

## PROCESSING OF COCOA

### Introduction:

“*Theobroma cacao*”, is the term referring to the tree that yields cocoa, an important raw material for production of chocolate, is one of the greatest treasures discovered in the 18th century. Chocolate has found to be originated from the Amazon base of South America. The Swedish Botanist Carolus Linnaeus renamed the cocoa tree in Greek to “*Theobroma cacao*” which means “*food of Gods*”. The term “**cacao**” is the botanical name and it indicates to the entire tree including the beans and products before processing and the term “**chocolate**” for processed beans in ground, liquid or in solid form. The term “**cocoa**” refers to concentrated cocoa powder.

## 1. CULTIVATION AND PROCESSING

### 1.1. Growing and Harvesting:

There are many stages in the processing of cocoa from harvesting to commercial processing.

**1.1.1. Growing:** The cocoa tree grows well in tropical areas. Generally, the cultivation of cocoa tree is done under the canopy of a long shady tree, and requires sufficient moisture and nutrients for its growth. Cocoa is also highly vulnerable to various rots, wilts and fungal diseases.

The cocoa tree has large and lengthy leaves with pale coloured flowers from which the large pods grow on the tree. The tree starts bearing fruit in its third year till its twentieth year. The flowers take about five months to develop into cacao pods. The colour of the pods range from bright red, green, purple or yellow. The pods grow straight out of the trunk and ripe pods are about 20cm by 8 inches in length, oval in shape with sharp edges possessing nearly 40 beans embedded in the white pulp.

### 1.1.2. Harvesting of Pods:

The pod turn to golden yellow in colour indicating the correct stage of harvesting for picking. The pods are harvested by cutting with knives fixed on a long pole, at varying distances.

## 2. Cocoa Pods:

The cocoa pods are termed grain, or seed. A pod or fruit is covered by a thick leathery rind of nearly 3 cm thick containing 20 to 40 flat or round, almond-shaped beans in a pod, varying in thicknesses from 0.5 to 1.27 inches, that varies with the species. It is filled with sugary and gum like pulp termed “baba de cacao” as it is called in South America and it possesses approximately 30 to 50 large seeds. Seeds are whitish that turns reddish violet brown while it is subjected to drying.

## 3. Opening of Pods:

For the removal of beans, the matured pods are opened within one week to ten days. The harvested pods are split by a heavy mallet, to open the pods at the centre that makes the splitting of the pods into two halves followed by opening by hands.

#### 4. Types of cacao beans:

Three distinct species of cacao are being used in manufacture of chocolate.

- i. Criollo (meaning “native”)
- ii. Forastero (meaning “foreign”)
- iii. Trinitario

**4.1. Criollo beans** are most delicate and represents only 10 to 15% of world’s production. Cultivated mainly in Central America, the bean is always used in combination with other varieties, recognized by their dark, purplish colour.

**4.2. Forastero beans** are much harder and higher yielding variety grown in Brazil and Africa accounting for 80% of world’s production; it has a stronger and bitter flavour and is used for blending of the different varieties of cocoa beans.

**4.3. Trinitario beans** are a hybrid variety combining of both Criollo and Forastero.

The world cocoa trade markets broadly two types of cocoa beans like:

- Fine or Flavoured beans
- Bulk or ordinary beans

Commonly, fine or flavoured cocoa beans are obtained from Criollo or Trinitario varieties of cocoa varieties, while bulk cocoa beans are received from Forastero trees.

**5. Curing:** The combined process of fermenting and drying involves curing. Fermentation lasts up to one week followed by immediate drying.

**5.1. Fermenting:** The next stage is to split the pods using a small sickle, with extreme care without causing any damage to the pods. The pods and the pulp are removed out and collected in the form of a conical heap on banana leaves. When the heap is complete the leaves are folded over to cover the heap fully. This step initiates the fermentation process that gets completed in 6 days. The chemical process involved are complicated, but the atmospheric microbes like bacteria and yeasts multiply on the sweet pulp that surround the beans, causing acidification and decomposing it to an acidic juice. The yeasts act on the sugars in the pulp and convert it to ethanol. Bacteria converts the ethanol to acetic acid and then to carbon dioxide and water by the process of oxidation.

The process raises the temperature from 40 °C - 45 °C in the heap giving rise to changing conditions within the bean itself within 48 hours. Continued bacterial activity prevails till the bean dies due to the activity of acetic acid and high temperatures. This leads to the breakdown of the cell wall causing complex chemical changes to occur in the bean due to the presence of enzymatic oxidation and the breakdown of proteins into amino acids. The colour change takes place to chocolate brown and the original cacao smell emerges which is the first crucial stage in the development of beans of superior quality.

#### 6. Other methods of fermentation include:

##### 6.1. Box method:

1. The boxes of measurement of 60x60 cm and holding nearly 150 kg wet beans.

2. In the bottom of the box there are number of holes of 1 cm diameter at 10 cm apart in three to four rows.
3. The beans are kept in the top most box followed by covering it with banana leaves or gunny bags.
4. After a duration of 2 days the beans are transferred into the next box and then into next consecutive box.
5. The fermentation is completed on sixth day.

### **6.2. Tray method:**

- i. Only Forestro beans variety employs the tray method.
- ii. Usually the sizes of the trays are roughly 90x60x12 cm which could hold nearly 40 kg of beans.
- iii. The bottom of the tray has opening of 1 cm holes at 4 cm square pattern.
- iv. Fermentation is similar to the previous method. Process is faster and completed in 4 to
- v. 5 days.

### **6.3. Basket method:**

- i. Baskets made of bamboo or cane with one or two layers of banana leaves at the bottom are filled with the beans and is covered with banana leaves at the top.
- ii. The beans are constantly raked on third and fifth day and entirely covered with gunny sacks.
- iii. This method requires six days for the completion of the fermentation.

### **6.4. Heap method:**

- i. The banana leaves are spread on a raised area over the ground to allow the flow of the sweat liquid, are used to heap a mass of 50kg beans.
- ii. The heaps are thoroughly turned in the third and fifth days. This process also needs about six days for the fermentation to be over.

### **7. Drying:**

After the completion of the fermentation process, the beans are placed on bamboo mats or wooden drying floors to bring down the moisture content to 7.5% for 10 to 20 days in thin layers of 2-3 cm. The beans are constantly raked to keep them ventilated and to prevent mould forming. In monsoon artificial drying could be adopted for 48 to 72 hours at 60 to 70°C only. A cracking sound on compressing a lump of dried beans is an indication of end point of drying. The colour changes from reddish brown to dark brown.

### **8. QUALITY CONTROL:**

The quality of the cocoa products is dependent on the quality of the raw cocoa. Fragile kernels with pure and bitter flavour, possessing dark brown to red colour is the indication of completely fermented and fully ripened cocoa bean.

Perfect beans must not contain foreign matter or mold and must not be infested by insects. The beans should exhibit their characteristic appearance and odor of their variety, without having sour, musty or smoky odour.

The quality of cocoa beans is assessed according to the following criteria. They must be:

- Fully matured and ripened
- Correctly fermented
- Firm and uniform in size
- Loose and undamaged shells
- Reddish-brown color
- Fragile kernel.

Poorly fermented cocoa beans have a slaty to solid kernel and an astringent (mouth-puckering) flavor. The excessive heating in over fermentation results in butyric acid fermentation, which impairs the quality.

## **9. PACKAGING:**

Cocoa beans are packed in bags of jute or sisal weighing 60 - 65 kg each. It must be stored in dry, cool and good ventilated and low humidity conditions.

## **10. MODERN MANUFACTURING:**

### **10.1. Cleaning and Grading:**

Cacao beans are sent for chocolate processing after undergoing fermenting and drying. They have only been fermented and dried but still they are enclosed in a hard skin which is dusty with the remains of the dried pulp. The beans undergo a preliminary cleaning, where foreign objects are removed by sieving operation. The beans pass on a moving belt to storage hoppers and to cleaners and graders. The beans are carefully inspected for the removal of any shrivelled or double beans and any undesirable materials. The beans are then sent to roasting machines.

### **10.2. Roasting for flavour:**

Roasting is a crucial part of the process and serves several functions. First it develops the flavour and aroma with colour enrichment. Roasting also dries the husk surrounding the “nib” or edible inner part of the bean and makes it easier to remove.

The following changes take place during roasting and fermentation of the roasted beans:

- Bean losses moisture.
- Loosening of the shell.
- Nib colour turns dark and friable.
- Breakdown of amino acids and proteins.
- Volatile acids and other substances that contribute to acidity and bitterness of the beans are lost heavily.

The changes that take place in the beans depend on the time and temperature of roasting and the moisture removal rate during the process. Over roasting destroys the natural flavour of the bean and produces a bitter product, while under roasting makes the removal of husk more difficult, also fails to remove the bitterness in the bean. The roasting temperature varies with the type of beans.

### 10.3. Roasting steps:

- The first step in drying process is when the bean is subjected to low temperature drying.
- This causes drying and loosening of the shell, but does not impart a roasting effect on the nib as the temperature does not exceed 100°C. This step is followed by a high temperature drying at the range of 127° to 130°C.

After roasting, the beans are subjected to instantaneous cooling to prevent continued roasting internally.

### 10.4. Winnowing:

During the next stage the beans are passed through the husking/winnowing machine, which cracks open the roasted beans and blows the lighter husks away from the heavier pieces of nib. Manufacturers may use the “nib” for low quality “shell butter” production.

### 10.5. Crushing:

The loosened shell is slightly crushed in impact rolls comprising of two rolls in hexagonal shape running unidirectionally thereby expelling the beans against metal plates. The cocoa bean devoid of its shell is termed as “**cocoa nib**”.

### 10.6. Alkalisation:

The nib or the cocoa mass is soaked in potassium or sodium carbonate, for an hour, termed as “Dutching”, which modifies the colour and flavour of the cocoa nib. Different range of colours can be produced by altering the alkali to nib ratio. Slow drying follows this step which results in removal of acidity, more smooth flavour and darker colour of cocoa.

### 10.7. Crucial Blend:

The blending process is done with the specified quantities of different varieties of cocoa nibs that are weighed and transferred to blenders. Final flavour is obtained from blending 2 or more types of bean after roasting.

### 10.8. Grinding:

The cocoa nibs are passed through a series of rollers, resulting in coarse particles that eventually turn into a paste known as “cocoa liquor” or “unsweetened chocolate” or “cocoa mass” containing 50-55% cocoa butter. It then follows a second grinding to reduce the size to 27 to 30 microns. After grinding, the cacao mass or “**cocoa liquor**” flows out of the machine into shallow containers.

Further treatment of the “cocoa liquor” depends on whether it is to be made into:

- Cocoa Liquor
- Cocoa butter
- Cocoa powder or
- Chocolate

## **11. COCOA LIQUOR**

Cocoa butter and cocoa powder is produced from cocoa liquor which is the basic raw material from which and is made up of 50% of fat. Cocoa liquor is a principle ingredient in determining the final quality of the chocolate. It is also called as cocoa mass or paste or chocolate liquor or chocolate. The Federation of Cocoa Commerce (FCC) defines cocoa mass or liquor as obtained from cocoa nib (roasted or unroasted with max. 5% shell and max. 10% ash, both on a fat-free dry basis), mechanically processed to a paste, which retains the natural fat content of the cocoa nib.

The flavor of cocoa liquor is governed by important factors like:

- the type of cocoa bean
- growing conditions
- the flavour development and bean type and quality .

### **11.1. PACKAGING AND STORAGE:**

Cocoa liquor is used in liquid form and so the temperature of the cocoa liquor should be maintained between 55°-65° C. Since cocoa liquor is a dispersion of cocoa butter, it is stirred by a stirrer or scraper regularly to prevent the liquid from settling at the bottom of the tank at 40-45 °C.

In solid form it is packed in cartons in solid blocks or in crumpled form in bags of 27 kg. Protection against direct sunlight and other heat radiation sources is essential during transportation and it is mandatory to store it in cool temperatures of 15°-20° C and at a dry RH of <50% in dark conditions.

## **12. COCOA BUTTER**

Extrusion, expeller or screw presses are the various methods of cocoa butter extraction from whole beans, mixtures of fine nibs, small nibs and immature beans. With Mild roasting or even no roasting, pressing of whole beans, gives mild flavoured cocoa butter. The extracted butter is kept in liquid or moulded form.

### **12.1. PACKAGING AND STORAGE OF COCOA BUTTER:**

Cocoa butter is stored in selective properly insulated tank containers or tank cars in liquid form during transportation. Loading temperatures are from 60°-75° C depending on the duration of transport and the distance travelled.

## **13. COCOA POWDER**

This is a major product from cacao. Extraction of large amounts of “cacao butter” from the “cocoa liquor” is done for producing cocoa powder. Cocoa butter is pressed out of the liquor, and the residue is used to form cakes, which is subjected to further grinding. Wetting agents like lecithin is added for instant drinks and beverages.

### **13.1. TYPES OF COCOA POWDER:**

- Dutch Process cocoa powder
- Low fat and High fat cocoa powder
- Natural (non-iodized) cocoa powder
- Single origin cocoa powder

### 13.1.1. Dutch Process cocoa powder:

The addition of alkali is known as “**dutching**” and the end product is termed as “Dutch Process cocoa powder”. It is treated with alkali to neutralize its acids, appearing reddish/dark brownish in colour, with good cocoa flavour and easy to dissolve in liquids. Alkalized cocoa powders tend to be smoother and darker in colour.

### 13.1.2. Low fat and High fat cocoa powder:

Most of the cocoa butter is removed when the cocoa cake is pressed. The amount of fat present in the powder determines the type of powder. High fat cocoa powders contain cocoa butter ranging from 18% to 24% , whereas low-fat cocoa powders possess cocoa butter in the range between 10% to 12%.

### 13.1.3. Natural or non-alkalized cocoa powder:

It renders a bitter taste and gives highly intensified chocolate flavour to baked products.

## 13.2. PACKAGING AND STORAGE:

**Cocoa Powder** is highly hygroscopic and is vulnerable to foreign odours. Proper packing and storage of the product is essential for maintaining the quality and extended shelf life of the product.

## 14. SUMMARY:

- “*Theobroma cacao*”, is the term referring to the tree that yields cocoa, an important raw material for production of chocolate and cocoa based products.
- The term “**cacao**” refers to the tree, the beans and products before processing and the terms “**chocolate**” and “**cocoa**” for processed beans and concentrated cocoa powder respectively.
- Ripe Cocoa pods are about 20cm by 8 inches in length, each containing 20 to 40 beans embedded in white pulp which is soft and sugary.
- The cocoa pod is ready for harvesting when it turns yellow in colour.
- The pods are opened within one week to ten days.
- A pod or fruit has a rind which is leather like in texture, containing 20 to 40 beans in a pod in a mucilaginous pulp.
- Three species of cacao are used in manufacture of chocolate namely, **Criollo, Forastero, Trinitario**.
- The combined process of fermenting and drying of cacao is curing. Fermentation lasts up to one week followed by immediate drying.
- The beans are subjected to final quality check and packed and stored.
- The cacao beans are subjected to cleaning, roasting and winnowing steps for the removal the outer lighter and feathery shell.
- The cocoa bean devoid of its shell is only termed as “**cocoa nib**”.
- The nibs are treated with alkali, termed “dutching” followed by blending and grinding to yield a paste called cocoa liquor.

- Further treatment of the “cocoa liquor” depends on whether it is to be made into **Cocoa Liquor, Cocoa butter, Cocoa powder or Chocolate.**
- Cocoa butter and cocoa powder is produced from cocoa liquor which is the basic raw material from which and is made up of 50% of fat.
- Pressing of whole beans, gives cocoa butter and the residue is used for manufacturing cocoa powder.

Thus cocoa bean is a wonderful gift of nature to mankind and this bean also yields many health benefits and gives high commercial profit worldwide