product, or both. This should be done frequently enough to ensure the product is completely acceptable.

Defective kernels (mouldy, discoloured, rancid, decayed, shrivelled, insect- or otherwise damaged) should be bagged separately and tagged as unsuitable for human consumption. Containers of defective peanuts should be removed from the processing area as soon as possible. Peanuts possibly contaminated or contaminated with aflatoxins exceeding food standards, based on previous analysis, could be redirected to oil production, non-food, or feed uses, given that any existing standard is met.

7.6 Blanching

Blanching is a process that involves the partial drying of raw shelled peanuts with the aim of loosening skins/testa for easy removal by blanching rollers. The blanched kernels are then sorted for discolouration manually or by using electronic colour sorters. As much as a 90 percent reduction in aflatoxin can be achieved when blanching is used in conjunction with gravity tables and manual or electronic sorting. If the colour sorting process is ineffective for blanched peanuts, as can occur when severe drought stress causes peanuts to dry in the soil before harvest, it is common practice to roast the blanched peanuts and perform the colour sorting process again. This accentuates the darkening process and facilitates colour sorting.

7.7 Packaging and storage of the end product

Peanuts should be packed in appropriate packages, such as clean jute bags, cartons, or food-grade plastic bags, such as polypropylene bags. Hermetic storage bags are also recommended for specific conditions such as room temperature storage, long-term storage, and high-humidity environments.
Ensure food-contact materials comply with the safety standards set by regulatory authorities.
All bags/cartons should be lotidentified to facilitate traceability before being moved to controlled storage facilities or transported.

Peanuts that have been processed should be stored and transported under such conditions as to maintain the integrity of the container and the product within it. Carriers should be clean, dry, weatherproof, free from infestation, and sealed to prevent water, rodents or insects from reaching the peanuts. Peanuts should be loaded, held, and unloaded in a manner that protects them from damage or water. Well-insulated carriers or refrigerated vehicles are recommended for transport when climatic conditions indicate such a need. Extreme care should be taken to prevent condensation when unloading peanuts from cold storage or a refrigerated vehicle. In warm, humid weather, the peanuts should be allowed to reach room temperature before exposure to external conditions. This may require one to two days. Peanuts that have been spilled are vulnerable to contamination and should not be used for edible products.

Export-grade peanuts should be clearly labelled as either “ready-to-eat” (or equivalent name) or “destined for further processing”, indicating that additional processing is required before they are used as an ingredient in foodstuffs, otherwise processed, or offered for human consumption.

8 Risk management for aflatoxin control in the peanut chain

The hazard analysis critical control point (HACCP) system is an all-encompassing integrated food safety management system that is used to identify and control hazards within the production and processing system. The general principles of HACCP are described in the *General principles of food hygiene* (CXC 1-1969).[1]

Aflatoxins in peanuts are both of microbial origin (due to fungal contamination) and present a chemical hazard. Therefore, integrated control measures are needed. When properly implemented, this system should result in a reduction in the levels of aflatoxins in peanuts. The use of HACCP as a food safety management system has many benefits over management control systems in some segments of the food industry. Control of aflatoxin contamination during agricultural production is mainly achieved through minimizing insect infestation and controlling irrigation. Particular attention should be paid to the soil population of the fungi, the health of the seed material, soil moisture deficit stress during pod formation and pod maturity stages, and rainfall at harvest. After harvesting, the critical control points may be identified for aflatoxins produced by fungi during drying and storage. For example, aflatoxins can be formed while peanuts are being dried, which is usually carried out in the field, and can also continue to form during farm storage if drying has been inadequate or when storage is carried out at high relative humidity and/or temperature. During manufacturing, sorting and roasting are the main steps in the reduction of aflatoxins, making them critical control points.

It is recommended that resources be directed to promoting GAPs and GMP at pre-harvest, harvest, drying, storage, processing and distribution of various products. A HACCP system should be built on sound GAPs and GMP.

Integrated aflatoxin control programmes may incorporate HACCP principles to control risks associated with aflatoxin contamination of foods and feeds. Implementing HACCP principles can minimize aflatoxin contamination of peanuts through the application of preventive controls to the extent feasible in the production, handling, storage and processing of each peanut crop.

Referenced texts

1 *General principles of food hygiene* (CXC 1-1969)

2 *Code of hygienic practice for groundnuts (peanuts)* (CXC 22-1979).

3 *General standard for contaminants and toxins in food and feed* (CXS 193-1995).

4 *Recommended methods of analysis and sampling* (CXS 234-1999).

5 *Standard for peanuts* (CXS 200-1995).

6 *Code of practice for the reduction of aflatoxin B1 in raw materials and supplemental feeding stuffs for milk-producing animals* (CXC 45-1997).

Codex Alimentarius

A collection of international food standards developed to protect consumer health and ensure fair practices in the food trade. Codex standards are adopted by the Codex Alimentarius Commission, an intergovernmental body with 189 Members, established by FAO and WHO. The standards are recognized by the World Trade Organization as the benchmark for the safety of internationally traded food.

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FAO and WHO. 2025. *Code of practice for the prevention and reduction of aflatoxin contamination in peanuts.* Codex Alimentarius Code of Practice, No. CXC 55-2004. Codex Alimentarius Commission. Rome. https://openknowledge.fao.org/handle/20.500.14283/cd8966en