HARVEST AND POST HARVEST TECHNOLOGY OF COCOA

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INTRODUCTION

The cocoa beans are derived from the matured cocoa pods. The major products from cocoa beans are cocoa powder, cocoa butter and chocolate.

HARVESTING

The change of colour of cocoa pods indicate their maturity. The green or green white pods turn yellow or orange and red pods turn dark as they ripen with traces of orange colour and these pods gives a metallic sound when tapped. The cocoa harvesting is done in two seasons, viz., April-August and October - January. The process involves cutting of matured pods from the tree and opening them to extract the wet beans. Pods are harvested by different types of knife. While harvesting care has to be taken to avoid damage to the flower cushion.

A special knife for harvesting cocoa pods costing Rs. 450/- has been designed at CPCRI, Kasaragod, Kerala. The curved blade is made of steel with both edges sharp and is attached to a long aluminium handle.

Harvesting may be done at 7-10 days intervals. Fallen, disease infected, immature, over riped and partially riped pods are to be discarded. Harvested pods may be kept for 2-4 days before they are opened. For breaking the pods, wooden mallet or hitting the pods against hard surface may be adopted and the use of metallic knifes should be avoided. While breaking, the placenta in the pods should be removed and the beans with adhering pulp should be collected for fermentation. Fermentation should be done at the earliest and for transportation of wet beans, non-metallic containers may be used.

The characteristics of cocoa beans are (i) initial moisture content (52-55 %), (ii) final moisture content (6-8 %), recovery of dry beans in terms of wet beans (35-40 %), weight of 100 dry beans (100-110 gms), fat content (55-58 %) and acidity (5.8)

The characteristics of pod husk are (i) crude protien (6-8 %) and crude fibre (24-56 %).

The average shell percentage is 14 % and shell contains crude protien (14-18 %) and crude fibre (9-20 %).

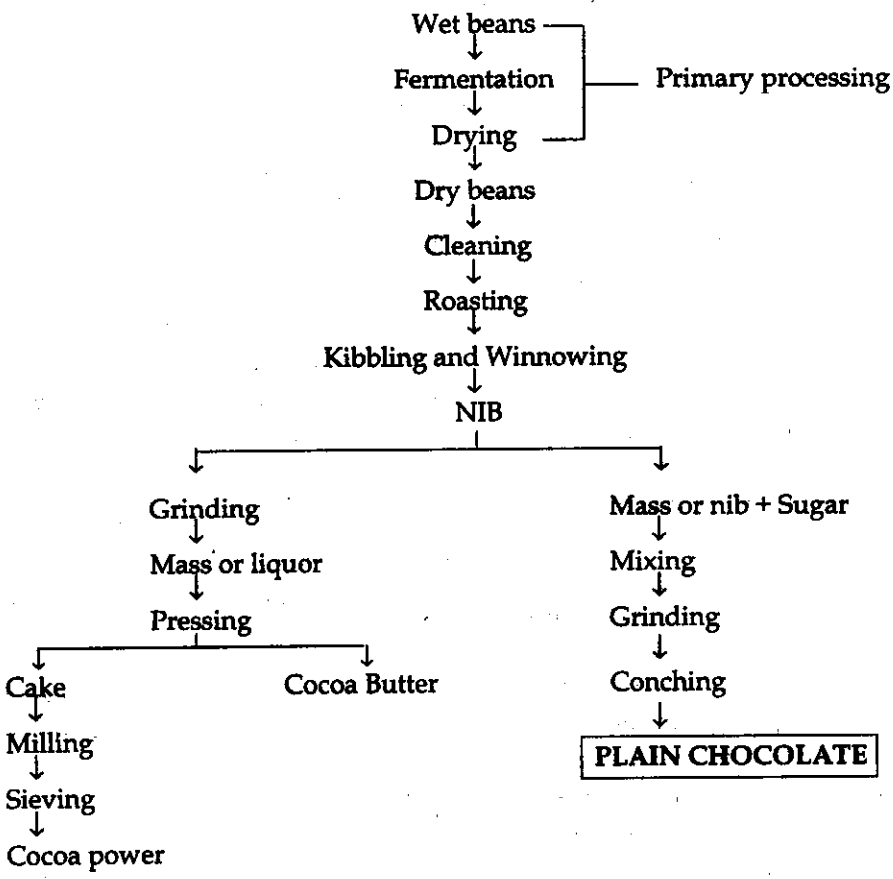
CURING

Curing of cocoa beans is an important step in cocoa processing. It comprises of two unit operations namely fermentation and drying. The chocolate flavour is developed in the beans during this process.

Fermentation:

Fermentation involves keeping a mass of cocoa beans well insulated so that heat is retained while allowing air to pass through it. During the process, which lasts six to seven days, the pulp or mucilage adhering to the beans disappears and the colour of the cotelydons which is originally purple or violet (for forastero variety) changes to light brown. The process involves complex chemical changes which are at to be fully understood.

Cocoa bean processing flow chart



An important requirement of proper fermentation is that the beans must have attained proper maturity so as to have sufficient pulp sugar for the micro organisms to act upon. The second requirement is that the germination of beans should not occur since these beans do not develop the desired flavour during fermentation. The temperature of the fermenting beans must be maintained around 50°C for the period after initial fermentation is yet another important requirement. Lower temperatures of 45-46°C and below gives rise to underfermented purple beans or unfermented beans which are devoid of chocolate flavour. For this reason, large scale fermentation is always preferred. Another requirement during this process is the carbon dioxide surrounding the beans must be removed by turning the mass.

In practice, several methods are employed for fermenting of cocoa beans, the choice being dependent on the quantity of beans available and the circumstances prevailing. Irrespective of the method adopted, it needs to be ensured that the beans are put for fermentation immediately after taking out of the pods and the fermenting mass is provided with proper insulation for

retention of temperature and adequate facilities for aeration of the beans and drainage of the sweat liquor. Boxes and trays made of thick hard wood with perforated bottoms or bamboo and cane baskets are suitable containers and depending on the quantity of beans available, one of these could be used in carrying out the process.

Bulk of the wet bean production is purchased by Co-operative organisations and private agencies which are fermented and dried in big batches. However there are a number of areas where there is no marketing arrangement for wet beans and the farmers themselves have to resort to on farm processing before disposal of the produce. In order to meet the requirements of different categories of farmers and large scale processors, the procedure for fermentation and drying of beans of different batch sizes of 5-10 kg, 40-100 kg, 200-500 kg. and above have been standardised. The methods recommended for each size group is given below:

Batch size 5 kg to 10 kg:

Fermentation of small quantities of wet beans ranging from 5 to 10 kg can be carried out in a small closely woven bamboo or cane basket of suitable size. The inner side of the basket is provided with a lining of one or two layers of banana leaves kept with the midrib side upward and the ends projecting slightly above the brim of the basket. Freshly collected beans are filled in this basket, and after giving a slight pressing by hand, the top surface is covered by folding in the ends of the banana leaves projecting out of the basket. A small weight is placed over to hold the banana leaves in position. The basket is then placed over a brick or on a raised platform to facilitate drainage of the sweatings. On the second day, the basket is covered with a thick gunny sack and kept in position by a light weight. The basket is uncovered, the beans are taken out and mixed thoroughly, and again kept covered with the banana leaves and the gunny sack as described above, on the third and fifth day of initial setting. Under normal weather conditions, the beans can be taken out for drying at the end of the sixth day.

Batch size 40 to 100 kg:

For fermenting quantities of 40 kg. to 100 kg. of wet beans at a time wooden boxes of suitable dimensions can be used. Care should be taken in making the box to ensure that metallic nails used, do not come in contact with the beans when filled. The box should have a minimum height of 15 cm. and a maximum of 45 cm. depending on the quantity of beans. Bottom of the box should be made of reapers (2.5-4 cm) keeping a space of 0.3-0.4 cm. in between. After filling the box with freshly collected beans the top is covered with a gunny sack. The box is kept raised about 15 cm. from the ground to allow the sweat liquor to drain away and for better aeration. After 24 hours, the beans are thoroughly mixed or transferred to another similar box and reset as before. Mixing is repeated again 24 hours, 48 hours and 96 hours. At the end of sixth day beans can be taken out for drying.

Batch size 200 to 500kg:

For this scale of operation. the tray method can be adopted. Wooden trays with their bottom made up of reapers 2.5-4 cm. kept at 0.3-0.4 cm. apart can be used. The trays may be of size 90 cm. x 60 cm. x 12 cm. each capable of holding 40-45 kg. of wet

beans. After filling the trays to an height not exceeding 10 cm. the trays are left for 24 hours on a raised platform for draining of the sweat liquor. On the second day the trays are stacked one over the other to a minimum of 4 and maximum of 12 and the stack is covered completely with gunny sack. No mixing or turning of the beans is required in this method. Under normal weather conditions fermentation will be over at the end of the fifth day and on the sixth day the beans can be taken out for drying.

Batch size 500 kg and above:

For fermenting large quantities of beans wooden boxes of dimension 120 cm. x 90 cm. x 60 cm. may be used conveniently. Four boxes are arranged in a cascade for fermenting each batch of beans. The cascade is built in such a way to provide sufficient space at the bottom of each box for the flow of sweat liquor through the perforated bottom planks. The front planks of individual boxes are fitted in grooves to permit their easy lifting one by one for transfer of beans from one box to another.

For fermentation the beans are put in the topmost box to a depth not exceeding 40 cm. and left uncovered. After 15-18 hours, they are transferred to second box. In doing so, it is to be ensured that their positions are changed i.e. the top beans in box-1 occupying the bottom of box-2 and vice versa. This is done by removing the front planks one by one and allowing the beans to fall through a 5 cm. x 5 cm. G.I. wire mesh placed at the mouth of box-2. The beans are then transferred from box-2 to box-3 and box-3 to box-4 after 48 hours of fermentation in each, following the same procedure. However, they are left uncovered in box-4. Depending upon the type of drying that follows, the beans are taken out from box-4 after 24 hours of fermentation. When forced air electric dryers are used, the beans are allowed to remain in box-4 for 48 hours.

Judging the end point of fermentation:

Under normal conditions the duration of fermentation can be taken as a satisfactory guideline for judging the end point of fermentation when a particular method is followed. Nevertheless seasonal variations, quantity of the beans etc. may lead to changes in the fermentation process. The following checks may therefore be made to ascertain proper fermentation viz., (i) portion of pulp adhering to the beans should be reddish brown as against original dull white, (ii) the fermented beans when squeezed, the colour of the exudate that comes out should be reddish brown and (iii) fermented beans when cut, the colour inside should be brown as against the original purple. The cut half of the bean when bent should reveal irregular cracks on the cut surface.

DRYING

At the end of fermentation, the moisture content of the bean is about 55% and this must be reduced to 6-7% for safe storage. The rate of drying varies greatly according to the method employed. If drying is too slow there is a danger of mould development, consequently leading to off flavours. The beans must therefore be skin dried within 24 hours. On the other hand, too much quick drying using artificial dryers may lead to the beans remaining acidic. Weather conditions and facilities permitting, sundrying is the best method. When artificial drying has to be resorted to, it must be spread over a period of 48 to 72 hours at moderate temperatures of 60°C to 70°C. Interrupted drying with short

period of drying and long resting period which allows migration of moisture to the surface during the rest period, gives good quality beans besides being economical.

Sundrying:

The beans can be dried on mats or concrete floors. They are spread in one or two layers thickness and turned over periodically to expose the beans uniformly to the sun and are heaped during night.

For good results the following schedule may be followed.

1st day	:	8 - 10 hours drying
2nd to 5th day	:	8 - hours drying per day
6th day	:	No drying
7th day	:	8 - 10 hours drying

Artificial drying:

During periods when sunshine is not available, artificial drying can be adopted. There are three main types of artificial dryers viz., tray type, bin type and samoan type. End product quality, thermal efficiency and energy cost are the major criteria to be considered for designing artificial dryers. The method to be adopted for different batch sizes are as follows:

Batch size (5 - 10 kg):

For smaller batches, the dryer developed by Kerala Agricultural University can be used. This consists of a wooden box of size 90 cm x 60 cm x 60 cm with three wooden matted trays spaced at 15 cm. Holes of 2 cm. diameter (10 numbers each) are to be provided at the front bottom and rear top of the box. The source of heat consists of four 100 watts bulbs, fitted at the bottom. The box can hold upto 25 kg of wet fermented beans. Drying will be completed (with a load of 25 kg fermented beans) in 45 to 72 hours depending upon the season. The beans are to be mixed frequently to ensure uniform drying. The cost of the dryer is about Rs. 500/- and the cost of drying is estimated as 50 paise per kg of dry beans.

Batch size (40 - 100 kg):

For drying of beans upto 40 kg per batch, the dryer designed by Central Plantation Crops Research Institute, Kasaragod, Kerala can be used. This dryer consists of a heat source, plenum chamber, drying chamber and exhaust air chamber and materials used for construction are hard wood, G.I.Sheet, aluminium sheet, aluminium angles and 500 watts industrial air heater. Perforated aluminium trays are used as drying beds. These dryers can handle upto a maximum of 40 kg of fermented beans at a time. With a 500 watts heater, the maximum temperature obtained is not more than 75°C. The temperature inside the dryer can be regulated by opening/closing the outlets. This dryer can also be fabricated with gas burning system. In this method the tray positions are interchanged every 8 hours to ensure uniform drying.

A 30 kg batch can be dried in 48 hours and a 40 kg batch in 65 hours. The beans after drying should be allowed to cool down in the dryer itself for about 2 hours. The fabrication cost of the dryer is estimated at Rs 1,500. Alternatively, commercially available cross flow dryers of suitable size with electrical heating system can also be used.

Batch size (200 kg and above):

For drying batches of this size, conventional Samoan dryers (commercially

available cross-flow dryers) with the required number of trays can be used. It is reported that Samoan type of dryers though cheaper to install, are costly to operate due to high cost of firewood and poor heat transfer. For large quantities, since sun-drying is cheaper and would give better quality produce, it is suggested to transfer the fermented beans to nearby areas where sun-drying is possible.

To examine completion of drying the dry beans when shaken should give a metallic sound or when the beans are pressed against hard surface, vertically, it should crumble to small pieces. Handfful of dry beans when pressed gives a crackling noise.

STORAGE OF DRIED BEANS

The dried beans after cooling to room temperature, should be cleaned to remove shell and shrivelled, discoloured, mouldy and flat beans and any extraneous materials. The beans are then packed in polythene lined (150-200 gauge) gunny bags and are kept on a raised platform made of wooden planks. If required to be stored for longer period, they have to be fumigated. Dry cocoa beans should not be stored along with spices, oil seeds, copra and other strong odorous materials since the beans may absorb odour from these commodities.

FINAL PROCESSING

Effective laboratory control at all stages of production is important in the processing of cocoa beans. The beans before cleaning and roasting should be subjected to laboratory tests which should continue through all stages of production.

Cocoa liquor can also be used directly to produce chocolate bars. Its important applications are in the manufacture of chocolates and preparation of certain sweets. It is used for pharmaceutical and perfume industries too. But these uses are very minimal. Cocoa powder is used in confectioner's coatings, cakes, cake mixes, breakfast foods, chocolate mild, other beverages and ice creams.

There are two types of techniques used in the final processing of cocoa - the expelling method and the roasting method. The press system, as the latter is called, is the modern method and has been adopted by all large scale processing plants. The expeller system is considered as less economical but still prevails in some parts of the world.

Press system:

The fermented and dried cocoa beans are first inspected for moisture content and then classified by colour. Then they are cleaned by removing all extraneous materials and passed into roasters which reduce the moisture content, lower acidity and deepens the colour. Then the beans are passed to huskers to remove the shells and the nibs are separated. The shells are disposed as fertilizers, mulch or fuel. In this process, the beans lose weight by 20%. The roasted and husked nibs are fed into heated disc crushers for grinding. The cell walls of the nibs are broken and a substance named as liquor or paste or mass, which contains about 55 per cent fatty matter comes out. The cocoa liquor subsequently is passed through a cooling tunnel and solidified into liquor blocks or kibbled liquor. These processes constitute the first stage of conversion of beans into various products. In modern plants, all these activities are well integrated, mechanised and fully sealed. Once the beans are fed, cocoa liquor comes out packed, ready for distribution. Sealing protects the liquor from

contamination. Laboratory checks for quality and cleanliness of the products are carried out.

In second stage, the cocoa liquor is pressed to extract cocoa butter. The butter contains some amount of fatty acids and through deodourisation, these are removed. Two types of methods of deodourisation are practiced. Batch deodourisation method used by many plants consists of passing bubbling steam through a stagnant pool of butter for several hours. The Parkinson method, offers a saving of large amount of energy as the butter is passed through a heat exchanger for very short period. The butter is then cooled and disposed either in the form of liquid or slabs. Another product obtained is the cocoa cake during the pressing of the liquor.

Next, the cake is pulverised and passed through breakers and grinders. To remove acidity and deepen the colour, it is treated with alkaline substances. This also increases the solubility of the powder.

Expeller system:

In the expeller system, the beans are cleaned and fed into the crushers. Natural butter is pressed out. The cake residue containing the shell is sent for solvent extraction. Residual butter can be extracted from these defatted cakes and the residues are good cattle feeds.

CHOCOLATE PROCESSING

Milk chocolates and plain chocolates (without milk solids) are two important types of chocolates. Milk chocolates are manufactured by mixing the mass with cocoa butter, pulverised sugar, milk powder and lecithin. The resultant paste is refined over steel rolls in roll refiners. To develop flavour, the paste is subjected to conching for 12 to 48 hours till the desired quality is obtained. Additional cocoa butter may be added at this stage and the flavours are added at the end. The liquid chocolate thus obtained is made into (i) moulded chocolate, (ii) enrober chocolate, (iii) panned chocolate, and (iv) covering chocolate.

Tempering of Chocolates:

Tempering the chocolate is essential to make it appear smooth and appealing. Cocoa butter contains a number of fats having different melting points. Tempering creates a finely balanced crystalline state of fats in the chocolate mass. On cooling, the crystals, coat the particles of solid cocoa.

Cooling:

In the chocolate mass, the latent heat is generated progressively as the crystalline point of each fat is reached and not at a specific temperature. Efficient extraction of this heat during the cooling process is necessary to improve the shelf life and appearance of the chocolate.

Moulding:

Tempered chocolate is deposited into tin, stainless steel or plastic moulds. On shaking the mould, the chocolate spreads and air bubbles are removed. On passing the moulds through cooling tunnels, the chocolates get solidified. Moulds are collected and the chocolate is extracted.

Enrober Chocolates:

Centres like creams, marsipan, caramael, jellies, etc. are passed over a wire belt into an enrober. Here, a curtain of chocolates completely enrobes these units. The coated centres are passed through cooling and then they are wrapped.

Panned Chocolates:

Nuts which are round in shape are made to revolve in stainless steel pans. Tempered chocolate is gradually added to build up a thin layer of chocolate. Cool air is blown to help the setting. The coated chocolate is given a final finishing of protective shellac before packing.

REFERENCES

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