DRAFT TANZANIA STANDARD

Code of practice for the prevention and reduction of Ochratoxin A contamination in cocoa

TANZANIA BUREAU OF STANDARDS

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0. Foreword

Ochratoxin A (OTA) is a toxic fungal metabolite classified by the International Agency for Research on Cancer as a possible human carcinogen (group 2B) produced by a few species in the genera Aspergillus and Penicillium.

Cocoa beans are extracted from a fruit, contamination of OTA producing fungi could begin when conditions become appropriate for growth. Generally, the fermentation and drying processes could create favorable condition when these processes are not properly done

This standard specifies code of practices for prevention and reduction of Ochratoxin A (OTA) contamination in cocoa from the farm to the shipment and transportation.

In the preparation of this Tanzania standard assistance was derived from CAC/RCP 72 Code of practice for the prevention and reduction of ochratoxin a contamination in cocoa

1. Scope

This standard specifies code of practices for prevention and reduction of Ochratoxin A (OTA) contamination in cocoa from the farm to the shipment and transportation.

2. Normative References

TZS 109, Food processing units — Code of hygiene

3. Terms and Definitions

3.1. cocoa bean
whole seed of the cocoa tree (Theobroma cacao Linnaeus) which has been fermented and dried

3.2. cocoa pod
cocoa fruit pericarp that arises from the ripened ovary wall of a fruit.

3.3. episperm or integument

protective layer of the seed also called shell when it is dried

3.4. pulp
aqueous, mucilaginous and acidic substance in which the seeds are embedded.

3.5. dry cocoa
commercial term designating cocoa beans which have been evenly dried throughout and which the moisture content corresponds to the requirements of this standard.

3.6. mouldy bean
cocoa bean in which mould is visible on the internal parts to the naked eye.

3.7. slaty bean
cocoa bean which shows a slaty colour over half or more of the surface exposed by a

cut made lengthwise through the centre.

3.8. insect damaged bean
cocoa bean with the internal parts of which contains insects at any stage of development, or has been attacked by insects, which have caused damage visible to the naked eye.

3.9. germinated bean
cocoa bean with the shell pierced, slit or broken by the growth of seed germ.

3.10. flat bean
cocoa bean of which the two cotyledons are so thin that it is not possible to obtain a cotyledon surface by cutting.

3.11. smoky bean
A cocoa bean which has a smoky smell or taste or which shows signs of contamination by smoke.

3.12 broken bean
A cocoa bean of which a fragment is missing, the missing part being equivalent to less than half the bean.

3.13. fragment
piece of cocoa bean equal to or less than the original bean.

3.14. piece of shell
part of the shell without any of the kernel.

3.15. foreign matter
any substance other than cocoa beans or residue.

3.16. fermentation
process intended to degrade the pulp and initiate biochemical changes in the cotyledon by inherent enzymes and micro-organisms from the farm environment.

3.17. sorting
handling and technological operation intended to remove foreign matter, fragments of dried cocoa beans, pod and pulp; as well as defective beans from dried cocoa beans.

3.18. roasting
heat treatment that produces fundamental chemical and physical changes in the structure and composition of cocoa beans and brings about darkening of the beans and the development of the characteristic chocolate flavor of roasted cocoa.

4. PROCESSING OF COCOA

4.1. Harvesting involves removing ripe fruits from the trees. The fruits are harvested by making a clean cut through the stalk with a cleaned and well sharpened harvesting tool.

4.2. The pods are opened to remove the cocoa beans with the pulp as soon as possible or within a 7 days after harvesting.

4.3. The cocoa beans with pulp removed from the pod are heaped together or put in boxes, trays, baskets or platforms to allow natural fermentation process.

4.4. The fermented cocoa beans are usually sun dried in an open drying yard, or on suspended tables with many variations and technological innovations to avoid cross contamination. Sun and mechanical drying can be combined and used together.

4.5. When the beans are appropriately dried to target moisture levels of maximum 7%, they must be sorted to remove flat beans, shriveled beans, black beans, mouldy beans, small and fused beans, beans with insect damage, germinated beans and others defects.

4.6. Once the drying and sorting processes are completed, the dried cocoa beans shall be stored into appropriate food grade packaging material.

4.7. A major part of OTA originally present in cocoa beans is found in the shell fraction. Accordingly, the industrial processing of removing cocoa shells, as well as dried episperm or integument of cocoa seed, before and after the roasting can reduce OTA levels significantly.

5. RECOMMENDED PRACTICES

5.1. PRE-HARVEST

5.1.1. The pulp and the cocoa beans are microbiologically sterile in relation to OTA producing fungi while inside the healthy cocoa pod. The contamination by spores of fungi that can produce OTA occurs during the opening process of cocoa pod and in subsequent processes.

5.1.2. The cocoa plantation should be properly maintained to ensure a low level of mould infestation , in order to avoid inoculation by OTA producing fungal spores during opening of the cocoa pod.

5.1.3. Recommended practices to reduce the development and spore load from OTA-producing fungi on cocoa beans are:

a) Keep cocoa plants healthy, through the appropriate use of good agricultural practices (GAP) such as weeding, improving soil texture, prevention of soil erosion, pruning, fertilizer application, pest and disease control, and irrigation. For establishment of new cocoa farms, cocoa trees should be planted in the most suitable soil, pattern and density to ensure easy management of the farms.

b) Avoid disposal of uncomposted organic wastes from cocoa or any other source, in or around the plantation. this could promote proliferation of OTA producing fungi.

5.2. HARVEST

5.2.1. Cocoa pods should be harvested when they are ripe. Harvesting should be done every week during peak periods and every two weeks in non-peak periods. Likewise, it is important to do a separate round of farm sanitation every week to remove diseased cocoa pods with any appropriate tools (eg. bushknife/machete and cocoa hook). Separate and discard diseased pods from healthy pods right in the field to avoid contamination during transport and storage.

5.2.2. Avoid harvesting unripe pods. The unripe cocoa pods have a solid pulp, without mucilage, hence the cocoa beans are difficult to separate from the pod, do not ferment properly and can contribute to slaty beans.

5.2.3. The harvester should avoid unnecessary cutting/wounding of the cocoa pods to prevent inoculation and development of OTA producing fungi in the cuts/wounds in the pod.

5.2.4. Harvesting must be carried out using sharp and clean tools. Baskets used to transport the pods must be clean

5.3. STORAGE AND POD OPENING

5.3.1. Once a sufficiently large quantity of pods suitable for fermentation has been harvested, the pods must be opened, manually (using wooden batons, pod splitters or machetes) or mechanically (using cocoa pod breaking machines) and beans extracted.

5.3.2. Care should be taken not to damage the seeds during pod breaking. It is recommended opening the pods as soon as possible or within 7 days after harvesting in order to avoid fungal proliferation.

5.3.3. Tools used to open cocoa pods should be clean and sharp.. personnel hygiene should be maintained during manual removal of seeds.

5.3.4. Wounded or mechanical damaged pods should not be stored longer than one day before opening and fermenting.

5.3.5. During the opening process any defective parts of the cocoa pod, mouldy beans, diseased beans, and damaged beans should be removed and appropriately disposed.

5.3.6. Good quality beans should be placed in a suitable container during transport. Transport of fresh/wet beans from pod opening sites to on-farm fermentation facility should be done under conditions that will prevent contamination e.g. spilled beans must be free of soil before being fermented.

5.4. FERMENTATION OF COCOA BEANS

5.4.1. The cocoa beans with pulp should be placed in reasonably clean, dry and suitable boxes, baskets, trays or platforms for the fermentation. Care should be taken to prevent cocoa beans from getting in contact with water during fermentation.

5.4.2. The mucilaginous mass should be turned frequently to ensure uniform heat in the heaps, to allow for aeration, to break up any lumps and to prevent fungi proliferation. The frequency depends on the method of fermentation.

5.4.3. The duration of fermentation is usually 4 to 7 days, which will also depend on the method of fermentation. It is however recommended that fermentation beyond 7 days be avoided as this could lead to fungal proliferation and seed germination.

5.4.4. Tools (paddle and shovel used for manual turning) and materials used during fermentation should be cleaned regularly. Organic materials used for fermentation

should be discarded when appropriate.

5.4.5. Fermentation is recommended to avoid ochratoxigenic fungal growth and ochratoxin A production because acetic, lactic and citric acid produced by bacteria during fermentation can compete with and inhibit these undesirable fungal species. Research has shown that fermentation carried out during drying on a drying mat; and partially depulped cocoa also being fermented directly on the drying mat can increase OTA production in cocoa beans.

5.5. DRYING PROCESS

5.5.1. After fermentation, the cocoa beans must be removed and immediately spread on appropriate elevated surfaces (i.e. not directly on bare ground or concrete floor) to dry, preferably under direct sunlight. If the drying is not started immediately, the cocoa beans will keep fermenting and over-ferment resulting in a loss of cocoa flavour.

5.5.2. The drying process could be done by direct sunlight or artificial drying or a combination of both. A moisture content of not greater than 7% in cocoa beans is considered optimal in order to avoid growth of microorganisms and for good storage.

5.5.3. The drying area should be located away from contaminant sources and should receive maximum sun exposure and air circulation during most times of the day, to speed up the drying process of cocoa beans. Shady areas should be avoided.

5.5.4. In rainy or wet regions, cocoa beans must be covered and re-spread once the drying surface has dried. Ensure that the drying surface is clean and located away from contaminants sources.

5.5.5. The layer of drying cocoa beans should not exceed 6 cm thick, which corresponds to 40 kg of wet cocoa beans per square meter of drying area to avoid slow or inadequate drying that may lead to mould growth.

5.5.6. Beans must be turned several times each day to ensure uniformly dried beans. Rake over the cocoa bean layer frequently during the day time to allow faster drying and reduce the risk of fungal growth (5 - 10 times per day).

5.5.7. Protect cocoa beans during drying from rain and dew. The cocoa beans should be heaped and covered at night or during rainy weather to avoid re-wetting.

5.5.8. Do not mix cocoa beans at different drying stages. Use specific identification methods in order to distinguish and identify each drying stage.

5.5.9. Re-wetting of cocoa beans should be avoided because cocoa beans with a level of moisture above 7% can allow rapid growth of the mycelium and the possibility of OTA production. Mouldy cocoa bean should be discarded.

5.5.10. Protect the cocoa beans during drying from domestic animals, which can be a source of biological contamination.

5.5.11. Drying equipment and tools should be cleaned regularly.

5.6. STORAGE, TRANSPORTATION AND TRADING OF DRIED COCOA BEANS

5.6.1. Before storage of dried cocoa beans, they must be sorted to remove flat beans, slaty beans, shrivelled beans, black beans, mouldy beans, small and/or fused beans, germinated beans, beans with insect damage, etc.

5.6.2. Ensure the facilities and equipment that are related with sorting process are regularly inspected, maintained and cleaned, in order to avoid physical damage to cocoa beans that make them more susceptible to contamination and deterioration and to prevent the introduction of new contamination and undesirable materials. An appropriate degree of personal hygiene should be maintained by all personnel.

5.6.3. The dried cocoa beans that will be stored must be properly identified by lots, at the farm level or in out-of-farm warehouses, in bulk or in clean bags under appropriate storage conditions. Bags used in storage and transport of cocoa beans need to be free of noxious substances such as mineral oils.

5.6.4. Cocoa beans should be packaged in clean bags which are sufficiently strong and properly sewn or sealed to withstand transport and storage and which are suitable for food contact use and discourage pest infestation.

5.6.5. The bagged cocoa beans must be placed in warehouses or storage sheds that are weatherproof, well aerated, cleaned, free from dampness and insect pests and away from smoke and other odoriferous materials that could contaminate the cocoa.

a) The design and structure of the warehouses or storage sheds should be adequate to maintain dryness and uniformity of the stored dried cocoa beans

b) The cocoa bags should be arranged on pallets and away from walls, to allow good air circulation.

c) The stored beans should not be exposed to direct sunlight nor stored near heating sources, to avoid the possibility of temperature differentials and water migration.

d) Cleaning and maintenance programs should be implemented and storage facilities should be periodically inspected, cleaned and repaired.

5.6.6. During the entire process, the cocoa beans must also be protected from re-wetting, degradation and cross – contamination. In long term storage conditions, humidity should be kept below 70% RH. Appropriate storage facilities should follow the use of good storage practices and conduct regular monitoring in order to prevent or reduce mould growth.

5.6.7. The moisture content of the stored cocoa beans should be periodically checked and kept not more than 7% by re-drying.

5.6.8. Any infestation must be dealt with by proper and approved methods of fumigation. Appropriate documentation accompanying the cargo should state in clear and correct terms the fumigants and the quantities that were used.

5.6.9. From the production areas, cocoa may be conveyed by various means to the trading points. The main aspect of concern here is to avoid rewetting of cocoa beans, due to possible climatic changes between different regions, and taking the necessary control measures.

5.6.10. Transport of cocoa beans 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:

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

b) Before receiving a new cargo, the vehicles must be cleaned from residues of previous cargo.

c) The vehicles must have floor, sidewalls and ceilings (in closed vehicles) checked for the presence of points where exhaust fumes or water from rain can be channeled into the cocoa cargo. Tarpaulins and plastic canvas used to cover the cargo should also be regularly checked to ensure that they are clean and without holes. The vehicles should also receive regular maintenance and should be kept in good condition.

d) Reliable transport service-providers, that adopt the recommended good transportation practices should be selected by operators.

5.7. CARGO SHIP LOADING AND TRANSPORT

Cocoa beans are transported from producing to consuming countries in bags or in bulk, usually in 15 to 25 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 cocoa loading and unloading areas to protect against rain.

b) Check cocoa lots to ensure that they are uniformly dried to maximum of 7% moisture content, free of foreign matter and conforming to the established defect levels.

c) Check containers before loading to ensure they are clean, dry and without structural damage that could allow water to enter 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 cocoa 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 outside elements, aboard the ship to store the cocoa to reduce the possibility of undesirable situations mentioned that can lead to OTA contamination.

f) Keep the ventilation holes in the containers free from clogging.

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

h) The moisture content should not exceed % anywhere, from the point where the cocoa beans leave the loading area to the point at which the cocoa is unloaded, stored and/or

subjected to other processing procedures such as roasting.

6. The complete cocoa value chain flowchart is shown in figure 2.

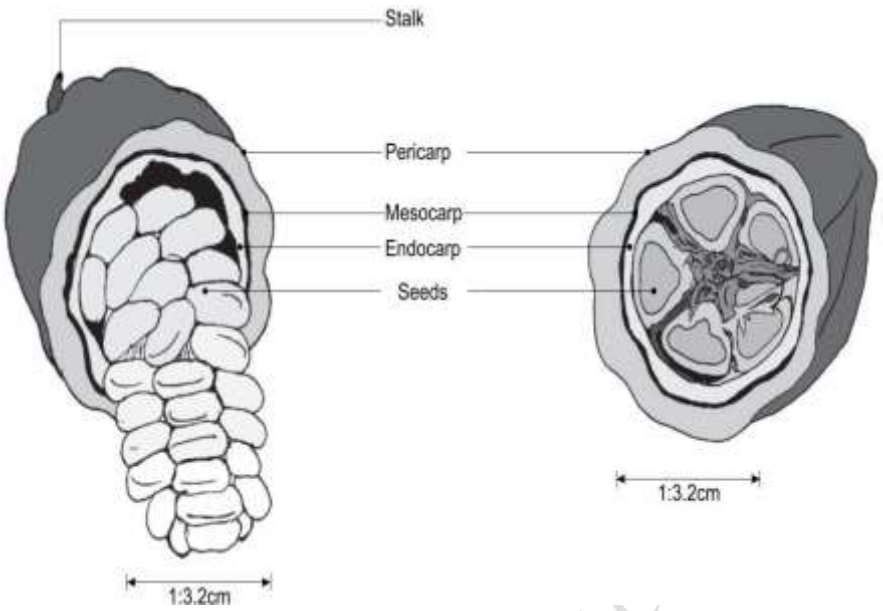

Figure 1a: Longitudinal and transverse sections of a cocoa pod
Scale: 1:3.2 cm

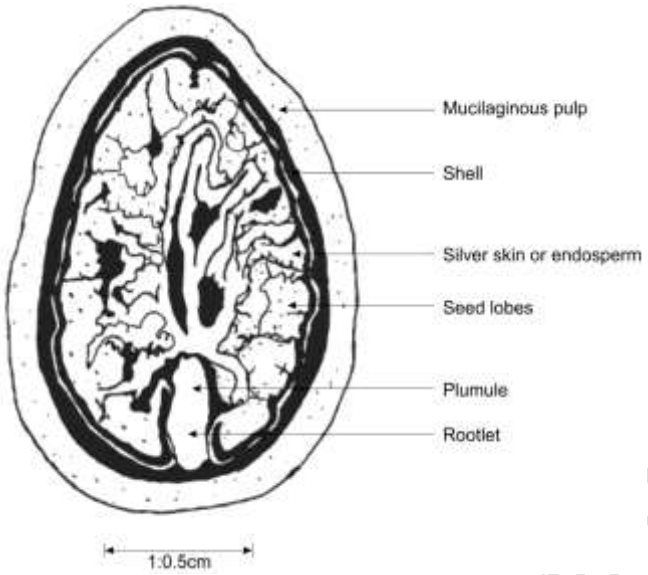

Figure 1b: Longitudinal section of a cocoa seed
Scale: 1:0.5 cm

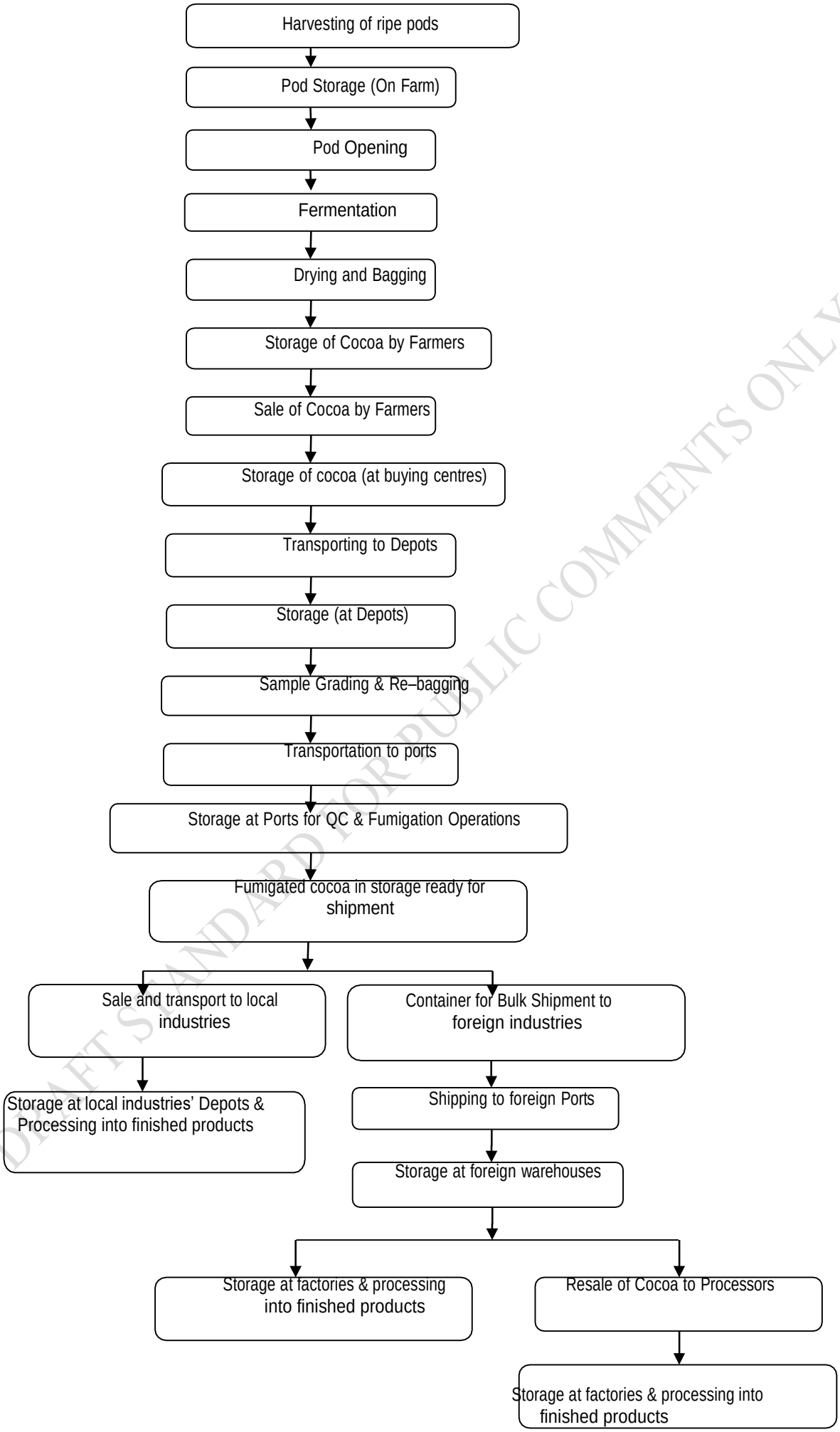

Figure 2: COCOA VALUE CHAIN