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

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CAC/RCP 55-2004

## I. SCOPE

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1. This document is intended to provide guidance for all interested parties producing and handling peanuts for entry into international trade for human consumption. All peanuts should be prepared and handled in accordance with the Recommended International Code of Practice – General Principles of Food Hygiene<sup>1</sup>, which are relevant for all foods being prepared for human consumption. These codes of practice indicate the measures that should be implemented by all persons that have the responsibility for assuring that food is safe and suitable for consumption.

## 2. DEFINITIONS

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2. **“Blows”** (Pops) means in-shell nuts 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.
3. **“Curing”** means drying of the in-shell peanuts to a safe moisture level.
4. **“Farmers stock”** peanuts means in-shell peanuts as they come from farms, after separation from the vines by hand and/or mechanical means.
5. **“Safe water activity”** means a water activity of in-shell peanuts and shelled peanuts that will prevent growth of micro-organisms normally present in the harvesting, processing, and storage environment.
6. Water activity ( $a_w$ ), is a measure of free moisture in a product and is the water vapour pressure of the substance divided by the vapour pressure of pure water at the same temperature. Water activities above 0.70 at 25 degrees Celsius (77 ° Fahrenheit) are ‘unsafe’ as far as growth of *Aspergillus flavus* and *Aspergillus parasiticus* and possible aflatoxin production are concerned.

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<sup>1</sup> Recommended International Code of Practice - General Principles of Food Hygiene (CAC/RCP 1- 1969, Rev. 4-2003).

### 3. RECOMMENDED PRACTICES BASED ON GOOD AGRICULTURAL PRACTICES (GAP)

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#### 3.1 Pre-harvest

7. To be effective, pre-harvest control of aflatoxin contamination of peanuts must take into consideration all the varied environmental and agronomic factors that influence pod and seed infection by the aflatoxin-producing fungi, and aflatoxin production. These factors can vary considerably from one location to another, and between seasons in the same location. Some environments may be particularly favourable to fungal infection and subsequent aflatoxin contamination of groundnuts, and in these circumstances it would be necessary to consider whether or not the crop should be grown in such areas. However, for most situations it should be possible to devise agricultural practices that should reduce aflatoxin contamination in peanuts.
8. The continued cultivation of peanuts on the same land may lead to a build-up of high populations of *A. flavus*/*A. parasiticus* in the soil, which will increase 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 *Aspergillus* may be very high, and crop rotations may have little influence on the fungal activity. Cropping systems in some regions involve varied cultivation and fertiliser practices that individually or taken together may affect survival or build-up populations of the toxigenic fungi. There is evidence that peanuts grown in different soil types may have significantly different levels of infection by the moulds. Light sandy soils, for example, favour rapid proliferation of the fungi, particularly under dry conditions. Heavier soils have a higher water-holding capacity and, therefore, there is less likelihood of drought stress occurring, which may be partly responsible for the lower than average levels of aflatoxin contamination in peanuts grown on such soils.
9. In areas that are vulnerable to erosion, no-till practices may be required in the interests of soil conservation.
10. Utilize the results of soil tests to determine if there is a need to apply fertilizer and/or soil conditioners to assure adequate soil pH and plant nutrition to avoid plant stress, especially during seed development, which makes peanuts more susceptible to fungal infestation.
11. The choice of peanut variety can be important and therefore before planting, farmers should consult with the appropriate plant breeding authorities or agricultural extension services to ascertain the peanut cultivars that have been adapted to their region, and the availability of varieties that are resistant to

various factors such as insect attack and microbial and fungal attack that can have an impact on the safety and quality of the peanuts produced. A cultivar should be selected that is suitable for a particular growing season and mature at the end of the rainy season so that post-harvest field drying can be done under favourable conditions. It is undesirable that a variety should suffer from drought stress during pod maturation and some compromise may have to be effected between harvesting under dry conditions and avoidance of drought stress by using short-duration cultivars that mature before the rains have ended.

12. Irrigation, if feasible, is recommended to combat heat and drought stress.
13. Irrigation to ensure adequate soil moisture during the last 4-6 weeks of crop growth should minimize pre-harvest aflatoxin contamination of peanuts. This may be achieved by growing a completely irrigated crop or by applying supplementary irrigation to a basically rain-fed crop. If irrigation is used, ensure that it is applied evenly and that all plants in the plot have an adequate supply of water.
14. Water used for irrigation and other purposes (e.g. preparation of pesticide sprays) should be of suitable quality for the intended use.
15. Avoid overcrowding of plants by maintaining the recommended row and intra-plant spacing for the species/varieties grown. Optimum plant populations should be established bearing in mind that too high a population may lead to drought stress where rainfall maybe below the optimum required in a growing season.
16. Excessive weed growth may deplete available soil moisture. Effective weed control by use of registered herbicides, or cultivation is therefore advisable. Care should be taken during cultivation to avoid damage to pegs and pods.
17. Cultivation and crop protection practices that lower the incidence of soil insects, mites, and nematodes should help in reducing aflatoxin contamination. Minimize insect damage and fungal infection in the vicinity of the crop by proper use of registered insecticides, fungicides, and other appropriate practices within an integrated pest management program. Growers should consult with local or national authorities to determine insects and other pests that are commonly found in their region that might attack peanuts causing them to be more susceptible to fungal infections that can lead to aflatoxin production.
18. No fungicide, or combinations of fungicides, or other chemical treatments appear to have been adopted for the practical control of *A. flavus*/*A. parasiticus* 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.

### 3.2 Harvest

19. Trade associations as well as local and national authorities should take the lead in informing growers of the hazards associated with aflatoxin contamination of peanuts and how they may practice safe harvesting procedures to reduce the risk of contamination by fungi, microbes, and pests. Personnel who will be involved in harvesting peanuts should be well-trained in the personal hygienic and sanitary practices that must be implemented throughout the harvesting season.
20. Make sure that all equipment, which is to be used for harvesting and storage of crops, is functional. A breakdown during this critical period may cause peanut quality losses and enhance aflatoxin formation. Keep important spare parts available on the farm to minimize time loss from repairs.
21. Plan to harvest the peanuts at full maturity, unless allowing the crop to continue to full maturity would subject it to extreme heat, rainfall, and drought conditions. It is very important to harvest the crop at optimum maturity, as excessive numbers of over-mature or very immature pods at harvest can be reflected in high levels of aflatoxin in the product also delayed harvest of peanuts already infected may cause significant increase in aflatoxin content of the crop. A system by which the growing conditions of the farming crop is monitored (soil temperature and precipitation) may be very useful.
22. Individual plants that die from attack by pests, pathogens, such as *Sclerotium rolfsii* or *Fusarium* spp., and diseases, e.g. rosette virus, or insects, such as termites, earwigs, and false wireworms that cause damage to the pods, should be harvested separately as their produce is likely to contain aflatoxin.
23. If peanuts have been irrigated, care should be taken to separately harvest peanuts that are beyond the reach of irrigation systems to avoid mixing aflatoxin-free peanuts with those that are potentially contaminated.
24. Damage to pods at the time of harvest should be avoided as much as possible since this can lead to rapid invasion of the pods by *A. flavus*/*A. parasiticus*. Peanuts should be handled as gently as possible and every effort made to minimize physical damage at all stages of harvesting and transportation procedures.
25. After harvest, pods should be exposed for maximum rate of drying. This may be accomplished by turning the vines to leave the pods uppermost where they are

away from the ground and exposed to sun and wind. Curing should be completed as soon as possible to a safe water activity so as to prevent the growth of microorganisms, particularly moulds that produce aflatoxins. However, drying too rapidly may cause skin slippage and off-flavours in the peanut kernels. When curing by supplemental heat, excessive heat should be avoided since this impairs the general quality of the peanuts, e.g. splitting of kernels after shelling. Close checks of moisture content/water activity of lots of farmer's stock peanuts should be maintained.

26. Peanuts should be dried in such a manner that damage to the peanuts is minimized and moisture levels are lower than those required to support mould growth during storage (generally less than 10%). This is necessary to prevent further growth of a number of fungal species in peanuts.
27. Freshly harvested peanuts should be cleaned and sorted to remove damaged nuts and other foreign matter. Cleaning procedures such as density separators or air legs to remove light pods and slotted screens to remove pre-shelled kernels, may remove some infected nuts.

### 3.3 Transport

28. The nuts should be moved to a suitable storage, or to the processing area for immediate processing as soon as possible after harvesting or drying.
29. Containers (e.g. wagons, trucks) to be used for collecting and transporting the harvested peanuts from the farm to drying facilities, or to storage facilities after drying, should be clean, dry, and free of insects and visible fungal growth before use and re-use.
30. Transport containers should be dry and free of visible fungal growth, insects, and any contaminated material. As necessary, transport containers should be cleaned and disinfected before use and re-use and be suitable for the intended cargo. The use of registered fumigants or insecticides may be useful. At unloading, the transport container should be emptied of all cargo and cleaned as appropriate.
31. Consignments of peanuts should be protected from all additional moisture by using covered or airtight containers or tarpaulins. Avoid temperature fluctuations that may cause condensation to form on the peanuts, which could lead to local moisture build-up and consequent fungal growth and aflatoxin formation.
32. Farmers' stock peanuts should be screened for aflatoxin contamination to more accurately segregate for proper storage. Aflatoxin-free loads should be

segregated from loads with low levels of aflatoxin contamination, destined for subsequent processing and clean-up, and from loads that are highly contaminated.

33. Avoid insect, bird, and rodent infestation during transportation by the use of insect and rodent proof containers or insect and rodent repellent chemical treatments provided they are approved for the intended use of the peanuts.

### **3.4 Segregation of aflatoxin contaminated lots**

34. The distribution of aflatoxin in peanuts has been thoroughly investigated. The results from the investigations indicate that sorting for quality removes a large part of the aflatoxin present at harvest. The distribution of aflatoxins is very heterogeneous in a lot of peanuts and consequently the sampling plan used is critical.

### **3.5 Storage**

35. Post-harvest storage of peanuts is the phase that can contribute most to the aflatoxin problem in peanuts. The primary goal for aflatoxin prevention in storage is to prevent mould development of the peanuts due to condensation or leaks in the warehouse.
36. A properly ventilated warehouse with a good roof, preferably double sidewalls and a concrete floor are required to prevent rewetting of peanuts. Make sure that the storage facilities include dry, well-vented structures that provide protection from rain, drainage of ground water, protection from the entry of insects, rodents, and birds, and minimum temperature fluctuations. Painting warehouse roofs with white paint reduces solar heat load when compared to conventional galvanized material. 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.
37. Water activity, which varies with moisture content and temperature, should be carefully controlled during storage.
38. Uniform loading of the warehouse allows excessive heat and moisture to escape and reduces favourable areas for insect infestation. Stock piling of peanuts can cause heat build-up and moisture accumulation with resultant mould growth and aflatoxin contamination.
39. Prevention of aflatoxin increase during storage and transportation depends on keeping a low moisture content, the temperature in the environment, and the

hygienic conditions. *A. flavus/A. parasiticus* cannot grow or produce aflatoxins at water activities less than 0.7; relative humidity should be kept below 70% and temperatures between 0 and 10 °C are optimal for minimizing deterioration and fungal growth during long time storage.

40. The aflatoxin level in peanuts coming into a storage and peanuts going out of a storage should be monitored, using appropriate sampling and testing programs.
41. For bagged peanuts, ensure that bags are clean, dry, and stacked on pallets or incorporate a water impermeable layer between bags and the floor.
42. Store at the lowest temperature possible consistent with ambient conditions but avoid temperatures near freezing point. Where possible aerate the peanuts by circulation of air through the storage area to maintain proper and uniform temperature levels throughout the storage area.
43. Measure the temperature of the stored peanuts at several fixed intervals during storage. A temperature rise may indicate microbial growth and/or insect infestation. Visually check peanuts for evidence of mould growth. Separate the apparently infected portions of the peanuts and send samples for analysis if possible. When separated, lower the temperature in the remaining peanuts and aerate. Avoid using infected peanuts for food or feed production.
44. Use good 'housekeeping' procedures to minimize levels of insects and fungi in storage facilities. This may include the use of suitable traps, registered insecticides or fungicides and fumigants. Care should be taken to select only those chemicals that will not affect or cause harm to the peanuts.
45. Document the harvesting and storage procedures implemented each season by making notes of measurements (e.g. temperature, moisture, and humidity) and any deviation or changes from traditional practices. This information may be very useful for explaining the causes of fungal growth and aflatoxin formation during a particular crop year and help to avoid similar mistakes in the future.

#### 4. GOOD MANUFACTURING PRACTICE (GMP)

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##### 4.1 Receiving and shelling

46. A buyer for a shelling plant, whether located at the plant or at an outlying buying point, should monitor the quality of peanuts offered to him and assist suppliers in eliminating improper practices. Buyers should encourage suppliers of farmer's stock peanuts to follow good production practices as described herein.

47. 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 which 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 peanut grade observation before an acceptance decision is made.
48. Specifications for the purchase of peanuts intended for further processing should include a maximum level for aflatoxin based in appropriate methods of analysis and a proper sampling plan.
49. Special precautions must be taken to reject peanuts showing signs of insect damage or mould growth because of the danger of their containing aflatoxins. 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.
50. The peanut processor must satisfy himself that the supplier of shelled peanuts is able to control properly his own operations to assure that the finished product is within the maximum limit for aflatoxin.
51. Examine all loose-shelled, damaged "Blows" and under-sized kernels for possible presence of mould. If no external mould is visible, split the kernels to disclose possible hidden mould growth. Excessive mould or presence of mould resembling *A. flavus* warrants a chemical test for aflatoxin or rejection of the lot.

## 4.2 Sorting

52. Sorting is the final step for removing defective kernels. Sorting belts should be well lighted, with peanuts passing through no more than one layer deep, and operated at a speed which enable hand sorters to assure effective removal of foreign material and defective kernels. Sorting machines should be adjusted as often as practicable against standards to assure removal of all defective kernels. Adjustment should be checked frequently and regularly.

53. To remove mould-contaminated nuts effectively, sorting should be performed before and after blanching and roasting. Where splitting is part of the processing



operation, nuts that resist splitting should be removed. The effectiveness of sorting techniques should be checked by regular aflatoxin analyses of the sorted peanuts stream or of the finished product, or both. This should be done frequently enough to ensure that the product is completely acceptable.

54. Defective (mouldy, discoloured, rancid, decayed, shrivelled, insect or otherwise damaged) kernels should be bagged separately and tagged as unsuitable for human consumption. Containers of defective peanuts should be removed as soon as practicable from the processing area. Materials which carry the danger of contamination by aflatoxin, or which are contaminated should be diverted to non-food uses.
55. Rejected peanuts from the sorting procedure should be destroyed or segregated from edible products. If they are to be used for crushing, they should be separately bagged and tagged as unsuitable for direct human consumption in their present state.

#### 4.3 Blanching

56. Blanching used in conjunction with gravity tables and manual or electronic sorting is very efficient in removing aflatoxin-contaminated kernels. Colour sorting, combined with blanching have been shown to reduce aflatoxin contamination by as much as 90%.

#### 4.4 Packaging and storage of end product

57. Peanuts should be packed in clear jute bags, cartons or polypropylene bags. If using jute, ensure bags are not treated with mineral hydrocarbon based oils. All bags/cartons should be lot identified to facilitate traceability of the product before being moved to controlled storage facilities or transported.
58. Peanuts that have been processed should be stored and transported under such conditions as will 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 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 from a refrigerated vehicle. In warm, humid weather, the groundnuts should be allowed to reach ambient temperature before exposure to external conditions. This tempering may require 1-2 days. Peanuts that have been spilled are vulnerable to contamination and should not be used for edible products.

## 5. A COMPLEMENTARY MANAGEMENT SYSTEM TO CONSIDER IN THE FUTURE

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59. 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 have been described in several documents.
60. When properly implemented, this system should result in a reduction of the levels of aflatoxins in peanuts. The use of HACCP as a food safety management system has many benefits over the types of management control systems in some segments of the food industry. At farm level there are many factors that influence the aflatoxin contamination of peanuts most of which are environmentally related, such as weather and insects, and these are difficult, if not impossible, to control. Particular attention should be paid to the soil population of the fungus, the health of seed material, soil moisture deficit stress at the pod formation and pod maturity stages, and rains at harvest. The critical control points often do not exist at the pre-harvest level. However, after harvesting, the critical control points may be identified for aflatoxins produced by fungi during drying and storage. For example a critical control point could be at the end of the drying process and one critical limit would be the water content/water activity.
61. It is recommended that resources be directed to emphasizing the Good Agricultural Practices (GAPs) at the pre-harvest level and during drying and storage and Good Manufacturing Practices (GMPs) during the processing and distribution of various products. A HACCP system should be built on sound GAPs and GMPs.
62. Integrated mycotoxin control programs should incorporate HACCP principles in the control of risks associated with mycotoxin contamination of foods and feeds. The implementation of HACCP principles will minimize aflatoxin contamination of peanuts through applications of preventive controls to the extent feasible in the production, handling storage and processing of each peanut crop.