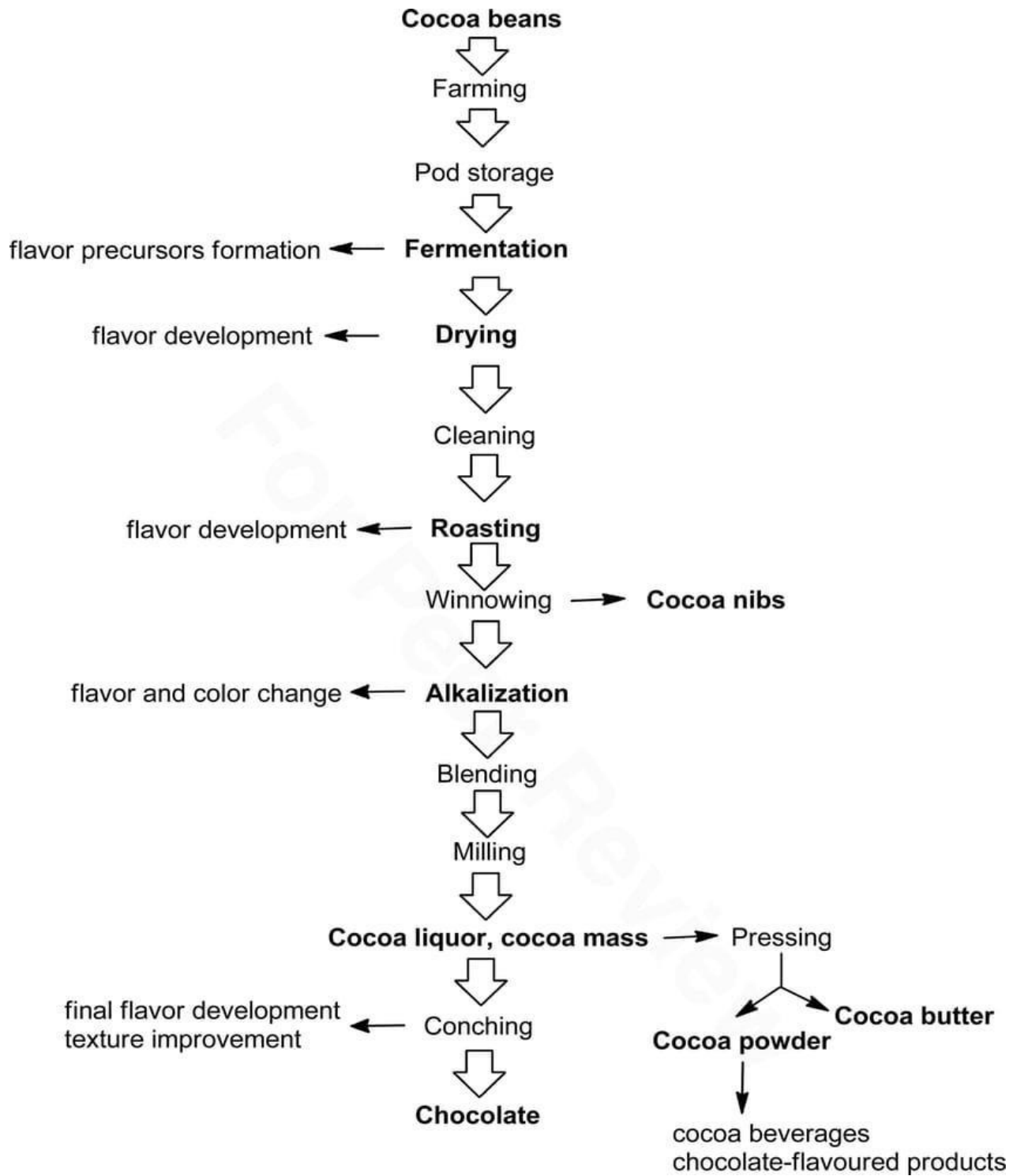


PROCESSING OF COCOA





Primary Processing

Raw cocoa is bitter, astringent and devoid of chocolate flavour. The original taste, flavour and colour of the chocolate are due to interplay of different chemicals developed during processing. Biochemical process for development of chocolate flavour start during fermentation stage and lasts during drying ,roasting and conching.

Harvesting of ripe pods

The first harvest takes place after approximately 3 years(hybrid/improved variety)or 4-5 years(traditional variety coming from the nursery) after planting. The cocoa tree can produce twice a year for more than 30 years.

- Harvest the pods at regular intervals of 10-15days(do not go over 3 weeks)
- Harvest the pods at optimum maturity(when fruits turn three quarters yellow, orange or red depending upon the variety)
- Harvesting is done at the stalk using a machete, pruning shears or sickle. Avoid damage to flower cushions which will produce new flowers and fruits of subsequent harvests
- Finally transport the pods from the plantation to pod breaking site



Breaking the pods

The pods are broken within 5 days of harvest. Separate the healthy pods from damaged ones to differentiate between the grades. Open the pod with a stick that have no pointed edges so as to extract the beans without damaging them. While breaking the pods remove any defective beans, rachis and cortex debris.

During breaking distal portion of the pod gets detached and beans remain conveniently attached to placenta from where they are extracted.



Farm level processing of cocoa

Several factors influence the quality of cocoa beans. The agrotechniques adopted, environmental conditions during the development of the pod and the processing technology also contribute significantly to the quality of finished product. As chocolate is sold in a highly competitive market, it is very important to produce good quality beans.

Cocoa beans have to be necessarily subjected to an initial process of fermentation and drying before being used for the manufacture of chocolate or other products. Chocolate flavour is developed by the two processes, fermentation of the beans at the producers level and roasting of them by the manufacturers.

Fermentation

The beans should be fermented to help produce chocolate flavour, reduce bitterness, lose its viability, remove mucilaginous coating and enable the cotyledons to expand. For proper fermentation there should be sufficient aeration to the beans, provision for drainage of sweatings and maintenance of temperature in the system.

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 6-7 days. The pulp or mucilage adhering to the beans disappears and the color of beans which is pale purple or violet changes to light brown.

Raw beans are covered by sugary mucilaginous pulp and the beans with pulp around them are 'wet beans'. During fermentation the pulp around the bean is lost and a series of biochemical reactions take place in bean which is necessary for imparting chocolate flavour. The beans are subjected to **fermentation immediately after the pods are broken.**

There are four different methods of fermentation which are as follows

- 1) **Heap method-** It involves keeping a mass of not less than 50kg of wet beans over a layer of banana leaves which are spread over few sticks to keep them a little raised over the ground level to facilitate the flow of sweating. The



leaves are folded and kept over the heap of beans, the heap is dismantled and the beans are mixed on the 3rd and 5th days. Beans can be taken out for drying on the seventh day.

- 2) **Tray method-** Wooden trays, 10 cm deep are divided into a number of sections by means of a wooden partition that will fit into appropriate grooves at required distance. A convenient tray can be of 25cm width and 60 cm length. Wet beans are filled in tray and levelled. Fermentation is completed in four days



- 3) **Basket method-** Mini bamboo baskets, closely woven with a diameter of 20cm and 15 cm height are taken for a capacity of 2kg. The baskets are lined with one or two layers of torn banana leaves to facilitate drainage of sweatings. Wet beans are then filled in these baskets and kept on raised platform to allow flow of drippings. The beans are to be taken out and stirred well 48 hours and 96 hours after the initial setting. Beans can be taken out for drying on the seventh day.



4) Box method- Boxes of different shapes and sizes are used. The bottom of boxes are provided a number of holes at 10cm distance and three such boxes are arranged in a row so that beans can be transferred from one box to the other. The beans are placed in top most box and covered with banana leaves. After two days, the beans should be uncovered and transferred to second box, then to third box after another two days. On the sixth day beans are taken out for drying.





End of fermentation

The optimal end of fermentation is checked from the end of 5th day.

- Bean colour changes to brown, becomes plump and filled with reddish brown exudate
- Testa becomes loose and gets detached from the cotyledons
- Longitudinal halves of cotyledon show bleached appearance in the centre with a brownish ring at the periphery
- When 50% of beans show these signs, the lot can be taken out for drying

Drying

At the end of fermentation the moisture content of beans is around 60% and this must be reduced to less than 8% before the cocoa can be stored, sold or transported. The beans are dried naturally or artificially.

Natural or solar drying is the simplest, most popular method and takes around 8-15 days. The beans are often spread out on a bamboo or straw mats placed in the sunlight, on black plastic sheets. Stir them frequently for around 5 days. Sort them to remove defective and damaged beans. Once dry, their average weight is one gram with a moisture content of 7% (approximate). Place them in a dry, sheltered and well aerated spot to protect them from damp rain, humidity to prevent mould development.

Artificial drying usually comes towards the end of natural drying to reduce the drying time. The heat is produced by a wood or gas fired furnace. There must be a system for ventilation and controlling other parameters like temperature as the taste quality of cocoa beans change above 55 degree celsius.

Regardless of the drying method used-

- Make sure the product to be dried is properly fermented
- Sort the beans to remove dirt, impurities or any beans that are flat or sprouting

- Follow the correct measurement for the layers to be dried (4-6 cm for natural drying and 5-10 cm for artificial drying)
- Monitor the cocoa beans by regularly taking a sample of few beans towards the end of drying process. Crack them with your hand and split few of them to ensure that beans are dry from both outside and inside

Natural sun drying



Greenhouse drying



Cocoa dryer machine

- Capacity- 1000kg
- Processing time-23hours
- Production capacity- 300kg-1500kg
- Price-2.50lakh/piece





Polishing

During drying the beans are polished to improve their appearance. The beans are polished at a stage where they are hard but not brittle. Polishing also protects the beans from fungal infections during storage.

Cleaning and bagging

After drying and polishing, beans are cleaned of any extraneous matter and are packed in clean, sufficiently strong and properly sewn jute bags.

Grading

Grading is done by a mechanical grader which separates the beans based on their size.



Cocoa bean grading machine

- Capacity- 200kg/hour
- Power- 2.2kw
- Price- Rs.75,000-7,50000/-

Storage

The great emphasis to achieve optimum quality from harvest to drying must continue during transport and storage. The jute bags containing dried cocoa beans are placed on a pallet to avoid contact with the ground and walls. The storage location must be clean, dry, well aerated and protected from the rodents and humidity to ensure the quality of produce.

Secondary processing

Secondary processing denotes the steps involved in conversion of raw beans into different finished products, the main product being chocolate. The essence of cocoa and chocolate manufacture, lies in the development of flavour by roasting the beans, followed by the extraction of cocoa butter from the nib to produce cocoa powder.

When the cocoa beans arrive in the processing unit, they are cleaned to remove any foreign matter and sorted to separate the small or broken beans.

Roasting of cocoa beans

Roasting of cocoa beans is one of the important operations in the processing of cocoa and the degree of treatment required being adjusted to the degree of ripeness of the beans concerned. The true purpose of roasting is not only restricted to the loosening of the shells, but also to develop positive flavour as well as the removal of excess moisture and other undesirable volatile matter. It enables to bring down the moisture content to 1.5-2%.

Objectives of roasting

- Color development
- Modification of the structure of the shell so as to permit easier subsequent separation
- Reduction of moisture content
- Solubilisation of cocoa starch and chemical changes especially oxidation of some minor constituent of beans

Most favoured temperature for proper roasting of cocoa beans for chocolate making lies between 120-125-degree Celsius. The discharged beans must be rapidly cooled to prevent over roasting with attendant discoloration and spoilage of flavour. The separation of shell of cocoa beans is necessary as the presence of significant amount of shell in chocolate will affect both colour and flavour and in addition reduces the effectiveness of refining. Cocoa beans are first cracked by

passing through rollers or rotating cones, where an air current is used to blow away the lighter shell.



Cocoa roasting machine

- Capacity- 50kg/hour
- Power consumption-350W
- Price- Rs 1.2lakh/piece

Winnowing

Once the beans are roasted well they should be winnowed or dehulled. Winnowing separates the cocoa nib(the edible and sought after portion)from the outer hull. The cocoa nibs are then processed into chocolate or other cocoa products.

Winnowing is done either manually using a basket that is rounded at one end and open at the other to efficiently toss the beans into air and immediately catch them as they fall back into the basket. As the beans are repeatedly tossed, the brittle shells break apart and separate from the beans. It is also done with the help of cocoa bean winnower machines.



Cocoa bean winnower

- Power consumption- 0.5hP
- Price- 1.70lakh/unit

Alkalisation

Cocoa alkalisation is a value added process in cocoa processing to produce alkalinized cocoa mass or powder. It involves treatment of cocoa nibs with a food grade alkali solution (saturated solution of sodium or potassium carbonate) to raise pH, thus producing dark colors and strong flavours. Alkalisation temperature of 80-85-degree Celsius gives the best flavour.

- Reduces the acidity of natural cocoa (pH is raised from 5.2-5.6 to almost neutral values 6.8-7.5)
- Reduces sourness
- Increases solubility and dispersibility of cocoa in water

Products of Cocoa

1) **Cocoa mass or liquor-** The dried beans are cleaned and roasted uniformly to get the desired aroma. The roasted beans are broken and winnowed to get good nibs(cotyledons). When these nibs are ground using a boll mill crusher or grinding machine, **cocoa liquor or cocoa mass** is obtained. There are two types of cocoa mass-natural mass and alkaline mass.



Cocoa liquor machine

Price-Rs 1,50000-2,50000/-

- In natural mass production water is added during roasting where as an alkaline solution (potassium carbonate)is added for the alkaline mass
- 100 kg of cocoa beans produces 80kg of cocoa paste



2) **Cocoa butter-** Cocoa butter and cocoa cakes are extracted from pure cocoa mass or paste with the help of a hydraulic press. The cocoa butter obtained is neutralized, hard in consistency, waxy, slightly shiny, pale yellow in color and oily to touch. The cake left behind at the bottom of the presses after extraction of butter, contains further 20% of butter. This cake is milled and sieved.



3) **Cocoa powder-** The solid blocks of compressed cocoa remaining after the extraction of cocoa butter are pulverised into a fine powder called cocoa powder-high fat powder containing 20-25% of fat which is used in drinks and low fat powder containing 10-13% of fat and is used in cakes, biscuits, ice-creams and other chocolate flavoured products.



Cocoa grinding machine

- Capacity- 100kg/hour
- Price-Rs 2,00000/ unit



4) Chocolate production

Un-refined local chocolate

Locally, the processing of dried fermented cocoa is largely limited to the production of the local chocolate, commonly called 'Creole Chocolate'. This is basically a crude form of the pure unsweetened (bitter) chocolate, which is used to make a beverage.

The production of local chocolate is typically done at the household level using basic utensils. Spices such as cinnamon, nutmeg, bay leaf are added during or after the grinding process. The mixture is shaped into balls, sticks or blocks. The end product is grated and boiled to make a chocolate beverage.

Chocolate manufacturing processes

a) Mixing-

Mixing of ingredients during chocolate manufacture is a fundamental operation employed using time-temperature combinations in a continuous or batch mixers to obtain constant formulation consistency. In batch mixing, chocolate containing cocoa liquor, sugar cocoa butter, milk fat and milk powder is thoroughly mixed normally for 12-15 minutes at 40-50 degree Celsius.

b) Refining-

Refining of chocolate is important to the production smooth texture that is desirable in modern chocolate confectionary. Mixtures of sugar and cocoa liquor at an overall fat content of 8-24% are refined using a combination of two-and-five roll refiners.

C) Conching

This process is regarded as the endpoint or final operation in the manufacture of bulk chocolate, whether milk or dark. It is an important process that contributes to the development of viscosity, texture and

flavour. Conching is usually carried out by agitating chocolate at more than 50 degree Celsius for few hours. Making chocolate considered "good" is about forming as many type V crystals as possible as this provides best appearance ,texture and creates the most stable crystals, so the texture and appearance will not degrade with time. To accomplish this temperature is carefully manipulated during the crystallization.

To give chocolate a suitable viscosity, additional cocoa butter and lecithin can be added towards the end of conching to thin or liquefy the chocolate prior to tempering.

A **conche** machine is a surface scraping mixer and agitator that evenly distributes cocoa butter within the chocolate. It promotes flavour development through heat, release of volatiles, acids and oxidation.

d) Tempering- The final process is called tempering. The fats in cocoa butter can crystallize in six different forms. The primary purpose of tempering is to assure that only the best form is present.

Two classic ways of manually tempering chocolate are

- Working the molten chocolate on a heat absorbing surface, until thickening indicates the presence of sufficient crystal "seeds" ,the chocolate is then gently warmed to working temperature
- Stirring solid chocolate into molten chocolate to" inoculate" the liquid chocolate with crystals

Chocolate tempering machines or temperers with computer controls can be used for producing consistently tempered chocolate. The temper of chocolate can be measured with a chocolate temper meter to ensure accuracy and consistency. A sample cup is filled with the chocolate and placed in the unit which then displays or prints the results.

The uniform sheen and crisp bite of properly processed chocolate are the result of consistently small butter crystals produced by the tempering process.

Chocolate processing machine

Price- 75 lakh/unit



Conche machine

- Price- 3,50,000
- Capacity- 40kg/hour



Types of chocolates

- a) **White chocolate:** It is made from cocoa butter, sugar, milk and flavouring such as vanilla.



- b) **Milk chocolate:** It is made from cocoa liquor, cocoa butter, sugar, milk and flavouring



c) **Dark chocolate:** It is made from cocoa liquor, cocoa butter, sugar and flavourings.



5) Cocoa juice

Wash the harvested pods, then open them with sticks devoid of any sharp edges in order to collect the beans without damaging them. Put the beans in clean containers with small holes. Place a cooking pot under the containers to receive the cocoa juice. To facilitate the extraction of juice, stir the beans occasionally. After 24 hours, collect the juice, approximately 1 litre of cocoa juice can be obtained from 35kg of fresh beans. Once the juice has been collected, the beans can be taken for the fermentation process. The cocoa juice can be consumed fresh as a non-alcoholic drink or fermented to obtain alcoholic drink





Other products from cocoa

Processing of cocoa both at primary and secondary levels have a large quantity of waste materials. Research on utilisation of these materials indicates that several useful by-products can be produced from cocoa wastes. The important waste materials are pod husk, sweatings and shell.

Animal feed can be made from cocoa pod husks. The husks provide high fibre, low protein and moderate energy feed stuff. Cocoa pod husks can be used as a substitute for corn and wheat bran in feed formulations for chickens, pigs and sheep.

Cocoa bean shells can be used as an organic mulch and soil conditioner for garden. Cocoa sweatings can be used for making jelly or jam. The pectin from sweatings show slow setting characteristics.

Total cost of setting up a cocoa processing plant

The total cost involved in setting up a cocoa processing plant varies from country to country and state to state. On an average it comes around **Rs 75,00,000** (including the machineries and other miscellaneous costs).