

HARVESTING AND PROCESSING

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Cocoa starts flowering from second year after planting in clones and fourth year in seedlings. Pods are ready for harvest after 135-170 days of successful pollination. Generally, cocoa gives two main crops in a year *i.e.*, May-July and October-December in Kerala and Karnataka conditions, whereas in Tamil Nadu major fruiting is in October. The stage of maturity is best judged by change of colour of pods *i.e.*, from green to yellow or red to orange. Maturity stage of pods and timely harvest is crucial for cocoa processing. Once mature, a pod will remain suitable for harvesting for up to 2 or 3 weeks (Wood, 1985) and they can be harvested at an interval of 10-15 days.

The pods are harvested by cutting the stalk with the help of a sharp knife, cutlass, or secateurs. CPCRI developed a cocoa harvester with light weighted telescopic pipe and sharp blades (Fig.1). The harvested pods can be kept for a minimum period of two days before opening; however the pods should not be kept beyond four days. The beans loose moisture during pod storage which allows more air to penetrate the cocoa beans once the pods are broken and start to ferment. More air results in faster fermentation (Meyer *et al.*, 1989) and gives better quality beans. Diseased, damaged, unripe, overripe and rotten pods have to be separated out to ensure quality of end product. For breaking the pods wooden hammer or mallet may be used. After breaking the pods crosswise, the placenta should be removed together with husk and the beans are collected for processing (Fig.2).



Fermentation:

Fermented dry cocoa beans are basic raw material for the production of chocolates. Raw/wet cocoa beans have astringent flavor, bitter and unpleasant taste. Hence, they must be cured to get good-tasty chocolates. Curing involves fermentation of wet /raw beans followed by drying and roasting. Fermentation is an important biochemical transformation process occurring in the cotyledon which leads to the formation of colour, aroma and flavor precursors of chocolate (Amoa-Awua, 2014). It is also needed to remove the adhering mucilagenous pulp, to develop flavour and aroma precursors, reduce bitterness, kill the germ of the seed and to loosen the testa.



During fermentation, several species of yeasts and bacteria (lactic and acetic acid bacteria) act on beans in the initial and later stages, respectively. The mixing of beans is done to facilitate uniform fermentation and to maintain proper temperature, moisture and aeration during fermentation.



Fig.2. Breaking of pods

1. Heap method:

In this method, wet beans (minimum of 50 kg) are placed over a layer of banana leaves kept over few sticks to keep them little raised on sloppy floor or raised platform, and covered with banana leaves on the first day and with gunny bags on the second day. On the 3rd and 5th day, the heap is dismantled and beans are mixed and kept again in position. Fermentation will be completed on the sixth day and are taken out for drying on seventh day.

2. Tray method:

Wooden trays of size 90 cm x 60 cm x 13 cm with reapers fixed at the bottom with gaps in between to allow flow of sweating are used in this method. They are filled up to 10 cm with 45 kg beans and are stacked one up on the other in tiers of 6 to 12 (Fig.3). After loading and stacking, trays are covered with gunny bags. An empty tray is kept at the bottom for draining of sweating. Fermentation is completed in just four days (Allison and Rohan, 1958). On the 5th day, beans are taken out and dried. This method can be

employed by small holder farmers as well as by large estate owners. Amoa-Awua (2014) opined that, labour saved by not turning the beans would be in the order of 20% and gives higher output in a shorter period and lesser space.



Fig.3. Tray method

3. Box method:

This method is more applicable to large estates or central fermentaries. The boxes of 1.2 m x 0.95 m x 0.75 m, made of wood and having reapers at the bottom to allow the sweating from the pulp to drain out and to provide aeration, are used. The boxes could be arranged in tiers for transferring beans from one to the next in line below. Two detachable wooden planks are provided on one side of the box for transferring (mixing) the beans by removing the planks. The beans are loaded in fermentation box and covered with banana leaves or gunny sacks. The mixing of beans is effected while transferring to the next box after 24 h, 72 h and 120 h. A total of six days (144 hours) are required to complete the fermentation.

4. Basket method:

Bamboo or cane baskets of suitable size could be used for fermenting small quantity (2-6 kg) of beans. One or two layers of banana leaves are placed at the bottom with provision to drain the sweating. The basket is filled with the beans and the surface is covered with banana leaves (Fig.4). The basket is placed over a raised surface to

facilitate drainage of the sweating for one day. Later the basket is covered with thick gunny bags. The beans are mixed thoroughly on the third and fifth days and covered with gunny bags. The fermentation will be completed at the end of the sixth day and the beans are taken out for drying.



Fig.4. Basket method

5. Gunny bag method:

Clean gunny bags and polythene lined bags are used in this method for small quantity of bags. Beans are filled loosely in the bags and allowed to drain the sweating for one day. The gunny bags are heaped one over the other and insulated properly to conserve the heat (Fig.5). The beans are mixed without opening the bag by shuddering on 3rd and 5th day. Beans are taken out for drying on the 7th day (Fig.6).



Fig.5. Gunny bag method

6. Mini tray method:

Wooden trays of 60 cm length, 25 cm width and 10 cm deep with slatted split cane bottoms divided into number of sections by means of wooden partition that will fit into appropriate grooves at required distances are employed in this method. About 10 kg wet beans are filled in these trays, then levelled and staked one above the other. The top tray is covered with gunny bag to keep the beans warm. Mixing is not necessary in this method, but fermentation gets completed in 4-5 days (Fig.6).

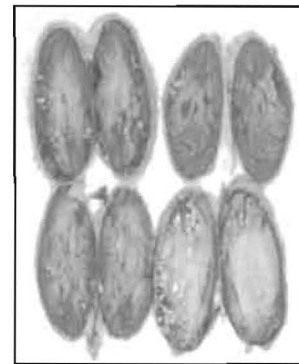


Fig.6. Fermented beans and ready for drying

Drying:

During drying, the moisture content is reduced from 55 to 6-7%. Properly dried beans have a long shelf-life and a good chocolate flavor (McDonald *et al.*, 1981)

(i) Sun drying:

Sun drying gives superior quality produce than artificial drying. The fermented beans are spread in a thin layer over a bamboo mat or cement floor and dried for 5-6 days. The beans are to be turned from time to time for uniform drying (Fig.7). When a fistful of beans are compressed in palm they produce a characteristic cracking sound with proper drying. Partially enclosed solar dryers can be used which could attain significantly high temperature and faster rate of drying (3-4 days), with better quality product.



Fig.7. Sun drying of beans

(ii) Artificial drying:

During the monsoon period, artificial drying has to be adopted. Drying usually takes place mainly by conduction or convection. In conduction driers, the beans are placed directly in contact with a heated surface, which is usually a non-perforated platform, and heat transfer into the beans to effect moisture loss. Cameroon drier is an example of conduction drier. In convection driers, heated air is made to flow over or through a bed of cocoa and the heat is transferred from the air to the beans by convection. Bin drier, Martin drier, Samoan drier, Secador drier, and Estufa are the natural convection driers, whereas, Tunnel drier and Platform drier are the forced convection driers used in different parts of the world for drying cocoa beans. The duration of artificial drying varies from 48-96 h. Mechanical dryers like unidrier and rotary dryer are used in larger plantations.

Electric ovens can also be employed. The beans have to be dried for 8-10 hours at 50-55° for the first two days, followed by continuous drying at 60°C. The total drying period will be 72-96 hours. The beans are to be turned at regular intervals for uniform drying and to prevent clump formation.

Grading and storage:

The dried beans after cooling to room temperature should be cleaned before storage. The flat, slaty, shrivelled, broken and other

extraneous materials are to be removed. The cleaned beans are packed in fresh polythene-lined (150-200 gauge) gunny bags. The bags are kept on a raised platform of wooden planks. The beans should not be stored in rooms where spices, pesticides and fertilizers are stored as they may absorb the odour from these materials.

Yield potential

Under normal cultivation practices, each cocoa tree yields about 1-2 kg dry beans annually. When cocoa is grown under arecanut with a spacing of 2.7m x 5.4 m, one hectare area accommodates about 650 trees with the yield potential of 650 to 1300 Kg dry beans.

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