INTERNATIONAL COFFEE ORGANIZATION
ORGANIZACIÓN INTERNACIONAL DEL CAFÉ
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Code of Practice

Prevention and reduction of ochratoxin A contamination in coffee

The Executive Director presents his compliments and, for the information of Members, attaches a copy of the Code of Practice for the prevention and reduction of ochratoxin A contamination in coffee adopted by the Codex Alimentarius Commission at its 32nd Session from 29 June to 4 July 2009.

CODE OF PRACTICE FOR THE PREVENTION AND REDUCTION OF OCHRATOXIN A CONTAMINATION IN COFFEE

(CAC/RCP 69-2009)

1. INTRODUCTION

1. Ochratoxin A (OTA) is a toxic fungal metabolite classified by the International Agency for Research on Cancer as a possible human carcinogen (group 2B). JECFA established a PTWI of 100ng/kg bodyweight for OTA. In recognition of this global concern, FAO developed the Guidelines for the Prevention of Mould Formation in Coffee (2006) as a strategy to enable coffee producing countries to develop and implement their own national programmes for the prevention and reduction of OTA contamination. OTA is produced by a few species in the genera *Aspergillus* and *Penicillium*. In coffee, only *Aspergillus* species, specifically *A. ochraceus* and related species *(A. westerdijkiae and A. steynii), A. niger* and related species, and *A. carbonarius* are involved. OTA is produced when conditions of water activity, nutrition and temperature required for growth and biosynthesis are present.

2. The main commercial coffee varieties produced and traded are *Coffea arabica* (arabica coffee) and *Coffea canephora* (robusta coffee).

3. After harvest, the crop is sorted, dried (as cherries or as beans), stored and traded. The moisture content of the beans is reduced to a maximum of 12.5% to prevent OTA production.

2. DEFINITIONS (based on ISO 3509)

Parts of the coffee fruit, undried (Figure 1)

Coffee Cherry: Fresh, complete fruit of the coffee tree.

Bean, fresh bean: endosperm (seed) of the coffee fruit. There are generally two beans per fruit.

Endocarp: Scientific term for 'parchment'. The tough integument tightly pressed to the seed when fresh but from which the seed shrinks during drying.

Endosperm: Scientific term designating the tissues that feed the embryo during germination, the bean consists of the endosperm and embryo, i.e., the material inside the developing fruit which ultimately forms the coffee beans. The endosperm fills the integument as the coffee cherry ripens.

Epicarp or Exocarp: Scientific word designating the skin of the fruit, a mono cellular layer covered with a waxy substance ensuring protection of the fruit.

Floating (or floats) coffee: Cherry coffee of low density, buoyant in water.

Mesocarp: Intermediate layer of tissues between the epicarp and the endocarp (parchment). It consists mainly of pectinaceous mucilage and pulp.

Mucilage: Common word to describe the slimy layer found between the pulp and adhering to the parchment inside a coffee cherry, but not removed by pulping. Not present in unripe and overripe coffee.

Naked beans or endosperm: Parchment coffee that has been partly or entirely peeled of its parch during pulping and/or washing.

Pulp: part of the coffee cherry composed of the external exocarp and most of the internal mesocarp (mucilaginous tissue).

Parts of the coffee fruit (dried)

Bean in parchment: coffee bean entirely or partially enclosed in its parchment (endocarp, pergamino).

Coffee bean: commercial term designating the dried seed of the coffee plant.

Defects: The general term for common undesirable particles, which can include various types of beans, parts of beans, fruit tissue and foreign matter, found in green and roasted coffee beans. Diverse and specific terms, according to the producing country, are used to describe the defects. The fruit defects are generally caused by faulty processing, pest damage, or adverse climatic conditions. Defects receive specific weight values to assist in the classification and grading of coffee lots under various national and international systems.

Natural coffee, dried coffee cherry, coco: dried fruit of the coffee tree, comprising its external envelops and one or more beans.

Green coffee bean: The dried seed of the coffee plant, separated from non-food tissues of the fruit.

Hull, dried parchment: dried endocarp of the coffee fruit

Husk, dried cherry pulp: assembled external envelopes (pericarp) of the dried coffee fruit.

Parchment (or Parch) or endocarp: The coffee fruit endocarp located between the fleshy part (pulp) and the silver skin. It is a thin, crumbly paper-like covering left on wet-processed beans after pulping and fermentation, removed during hulling.

Silverskin, dried testa, dried seed perisperm: coat of the coffee bean. It has generally a silvery or coppery appearance.

Washed and cleaned coffee: dry processed green coffee from which the silverskin has been removed by mechanical means in the presence of water.

Processes

Splitting of cherry: A variation of dry processing wherein the cherry is mechanically split open and the fruit and seeds maintained together in a mass.

Gleaning (or Sweeping): Coffee fruit found lying on the ground beneath coffee bushes, detached during harvest or abscised during development.

Selection: technological operation intended to eliminate foreign matter (e.g. stones, twigs, leaves) and to sort coffee cherries according to size, density and degree of maturity.

Dry process: treatment of coffee cherries consisting in drying them, either under sunlight or in drying machines, to give husk coffee. This is usually followed by mechanical removal of the dried pericarp (husk) to produce “natural” green coffee.

Dehusking: mechanical removal of the husks (pericarp) from dry coffee cherries.

Wet process: treatment of coffee cherries consisting of the mechanical removal of the exocarp (pulp) in the presence of water, alternatively followed by

- either removal of the mucilage (mesocarp) by fermentation or other methods, followed by washing to give parchment coffee, or
- direct drying of the pulped beans within their mucilaginous parchment, followed by hulling to produce “semi-washed” green coffee. Removal of the mucilage is usually followed by drying and hulling to produce “washed” green coffee.

Pulping: technological operation used in the wet process to remove the pulp (exocarp) and as much as possible of the mucilage (mesocarp) by mechanical means. A portion of the mucilaginous mesocarp usually remains adhering to the parchment (endocarp).

Fermentation process: treatment intended to digest the mucilaginous mesocarp adhering to the parchment of the pulped coffee, allowing its elimination by washing. The fermentation process can be replaced by a mechanical demucilaging system to remove the mucilage by friction.

Washing: technological operation intended to remove by water all traces of the mucilaginous mesocarp from the surface of the parchment.

Drying of parchment coffee: technological operation to reduce the moisture content of parchment coffee to a level that allows hulling under satisfactory technical conditions and that will not be detrimental to further storage of the coffee.

Hulling: removal of the dried endocarp of parchment coffee to produce green coffee.

Polishing: technological operation to remove the residual silverskin (perisperm) from green coffee by purely mechanical means.

Sorting: technological operation intended to remove foreign matter, fragments of coffee and defective beans from green coffee.

Roasting: heat treatment that produces fundamental chemical and physical changes in the structure and composition of green coffee, bringing about darkening of the beans and the development of the characteristic flavour of roasted coffee.

3. PROCESSING OF COFFEE CHERRIES

4. Coffee cherries are processed under two basic systems (Figures 2 and 3): a) the dry processing system which produces what is called natural coffee or dried coffee cherry (the seed is enclosed in the whole fruit) and b) the wet processing system, that generates what is called parchment coffee, where the seed is enclosed in the inner integument or endocarp.

5. In the dry processing of natural coffee, the whole fruit is either directly sun dried, on bare soil, bricks, tiles, concrete or even asphalt, or dried using a combination of sun and mechanical drying (particularly on more technologically advanced farms).

6. In wet processing, the fruit parts are mechanically separated, giving the pulp as by-product and the parchment as the main product. The latter is coated with mucilage, which can be degraded by fermentation and then washed or mechanically removed directly, without fermentation. After removing or not removing the mucilage, the parchment is usually sun dried, in a drying yard, or on suspended tables with many variations and technological innovations. Sun and mechanical drying can be combined and used together.

7. After processing, the dried coffee can be stored, separated from the fruit tissues by hulling and passed through sizing (grading), sorting, polishing, cleaning and bagging, before being sold.

8. Coffee roasting can remove a very significant percentage of OTA. Depending on the roasting process, 65 to 100% reduction of OTA can be achieved.

9. While this code of practices is focused on the reduction of OTA contamination, which is the primary food safety issue in the production of green coffee bean, industry food safety programmes must also effectively manage other potential hazards associated with the production, processing and handling of coffee.

4. RECOMMENDED PRACTICES

4.1 Pre-harvest

10. It is not certain whether OTA-producing fungi can infect coffee fruits and grow to produce OTA still on the plant. It is possible that infection on the plant may involve two different contamination routes: either through the flowers without visible sign, or by insect invasion such as the coffee berry borer (CBB) (*Hypothenemus hampei*), that can carry spores to the fruit by making holes in the cherries and one or more tunnels in the beans leaving visible signs.

11. Recommended practices to reduce the development and spore load from OTA-producing fungi on coffee plants and beans are:

a) Keep coffee plants vigorous, through the regular use of good agricultural practices (GAP) at the proper time, such as weeding, improving soil texture, pruning, fertilization, pest and disease control, and irrigation.

b) Do not use overhead irrigation during the flowering period. This could augment normal spore dispersal rates and increase the chance of infection of beans by OTA producers.

c) Use traps (such as alcohol traps) for *Hypothenemus hampei* control before harvesting, and encourage the use of the integrated pest management (IPM) programme.

d) Avoid disposal of uncomposted organic wastes, from coffee or any other source, in or around the plantation. Coffee seeds and seed-associated material, such as dust, earth, parchment and other seed processing residues, can allow proliferation of OTA producing fungi.

4.2 Harvesting

12. The harvesting method chosen on any farm is a conjunction of the requirements of the processing method, economic considerations and labour availability.

13. Four basic harvesting systems are known: (i) single-pass stripping, where all branches bearing fruit are harvested at once; (ii) multi-pass stripping, where only branches bearing mainly ripe cherries are harvested; (iii) multi-pass selective picking (finger picking), where only ripe cherries are harvested and (iv) mechanical harvesting, where different types of machines are used to harvest fruit all at once.

14. Besides these basic main harvest systems, additional procedures can be used, such as a 'fly harvest' to collect prematurely ripe fruit or the collection (gleaning or sweeping) of cherries that fall on the ground or are left on the plants during harvest. In general, berries that fall onto the ground should not be collected, particularly in humid conditions, as fungal growth may occur, which can give rise to OTA contamination. However, brief contact with the ground is not problematic but can become so if the contact period lengthens. In wet or humid climates, only collection from the ground on the same day should be considered acceptable. If it is necessary to harvest beans that have fallen onto the ground, these should be stored separately until they are processed, to avoid the risk of contaminating the rest of the crop. Care should be taken to ensure that any fallen berries that are collected are rapidly subjected to the processing and drying stages, as these commodities may have a higher likelihood of fungal growth.

15. The harvest should be started as soon as there are sufficient ripe cherries for it to be economically viable. When the right time to commence harvest is decided, the following should first be carried out:

a.) Remove weeds, fallen cherries and brush from the proximity of the trees before harvest.

b.) Where possible, place mats, canvas or tarpaulins beneath the trees to prevent contamination by old fallen cherries.

c) Ensure that there are adequate arrangements for the subsequent storage and processing of the crop, so that conditions favour mould growth or other damage are avoided.

16. Coffee cherries should be processed as soon as possible after harvesting. The harvesting rate, processing performance and labour availability must follow the pace of the drying rate.

17. Coffee ready to be processed should be uniform and not of mixed categories i.e. wet with dry coffee in dry processing or pulpable with not pulpable in wet processing. Prior to processing low quality cherries (e.g. unripe or overripe fruit, or fruit that has coffee berry disease) should be removed. This can be done either by visual sorting, or via water separation. It should be ensured that any material that is out sorted is disposed of in an appropriate manner.

4.3 Post-harvest

18. Senescence and changes follow once coffee fruit is detached from the plant. The post harvest period is characterized by initial, transitional and final phases.

19. The initial or high moisture phase starts with harvest. The product is then in an unstable state, and spoilage can be controlled through competitor microrganisms, restricting oxygen and reducing the time which is critical in this state. In wet processing the high moisture phase may be extended and controlled through fermentation, but it is desirable to reduce this time.

20. The transitional phase is the least stable and most difficult to predict, when spoilage can only be controlled by time limitation. Mesophilic and xerophilic spoilage microrganisms have enough water to grow but not their hydrophilic competitors. Turning or stirring of the coffee is essential to promote uniform drying. When harvest coincides with a rainy or high humidity season, measures to optimize drying must be adopted.

21. The final or low moisture phase starts at the end of drying and continues until roasting. The product is in a stable condition and control is necessary to prevent water re-introduction or redistribution in the bulk coffee. At some point during drying, there is no further growth as the product reaches the low moisture phase.

4.4 Dry processing

22. In the dry processing system (Figure 2) the whole harvested fruit is dried. Although it is a simpler process compared to wet processing, a good quality finished product can only be obtained through the application of good practices and proper management.

23. One option used in regions where the harvest time normally occurs under arid weather conditions is to allow the fruit to dry on the plant. This method results in a lower level of immature fruit, which is safe, of good quality and is cheaper than the traditional harvest, as it allows one-pass stripping.

24. Wherever possible, freshly picked cherries should be dried on the same day that they are harvested. In some instances, the harvested fruit is retained in bags or heaps for up to a week. This practice leads to high temperatures and quick fermentation, different in nature from the fermentation process employed in wet processing, causing quality losses and increasing the risk of OTA in the product.

25. Prior to drying, the harvested fruit should be sorted to remove immature and over mature cherries, and cherries damaged to CBD (coffee berry disease). Sorting may be done either visually, or in combination with water floatation.

4.5 Wet processing

26. Wet or washed processing (Figure 3) requires a raw material composed of only ripe cherries that have been selectively picked or are mechanically separated in the process itself. Green immature cherries and dried fruits are removed in a water separator. The mucilage is removed, either by fermentation, mechanically or using chemicals.

27. In the fermentation process, the mucilage is broken down by fermenting the beans in water at ambient temperature (using microrganisms) for between 12 and 36 hours. The fermentation process must be carefully monitored to ensure that the coffee does not acquire undesirable (sour) flavours. After fermentation is complete, the coffee beans are washed in clean water tanks or in special washing machines.

28. After passing through the washer separators and before removal of the pulp, the separation of the green immature cherries from the ripe ones can be performed, using differences in pressure, in a green cherry separator. The soft, ripe cherries pass through the holes of the screen. The hard, unripe cherries, which cannot pass through the holes, go to the edge of the cylinder where a counter weight controls their outflow.

29. Factors that need to be controlled are as follow:

a) Any equipment should receive regular maintenance, to reduce the possibility of failures which could delay processing and compromise coffee quality and safety.

a.1) Before the beginning of the crop season: clean, reassemble and lubricate the processing equipment; inspect the installation and check it is operational, so that there is enough time for repairs if any problem occurs.

a.2) At the end of the crop season: clean, repair, lubricate, dust all equipment and protect from water. Check pulping surfaces for wear.

b) Provide proper orientation/training to the workers and define their responsibilities. In addition define quality and acceptability criteria, the monitoring procedures and frequencies, and the corrective measures for each key element of the process, regarding:

b.1) Cherries – maximum acceptable proportion of immature and over-mature/tree-dried cherries.

b.2) Pulping - acceptable proportion of un-pulped cherries and nipped beans; cost-benefit to increase size uniformity of the cherries and effectiveness of skin removal. The efficiency of the operation can be improved based on the various estimates of the monitoring the quality and safety of the product.

c) Water quality – clean water[1] should be used for processing, as dirty water could lead to conditions favourable to OTA production.

[1] As defined in the General Principles of Food Hygiene (CAC/RCP 1-1985)

d) Fermentation should be as short as possible (12 to 36 hours), to get the mucilage degraded and the beans washable. Monitoring procedures and frequencies should be established as well as the type and level of inoculum (in the in-coming cherry) and ambient temperature.

e) Fruit-flies should be monitored, as high populations can affect fermentation.

f) Secondary cherry coffee, which can be defined as products separated by sorting or other procedures and are returned to the processing, should have a specific control program; i.e. good drying practices should be applied, such as maintenance of separate facilities for drying.

g) Washing protocols should be defined and implemented (e.g. by measuring the quantity of broken, nipped and naked beans, and non coffee objects, and the quantity of water used).

4.6 Drying of sorted and processed coffee beans

30. The main purpose of the drying operation is to efficiently decrease the high water content of the just harvested cherries to a safe level in order to get a stable, safe and good quality product.

31. In this section both dry and wet processes will be discussed. Most of the coffee produced is dried using direct sun.

32. In the sun drying process, the product is spread on surfaces such as cement or brick terraces, tarpaulin, plastic canvas, bamboo and sisal mats, raised tables covered in wire mesh or fish farm netting.

33. The drying process can be divided into three stages. In each stage OTA producing fungi will have varying opportunities for growth.

34. At the first stage, there is a slight decrease in moisture content that takes a time interval between 1 to 3 days for cherry coffee and 1 day or less for parchment coffee. The high moisture content ($a_w > 0.95$) provides unsuitable conditions for OTA producing fungi to grow.

35. The second stage is the one of maximum loss in moisture content for both cherry and parchment coffee, under similar conditions at the same period of time. This is mainly dependant on drying conditions and drying yard technology. During this stage, there are favourable conditions for OTA producing fungi to grow and therefore it is necessary to implement precautionary measures as recommended in paragraph 38.

36. At the third stage both cherry and parchment coffee, is much drier compared to the previous two stages. There is a slower slight decrease in the remaining moisture content. Conditions at this stage do not favour the growth of OTA producing fungi.

37. The OTA-producing fungi require favourable conditions during a certain period of time to grow and produce the toxin. The level of available water is the most important factor to be considered. At high water activity ($a_w > 0.95$) OTA-producing fungi will not likely grow, as fast-growing hydrophilic fungi and yeasts grow first. At lower water activity ($a_w < 0.80$) the OTA-producing fungi can be present but not produce the toxin, and at a_w below 0.78-0.76 they cannot grow. Therefore the most important point is to control the period of time in which coffee remains in the drying yard, in the range of water activity where OTA-producing fungi can grow (a_w 0.8 – 0.95). According to experimental results, 5 days or less in the drying yard is enough and effective to prevent OTA accumulation. In general, a maximum a_w of 0.67 to 0.70 and moisture content < 12.5% (wet basis) is sufficient for protecting parchment coffee from damage by fungi.

38. Recommended measures to dry the coffee beans efficiently are:

a) The drying yard should be located away from contaminant sources such as dusty areas and should receive maximum sun exposure and air circulation, during most of the day, to speed up the drying of the beans. Shady and low areas should be avoided.

b) The surface for the drying yard should be chosen according to the climate of the region, cost and quality of the dried product, as any type of surface has advantages and disadvantages. Bare soil is not appropriate for rainy areas. Plastic canvas gets humid under the coffee layer, promoting fungal growth. In rainy or wet regions coffee must be covered and re-spread, once the surface has dried. If parchment coffee is to be dried, ensure that the drying surface is cleanable, in order to avoid picking up taints.

c) The pace and total time of the harvest should be based on the available area of the drying yard and the average time necessary for drying, considering both good and bad weather.

d) The following practical measures should be incorporated into the drying process:

d.1) Dry coffee only in thin layers, 3 to 5 cm in depth which is equivalent to 25 to 35 kg/m^2 of fresh parchment or cherry coffee. In some cases (e.g. low air humidity, good air circulation and sun intensity, or in usually dry regions), thicker layers can be used.

d.2) Turn over the coffee layer constantly during the day time to allow faster drying, to reduce the risk of fungi growing and help to produce a better quality product.

d.3) Allow for the appropriate ventilation of the wet coffee during the night in order to avoid condensation. After one day of drying for parchment and three days for cherry coffee, the coffee can be heaped and covered at night or during rainy weather, to avoid re-wetting.

d.4) Do not mix different types of coffee nor coffee from different days of harvest. Use a specific identification for each one of them to identify each type of coffee and day of harvest.

d.5) Protect the drying yard area from animals, which can be a source of biological contamination for the drying coffee.

d.6) Regularly control CBB and other pest populations, using integrated pest management in drying yard.

d.7) Monitor the drying process regularly (<12.5% for both parchment and cherry coffee). Start taking samples from different points of each lot, two or three days before it is expected to be fully dry and continue re-evaluating it daily until it reaches the desired moisture content. Instrumental measurements should be adopted at field level. Moisture content measures should be calibrated to ISO 6673 method.

d.8) Avoid rewetting the beans because it favours rapid fungal growth and the possibility of OTA production.

e) Provide a clear and practical training for drying yard workers, including adequate use of moisture measuring equipment.

f) Repair, clean, protect and keep equipments in a clean storage area until the next season. Moisture measuring equipment should be regularly cross checked and calibrated once a year before harvest against the ISO 6673 method.

39. Mechanical driers are generally used as complementary after sun-drying, but in some regions it plays a major role in the drying process. Mechanical driers usually need to have control of two items: inlet temperature and duration of drying time. The most common problem with mechanical drying is over drying, causing weight loss and consequently income loss. The other problem is black beans from immature beans submitted to excessive inlet temperature, decreasing the quality of the product.

4.7 Storage, transportation and trading

40. Properly identified lots of dried cherries or the dried parchment coffee should be stored, at the farm level or in out-of-farm warehouses, in bulk or in clean bags under appropriate storage conditions.

41. In different producing countries handling coffee in local trading varies in relation to the proper structure of the chain and the way the operations are performed. These functions include: post-cleaning, sorting, grading into size classes, re-bagging, sometimes re-drying, storage and transport. These operations add value to the traded product, before it is sold and sent for roasting.

42. During the entire process, the coffee must also be protected from re-wetting, degradation and cross-contamination. In long term storage conditions, humidity should be kept under strict control. Under a relative humidity below 60% coffee will continue to dry but if the relative humidity is above 80% the coffee will start to absorb water. Moisture in the storage place can originate from damp floors and walls, rain (wind-driven or through leaks), dead air, and the mixing of dry with wet coffee. Appropriate storage facilities, the use of good storage practice and regular monitoring can prevent or reduce problems.

43. In lower grade coffee, it has been observed that fruits with black and sour defects contained the highest levels of OTA. Tolerance for such defects in sorted green beans should be low and the out-sorted defective beans should not be re-blended into clean coffee or sold directly to roasters unless representative sampling plan and direct OTA analysis has shown them to be acceptable.

44. From the production areas coffee may be transported by different means of transportation to the trading points. The main aspect of concern here is to avoid rewetting of coffee, due to possible climatic changes between different regions, and taking the necessary control measures.

45. In the production chain, the local market is the most sensitive part from where improvements in practice can be administered. Here the authorities, through regulatory and non-regulatory mechanisms can enforce and influence practices in order to guarantee that producers reliably operate in a way as to assure the product safety.

46. Stakeholders should adopt procedures to protect coffee in each part of the chain, refuse suspect coffee and avoid practices that could generate or increase a problem. Dried coffee must be protected from re-wetting through contact with water, mixture with wet lots, absorption from wet air or surfaces or redistribution of water within the lot. Defects associated with high levels of OTA should be reduced to acceptable levels. Protection from contamination by other materials is also necessary.

a.) Minimum hygiene requirements and a rapid assessment method (including a sampling method with representative sub-sample of the in-coming lot for moisture content determination, defect levels, general physical quality assessment and visual or smell signs of mouldiness) should be established.

b) The warehouse design and structure should be adequate to maintain dryness and uniformity of the stored coffee.

b.1) The desirable characteristics are: cement floor with a damp proof course; not subject to flooding; water pipelines properly located to avoid wetting coffee in case of plumbing problems; water proof windows and roof and a high ceiling to allow good air circulation.

b.2) Do not expose stored coffee to direct sunlight nor store it near heating sources, to avoid the possibility of temperature differentials and water migration.

c) The operation of a storage facility must be optimised to prevent cross contamination, the reintroduction of moisture and to allow the best execution of receiving, sale and value-added operations that will preserve the coffee quality until it is sold to the next stakeholder in the production chain. The main recommendations are:

c.1) Record initial condition and age of the received stocks.

c.2) Arrange the coffee bags on pallets and away from walls, to allow good air circulation.

c.3) Implement cleaning and maintenance programmes in order to ensure that storage facilities are periodically inspected, cleaned and renewed.

c.4) Check coffee weevil in the warehouse, using integrated pest management.

c.5) Farms and other operations should separate coffee types. This requires planning of the storage area and adoption of a labelling system. Non-food materials should not be stored with coffee to prevent contamination or taints in the product.

d.) Coffee cleaning and sorting should not physically damage the product as this will make it more susceptible to contamination/deterioration nor introduce new contamination and should assure reduction of undesirable materials to acceptable pre-determined levels.

d.1) Ensure the facilities and equipment are regularly inspected, maintained and cleaned, through implementation of cleaning and maintenance programmes.

d.2) When storage is combined with cleaning and sorting, attention is required to avoid contamination of post-cured coffee with the curing by-products of dust and foreign matter, (e.g. through the use of partition walls or extractor fans).

d.3) Remove defects from main-crop production, discarding or screening them before their inclusion into the food chain. There is no uniform distribution of defects within the classes of beans separated from bulk coffee and evidence shows that defective beans and husk (also a defect) sometimes contain higher OTA levels than sound beans. Based on further investigations of OTA contamination of defects authorities should provide clear guidance to the stakeholders.

e) Transport of coffee also requires the adoption of practices to avoid re-wetting, to maintain temperature as uniform as possible and to prevent contamination by other materials. The main requirements here are:

e.1) cover coffee loading and unloading areas to protect against rain;

e.2) before receiving a new cargo, the vehicles must be cleaned from residues of the previous cargo;

e.3) the vehicles must have floor, side walls and the ceiling (in closed vehicles) checked for the presence of points where exhaust fumes or water from rain can be channelled into the coffee cargo. Tarpaulins and plastic canvas used to cover the cargo should also be regularly checked to ensure they are clean and without holes. The vehicles should also receive regular maintenance to be kept in good condition;

e.4) reliable transport service-providers that adopt the recommended good transportation practices should be selected by operators.

4.8 Ship transportation

47. Coffee is transported from producing to consuming countries in bags or in bulk, usually in 18 to 22 tonnes capacity containers. Temperature fluctuations, during the transportation time, can cause condensation of the remaining water (present even in well-dried beans) and local re-wetting. The redistribution of water can lead to fungal growth, with the possibility of OTA production. The recommended practices during transportation in the port are:

a) Cover coffee loading and unloading areas to protect against rain.

b) Check coffee lots to ensure that they are uniformly dried and below 12.5% moisture content, free of foreign matter and respecting the established defect levels.

c) Check containers, before loading, to ensure they are clean, dry and without structural damage that could allow water entrance into the container.

d) Bags should be well stacked and crossed over for mutual support in order to avoid the formation of empty vertical columns (chimneys). The top layer and sides of bags should be covered with materials that can absorb condensed water, such as silica gel or cardboard for protection against the growth of fungi that could result in OTA production. For coffee in bulk a sealable plastic liner (e.g. big bag which allows aeration) is desirable and this should be kept away from the roof of the container.

e) Choose an appropriate place, not directly exposed to the weather, aboard the ship to reduce the possibility of undesirable situations mentioned that can lead to OTA contamination.

f) Keep the ventilation holes in the containers free.

g) Avoid unprotected stowage on the deck (top layer) and stow away from boilers and heated tanks or bulkheads.

h) The moisture content level should not exceed 12.5% anywhere, from the point where the coffee leaves the loading area to the point at which the coffee is unloaded, stored and/or subjected to other processing procedures such as roasting.

Figure 1. Coffee Cherry

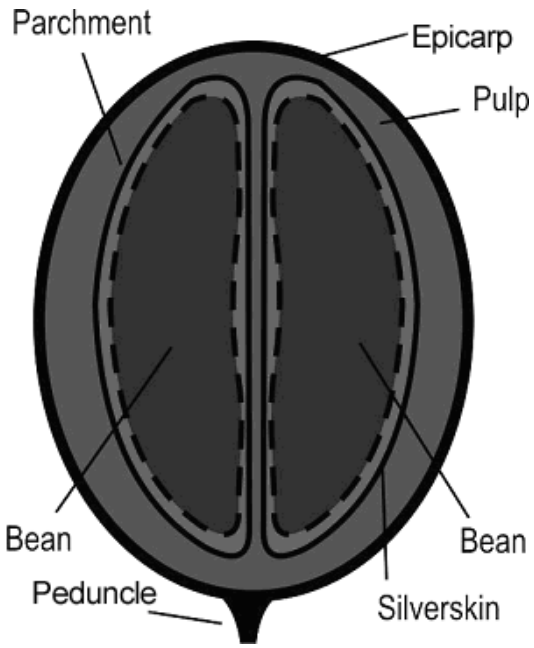

Figure 2. Dry processing flow

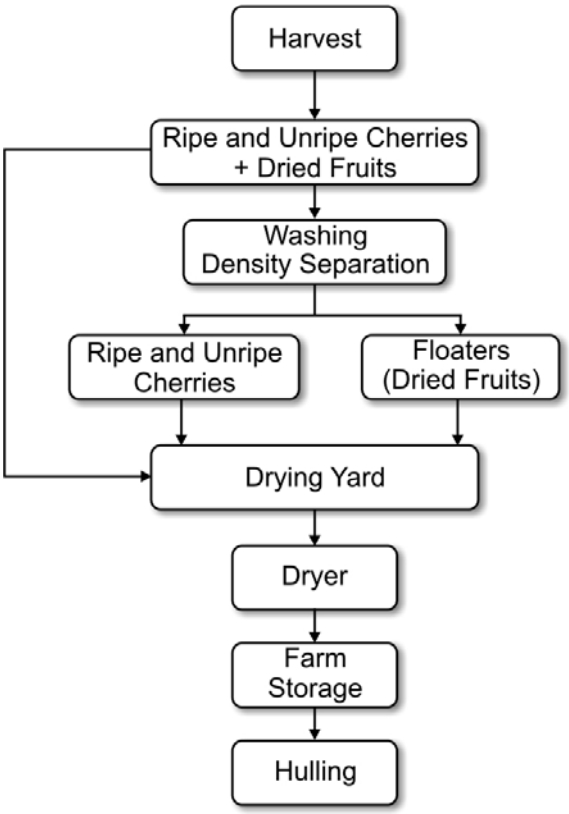

Figure 3. Wet processing flow.