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**Prevention and reduction of mycotoxins  
contamination in coffee — Code of  
practice**

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Requests for permission to reproduce this document should be addressed to:

Rwanda Standards Board

P.O Box 7099 Kigali-Rwanda

KK 15 Rd, 49

Tel. +250 788303492

Toll Free: 3250

E-mail: [info@rsb.gov.rw](mailto:info@rsb.gov.rw)

Website: [www.rsb.gov.rw](http://www.rsb.gov.rw)

ePortal: [www.portal.rsb.gov.rw](http://www.portal.rsb.gov.rw)

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PUBLIC REVIEW

## Foreword

Rwanda Standards are prepared by Technical Committees and approved by Rwanda Standards Board (RSB) Board of Directors in accordance with the procedures of RSB, in compliance with Annex 3 of the WTO/TBT agreement on the preparation, adoption and application of standards.

The main task of technical committees is to prepare national standards. Final Draft Rwanda Standards adopted by Technical committees are ratified by members of RSB Board of Directors for publication and gazettment as Rwanda Standards.

DRS 259 was prepared by Technical Committee RSB/TC 035, *Coffee and derived products*.

This second edition cancels and replaces the first edition (RS 259: 2014), which has been technically revised.

### Committee membership.

The following organizations were represented on the Technical Committee on *Coffee and derived products* (RSB/TC 035) in the preparation of this standard.

Rwanda Standards Board (RSB) – Secretariat

PUBLIC REVIEW

## Introduction

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 100 ng/kg bodyweight for OTA. 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.

Coffee cherries may be processed under two basic systems: 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.

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).

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.

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.

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

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



# Prevention and reduction of mycotoxins contamination in coffee—Code of practice

## 1 Scope

This Draft Rwanda standard provides guidelines for prevention and reduction of mycotoxins in coffee (*Coffea arabica* and *Coffea canephora*) production chain.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

RS CAC/RCP 1, *Code of practice —General principles for food hygiene*

## 3 Terms and definitions

For the purposes of this standard, the following terms and definitions apply.

### 3.1

#### **coffee cherry**

fresh, complete fruit of the coffee tree

### 3.2

#### **floating (or floats) coffee**

cherry coffee of low density, buoyant in water

### 3.3

#### **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

### 3.4

#### **pulp**

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

### 3.5

#### **bean in parchment**

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

### 3.6

#### **defects**

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

### 3.7

#### **green coffee bean**

dried seed of the coffee plant, separated from non-food tissues of the fruit

### 3.8

#### **parchment (or Parch) or endocarp**

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.

### 3.9

#### **gleaning (or Sweeping)**

coffee fruit found lying on the ground beneath coffee bushes, detached during harvest or abscised during development

### 3.10

#### **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

### 3.11

#### **wet process**

treatment of coffee cherries consisting of the mechanical removal of the exocarp (pulp) in the presence of water

**3.12**

**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

**3.13**

**fermentation process**

treatment intended to digest the mucilaginous mesocarp adhering to the parchment of the pulped coffee, allowing its elimination by washing

**3.14**

**washing**

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

**3.15**

**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.

**3.16**

**hulling**

removal of the dried endocarp of parchment coffee to produce green coffee

**3.17**

**polishing**

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

**3.18**

**sorting**

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

### 3.19

#### 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

## 4 Recommended good practices

Mycotoxins are sec metabolites produced by toxigenic moulds, which can infect coffee at any stage of production chain. The most known mycotoxin that contaminates coffee is ochratoxin A (OTA)

### 4.1 Pre-harvest

**4.1.1** 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.

**4.1.2** 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) , encourage the use of the integrated pest management (IPM) programme such as use of traps (such as alcohol traps) for *Hypothenemus hampei* control before harvesting
- d) avoid disposal of uncomposted organic wastes, from coffee or any other source, in or around the plantation.
- e) Avoid disposal of coffee seeds and seed-associated material, such as dust, earth, parchment and other seed processing residues in or around the plantation. that can allow proliferation of OTA producing fungi.

### 4.2 Harvesting

**4.2.1** The harvesting method chosen on any farm shall be applied to avoid fungal contamination. It should be in conjunction with the requirements of the processing method, required quality, economic considerations and labour availability

**4.2.2** Four basic harvesting systems may be adopted:

- a) multi-pass selective picking (finger picking), where only ripe cherries are harvested; and is the most recommended harvesting system in Rwanda

- b) single-pass stripping, where all branches bearing fruit are harvested at once;
- c) multi-pass stripping, where only branches bearing mainly ripe cherries are harvested;
- d) mechanical harvesting, where different types of machines are used to harvest fruit all at once.

**4.2.3** Besides above basic main harvest systems, the following additional procedures may be used:

- a) during 'collection of prematurely ripe cherries during fly harvest'
- b) collection (gleaning or sweeping) of cherries that fall on the ground or are left on the plants during harvest.
- c) Collected cherries from ground should be handled and processed separately from the other cherries
- d) 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.
- e) 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.
- f) 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.

**4.2.4** 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; and
- 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;

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

**4.2.6** Coffee ready to be processed should be uniform and not of mixed categories i.e. wet with dry coffee or pulpable with not pulpable. Prior to processing low quality cherries (e.g. unripe or overripe fruit, or fruit that has coffee berry disease) should be removed.

**4.2.7** Cherries sorting and floating shall be done

**4.2.8** Out sorted cherries shall be processed separately.

### 4.3 Post-harvest

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

**4.3.2** The transportation of cherries from farm to coffee washing station should be done in a manner to avoid contamination. Once cherries reach the coffee washing station, processing should start immediately within 8 hours after harvesting as per good processing practices,

**4.3.3** Water used in processing should be clean

**4.3.4** 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 and the following should be considered:
  - 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; and
  - 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:
  - 1) cherries – maximum acceptable proportion of immature and over-mature/tree-dried cherries.
  - 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) where applicable, fermentation should be as short as possible (between 12 hours and 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; and
- d) fruit-flies should be minimized; as high populations can affect fermentation.
- e) If returned to the processing line, secondary cherry coffee (outsorted cherries) should have a specific control program; i.e. good drying practices should be applied, such as maintenance of separate facilities for drying; and
- f) washing protocols should be documented and implemented

#### 4.4 Drying of sorted and processed coffee beans

##### 4.4.1 Recommended measures to dry the coffee beans

For efficient drying, the following should be considered:

- 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; Mechanical driers may be used as complementary after sun-drying,
- b) To ensure uniform drying, parchment should continuously turn to avoid possible growth of microorganisms. When harvest coincides with a rainy or high humidity season, measures to optimize drying should be adopted.
- c) During drying, moisture content of parchment should be monitored and kept below 12.5%
- d) 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 shall be covered and re-spread, once the surface has dried;
- e) the drying surface should be cleanable, in order to avoid picking up taints;
- f) drying tables should be raised/ risen at 75 cm above the ground to allow uniform air circulation;
- g) 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;
- h) the following practical measures should be incorporated into the drying process:
  - 1) dry coffee only in thin layers, 3 cm - 5 cm in depth which is equivalent to 25 - 35 kg/m<sup>2</sup> of fresh parchment.
  - 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;
  - 3) allow for the appropriate ventilation of the wet coffee during the night in order to avoid condensation. After one day of drying, the coffee can be heaped and covered at night or during rainy weather, to avoid re-wetting;
  - 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;
  - 5) protect the drying yard area from animals, which can be a source of biological contamination for the drying coffee;

- 6) regularly control coffee berry borer (CBB) and other pest populations, using integrated pest management in drying yard;
  - 7) monitor the drying process regularly (< 12.5 %). 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.
  - 8) Instrumental measurements should be adopted at field level. Moisture content measures should be calibrated to ISO 6673 method; and
- i) provide a clear and practical training for drying yard workers, including adequate use of moisture measuring equipment;
  - j) repair, clean, protect and keep equipment in a clean storage area until the next season.

#### **4.5 Storage, transportation and trading**

**4.5.1** Properly identified lots of 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.

**4.5.2** During storage, transportation and trading, the coffee shall also be protected from re-wetting, degradation and cross contamination.

**4.5.3** In long term storage conditions, relative humidity shall be kept between 60% and 80%

**4.5.4** 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 are recommended to prevent or reduce problems.

**4.5.5** Coffee beans with black and sour defects may contain the highest levels of OTA, and should not be re-blended into clean coffee or sold directly unless representative sampling plan and direct OTA analysis has shown them to be acceptable.

**4.5.8** 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.

**4.5.9** Stakeholders should adopt procedures to protect coffee in each part of the chain by ensuring the following:

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

- 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 shall 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:
- 1) record initial condition and age of the received stocks;
  - 2) arrange the coffee bags on pallets and away from walls, to allow good air circulation;
  - 3) implement cleaning and maintenance programmes in order to ensure that storage facilities are periodically inspected, cleaned and renewed;
  - 4) check coffee weevil in the warehouse, using integrated pest management;
  - 5) farms and other operations should separate coffee types. This requires planning of the storage area and adoption of a labelling system.
  - 6) Non-food materials should not be stored with coffee to prevent contamination or taints in the product.
  - 7) regular monitoring of the moisture content of coffee and relative humidity of warehouse
- d) coffee cleaning and sorting should not physically damage the product as this will make it more susceptible to contamination/deterioration or introduce new contamination and should assure reduction of undesirable materials to acceptable pre-determined levels.
- 1) when storage is combined with cleaning and sorting, attention is required to avoid contamination of post-sorted coffee with the sorting by-products of dust and foreign matter, (e.g. through the use of partition walls or extractor fans); and
  - 2) remove defects from main-crop production, discarding or screening them before their inclusion into the food chain.
- 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:
- 1) cover coffee loading and unloading areas to protect against rain;
  - 2) before receiving a new cargo, the vehicles shall be cleaned from residues of the previous cargo;
  - 3) the vehicles shall 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.

- 4) Tarpaulins and plastic canvas used to cover the cargo should also be regularly checked to ensure they are clean and without holes.
- 5) The vehicles should also receive regular maintenance to be kept in good condition; and
- 6) reliable transport service-providers that adopt the recommended good transportation practices should be selected by operators

## 4.6 Shipping

**4.6.1** Coffee is transported from producing to consuming countries in bags or in bulk, usually in 18 – 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).
- e) 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.
- f) 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;
- g) choose an appropriate place, not directly exposed to external weather conditions, aboard the ship to reduce the possibility of undesirable situations mentioned that can lead to OTA contamination;
- h) keep the ventilation holes in the containers uncovered;
- i) avoid unprotected stowage on the deck (top layer) and stow away from boilers and heated tanks or bulkheads;
- j) 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.

## Bibliography

[1] RS 259: 2014, *Prevention and reduction of Ochratoxin A contamination in coffee — Code of practice, First Edition*

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