18.1 INTRODUCTION

Fresh tea is sterile, and is the second most consumed liquid worldwide after water. Fresh tea is sterile, and is the second most consumed liquid worldwide after water. Fresh tea is sterile, and is the second most consumed liquid worldwide after water. Coffee is second in importance only to petroleum and its by-products, in terms of annual trade value in the international market. Beverages (excluding soft drinks) can be grouped into two heads: (i) alcoholic, and (ii) non-alcoholic (as shown in Table 18.1).

The drinking of tea, coffee and chocolate has become an important part of our lives; these three beverages like some others (Table 18.1) are stimulants because they contain a chemical primarily caffeine (Table 18.2) and its relatives. These chemicals cause physiological reactions in our body. Five minutes after drinking coffee, the caffeine in it reaches the bloodstream. As it circulates throughout the body, it stimulates the heart, increases stomach acidity and urine output, and causes a rise in metabolic rate. After a tiring day when we drink one of these beverages we feel stimulated or alert because of the presence of caffeine in it. Caffeine mimics the same feelings as which are produced when the body releases adrenaline. If these beverages are consumed in excess, for example 10 cups of coffee (equivalent to one gram of caffeine) it can cause anxiety, headache, dizziness, insomnia, heart palpitation, and even mild delirium. Heavy tea or coffee drinkers can develop a tolerance to caffeine and can even suffer withdrawal symptoms if they quit their habit. In this unit we will discuss the above mentioned three beverages in detail.

Objectives

After studying this unit, you should be able to:

- differentiate between alcoholic and non-alcoholic beverages;
- discuss the importance of the presence of caffeine in tea, coffee and cocoa;
- prepare detailed accounts on tea, coffee and cocoa;
- differentiate between China and Assam tea;
- explain the processing methods for the preparation of various kinds of teas;
- explain the difference between Arabian, Robusta and Liberian coffee;
- appreciate the difference between raw, roasted, powdered, instant, and decaffeinated coffee; and
- identify the adulterants of tea, coffee and cocoa products.

18.2 TEA

Botanical name: *Camellia sinensis*

Family: Theaceae (Ternstroemiaceae)

Common names: Cha, Chai

n = 15

Origin and distribution

Southeast China, foothills of the Himalayas of Myanmar and Assam are considered the areas of origin of tea. Presently the most important tea producing areas lie within a restricted region, from 5°S (in Java) to 35°N (in Japan) and from 80°E to 140°E; this includes China, Japan, Taiwan, Sumatra, Sri Lanka and India. The major tea growing areas in India are Assam, West Bengal, Kerala, Karnataka, Tamil Nadu, Tripura, and Himachal Pradesh.
Table 18.1: The common beverages

Alcoholic (Depressants)

- Fermented (alcohol is formed by the fermentation of sugar)
  - Wines: Fruit juices, mainly from grapes, 7-16% alcohol
  - Beers: Cereal starch mainly from barley, flavoured with hops (Humulus lupulus) 3-8% alcohol
  - Cider: Juice of apple
  - Perry: Juice of pear
  - Palm wine: Juice of palm inflorescence
  - Chicha: Maize kernels

Distilled (alcohol obtained by successive distillation of fermented liquors)

- Whisky: Fermented mash of cereals and potatoes
- Brandy: Fermented juice of various fruits especially grapes
- Rum: From sugarcane juice or molasses
- Gin: Fermented malt of barley and rye (flavoured with the 'berries' of common junipers, coriander and other spices)

Non-alcoholic (Stimulants)

- Tea: leaves
- Coffee: seeds
- Cocoa: seeds and pulp
- Mate or Paraguay tea: leaves of *Berberis aurea*
- Guarana: seeds of Amazonian climber - *Paullinia cupana*
- Cola: powdered seeds of *Cola nitida*
- Khat: leaves and buds of a north-east African plant *Catha*
- Yoco: bark of S. American tree *Paullinia yoco*
Table 18.2: Amounts of caffeine in commonly consumed beverages. (From Simpson & Conner-Ogortza, 1986)

<table>
<thead>
<tr>
<th>Beverage</th>
<th>Caffeine (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coffee</td>
<td></td>
</tr>
<tr>
<td>5 oz cup, drip method</td>
<td>146</td>
</tr>
<tr>
<td>5 oz cup, percolator method</td>
<td>110</td>
</tr>
<tr>
<td>5 oz cup, instant</td>
<td>53</td>
</tr>
<tr>
<td>5 oz cup, decaffeinated</td>
<td>2</td>
</tr>
<tr>
<td>Tea</td>
<td></td>
</tr>
<tr>
<td>5 oz cup, brewed (1 min)</td>
<td>9 – 33</td>
</tr>
<tr>
<td>5 oz cup, brewed (3-5 min)</td>
<td>20 – 50</td>
</tr>
<tr>
<td>12 oz cup, canned</td>
<td>22 – 36</td>
</tr>
<tr>
<td>Cacao and chocolate</td>
<td></td>
</tr>
<tr>
<td>6 oz, made with canned milk powder</td>
<td>10</td>
</tr>
<tr>
<td>1 oz milk chocolate</td>
<td>06</td>
</tr>
<tr>
<td>1 oz (1 square) baking chocolate</td>
<td>38</td>
</tr>
<tr>
<td>Soft drinks</td>
<td></td>
</tr>
<tr>
<td>12 oz Pepsi, regular</td>
<td>37</td>
</tr>
<tr>
<td>12 oz Coca Cola</td>
<td>34</td>
</tr>
</tbody>
</table>

Morphology

Tea plant (Fig. 18.1) is an evergreen or semi-evergreen woody shrub (9-15 m); the bushes are constantly pruned to encourage maximum leaf production and are also kept at plucking height. After about 10 years the bushes are often cut back to ground level allowing suckers to replace the old bushes. Leaves are alternate, generally elliptic to lanceolate with toothed margins (5-30 cm long); the undersurface of young leaves is covered with soft hairs that vanish with age. The old leaves become leathery. The characteristic fragrance and glossy of the leaves is due to the presence of numerous oil glands. See Fig. 18.2 for leaf anatomy. Flowers are white or pinkish with yellow centre, and are borne in leaf axils either singly or in groups of 2-4, from July to October. Fruit is a 3-celled woody capsule, each compartment of which contains a brown seed (about 1.25 cm in diameter). Fruit takes 9-12 months to mature, and deliquesce by splitting from apex into three valves.

The cultivated tea is generally grouped into two major types:
(a) China tea (C. sinensis var. sinensis)
(b) Assam tea (C. assamica var. assamica). Also see Table 18.3. In addition some hybrid tea varieties are also cultivated outside China, Japan and Assam.

![Fig. 18.1: A flowering twig of tea (From Koehlhar, 1998)](image)

![Fig. 18.2: A V.S. through a tea leaf. Vascular bundles are arranged in the midrib region. Stomata and thick-walled uniseriatal hairs are present on the upper surface. Druses are scattered throughout the mesophyll. Edible hairs are present on local stinging hairs to give the same. Tannin cells are distributed throughout. The margin of the tea leaf terminus is a stoma-covered gland that bleeds off easily, and is often not seen in mature leaves.](image)
Table 18.3: Difference between Assam and China teas.

<table>
<thead>
<tr>
<th>Assam tea</th>
<th>China tea</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Quick growing</td>
<td>1. Slow growing</td>
</tr>
<tr>
<td>2. Tree single-stemmed, 6.1-18.3 m in height</td>
<td>2. Bushes multi-stemmed, 1.2-2.7 m in height</td>
</tr>
<tr>
<td>3. Leaves large (15-20 cm long) held horizontally or pointing slightly downward, pale green with glossy and bullate upper surface</td>
<td>3. Leaves small (4-7 cm long), narrow, dark greenish with a dull flat surface</td>
</tr>
<tr>
<td>4. Flowers borne in clusters of 2 to 4</td>
<td>4. Flowers borne singly</td>
</tr>
<tr>
<td>5. Crop yield more</td>
<td>5. Crop yield less</td>
</tr>
<tr>
<td>6. Economic life up to 40 years</td>
<td>6. Economic life of at least 100 years</td>
</tr>
<tr>
<td>7. Richer in caffeine and polyphenolic compounds</td>
<td>111</td>
</tr>
</tbody>
</table>

In India a large number of promising triploid lines of tea have been produced by crossing tetraploid stocks with diploid clones.

**Agroclimatic conditions**

About 150 cm per annum rainfall that is well distributed throughout the year, and temperature between 21-32°C is required for vigorous growth. It grows best in deep, well-drained, acid soils (pH between 4.0-5.0), rich in humus. It does not grow in alkaline soils. Tea is tolerant of high levels (17,000 ppm) of aluminium. In some instances the accumulation of aluminium has been found to even cause aluminium toxicity in tea leaves. Aluminium is also a diagnostic characteristic for determining good tea soil, where it plays a regulatory role in the uptake of ions of manganese, or is associated with phosphorous uptake. Because tea is a leaf crop, nitrogenous manuring should be provided to neutralize the drain on nitrogen brought about by the regular removal of leaves. Application of ammonium sulphate consistently gives a good crop, because it maintains soil acidity, which is necessary for tea to flourish and it also imparts resistance to red rust caused by an alga (Cephalosporium). Tea develops more vigorously under light shade than in exposed situations. The shade trees are planted 12-15 m apart and the most commonly used species are Albizzia chinensis, A. procera, A. stipulata, Dalbergia assamica, Derris roxburghii, Gliricidia sepium, and Erythrina species. In addition to providing shade, they supply some of the essential plant nutrients and their roots ventilate the soil.

**Propagation**

Tea is usually propagated by seeds sown in nurseries. The viability of the seed is short and therefore it should be sown within a few days of gathering. Seeds germinate soon and the seedlings when nearly 30 cm tall are planted in the field. Vegetative propagation is by single internode cuttings taken immediately above the leaf and axillary bud. Plant is kept bushy through regular pruning. After about 10 years the bushes are often cut back to ground level allowing suckers to replace the old bush. Harvesting or plucking involves removing the young tender shoots, i.e., the terminal bud and two or three of the youngest leaves (Fig. 18.3). Plucking is done generally when trees are 4 years old. A single bush can be plucked about once a week.

![Fig. 18.3: The plucking of tea leaves. The terminal bud and the first two leaves of the young shoot are plucked for preparing finer grades of tea.](image-url)
The type of processing of the leaves depends on the final type of tea desired. Commercially, tea is of three basic types: black, green, and oolong tea. The oolong tea is made from a particular variety of tea (Camellia sinensis var. chinensis). Also see Table 18.4. The fresh leaves after picking are lightly packed in baskets to prevent bruising and heating, and are immediately sent to the processing units (Fig. 18.4 a-f).

Fig. 18.4 The basic steps involved in the processing of tea. a) Harvesting of tea (also Fig. 18.3). b) Withering and fermentation of tea. c) Drying leaves in bamboo baskets over charcoal, this way is common in China, d) A tea cutter. e) Withering and fermenting technique on wicker trays, a method commonly used in the Orient. f) Drum is also employed for accomplishing withering. g) Hand rolling in black tea production. h) Rolling of tea also done by machine, one such early rolling machine is shown in the figure. i) A power tea dryer. (From Simpson & Conner-Oguzery 1986).

Table 18.4: Difference between Black, Green and Oolong tea.

<table>
<thead>
<tr>
<th></th>
<th>Black tea</th>
<th>Green tea</th>
<th>Oolong tea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Four-fifth of the world's tea is processed into black tea.</td>
<td>It is fermented (this causes alteration of various chemical constituents of the leaf)</td>
<td>About 1/5 of the tea drunk worldwide is the green tea</td>
<td>2/5 of the tea drunk is oolong tea</td>
</tr>
<tr>
<td>1. It is semi-fermented.</td>
<td></td>
<td>1. It is unfermented.</td>
<td></td>
</tr>
</tbody>
</table>

(Contd.)
2. It involves 6 main operations:
   i) Withering
   ii) Rolling
   iii) Fermentation
   iv) Drying or firing
   v) Cleaning process
   vi) Grading

This is also known as orthodox method of tea processing.

i) Withering – is done in open sheds or in special sheds equipped with controlled heating and ventilating facilities. The leaves are spread thinly over withering racks, arranged one above the other horizontally, and allowed to remain there for 12 to 18 hours at 30°C to let them lose the excessive moisture. Moisture content is reduced to 50 - 60% from 75 - 80%. Sometimes, heated air is forced over these racks if the atmosphere around is humid. The leaf slowly and evenly becomes soft and flaccid like soft leather and is ready for rolling.

ii) Rolling – imparts the characteristic twist to the leaf, breaks the leaf cells, exposes the juices to the air for fermentation, to set in. After half-an-hour of rolling the leaf is removed in aluminium trolleys to a sifter and ball breaker. This machine consists of a long and flat metal sheet with perforations, fixed on a frame which makes reciprocating motion; as a result the broken leaf and fine particles fall below and the rest is taken out after sieving to be rolled for the second time with increased pressure. The leaf which is still green and quite flaccid is removed to the fermenting room.

iii) Fermentation – The temperature (24-27°C), and relative humidity (RH-90%) are controlled in the fermenting room.

2. It involves 3 main operations:
   i) Heating or steaming
   ii) Rolling
   iii) Drying

i) The leaves are generally plucked without stalk and are heated in an iron pan, i.e., pan fired (as in China) or steamed (as in Japan), instead of natural withering. Steaming makes the leaves pliable for rolling and protect the leaves against fermentation and blackening. This process inactivates the enzymes polyphenol oxidase and thus prevents the oxidation of polyphenols.

ii) The leaf is rolled and dried more or less in a similar way to black tea.

2. It involves 4 steps:
   i) Withering
   ii) Light fermentation
   iii) Rolling
   iv) Drying

i) The leaves are slightly withered before pan firing; during this process a slight fermentation is allowed.

ii) Rolled and dried like black tea.
fermentation house. The rolled leaves are spread on tiles of aluminium or even glass sheets for oxidation. During fermentation, the tannin (polyphenols) in tea are partly oxidised and the leaves change colour and turn bright coppery-red. As a general rule, the shorter the fermentation, the more pungent would be the liquor obtained; and the longer the fermentation, the softer the liquor and deeper the colour.

iv) Drying or firing - is done to arrest further oxidation of the leaf and to reduce moisture content to 3-5%. Careful regulation of temperature is essential as excessive heat will scorch the leaves while lack of it will result in incomplete drying. A current of hot (90-100°C) air is passed for 20-25 minutes in specially constructed ovens.

v) Cleaning process - Tea is now cleaned and sorted with the help of rotating or vibrating screens.

vi) Grading - There are essentially three grades of Indian tea: leaf, broken waste left, and dust (smallest particle's) excluding tuft and stalk, which after sorting and grading is called 'fluff', it contains 3.5% caffeine and can be used for the extraction of caffeine. After grading tea is packed in tea chests lined with tin or aluminium foil and paper. It is produced mainly in India and Sri Lanka.

<table>
<thead>
<tr>
<th>Beverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>In each of these main classes, the tea is further classified, according to size, and final grades which generally bear fancy names (Table 18.5).</td>
</tr>
<tr>
<td>There is a special market for Oolong tea in America and is exclusively manufactured in southern China and Taiwan.</td>
</tr>
<tr>
<td>Most teas made in China and Japan are of this type. A small quantity of green tea is also manufactured in North India but mainly for sale in Afghanistan, Iran. and in America.</td>
</tr>
<tr>
<td>Polishing is done with soapstone or French chalk to improve colour.</td>
</tr>
<tr>
<td>Drying retains the greenish colour of the leaf due to the absence of fermentation. Tea obtained by iron pan firing is of better quality.</td>
</tr>
<tr>
<td>Drying or firing is done to arrest further oxidation of the leaf and to reduce moisture content to 3-5%. Careful regulation of temperature is essential as excessive heat will scorch the leaves while lack of it will result in incomplete drying. A current of hot (90-100°C) air is passed for 20-25 minutes in specially constructed ovens.</td>
</tr>
<tr>
<td>Cleaning process - Tea is now cleaned and sorted with the help of rotating or vibrating screens.</td>
</tr>
<tr>
<td>Grading - There are essentially three grades of Indian tea: leaf, broken waste left, and dust (smallest particle's) excluding tuft and stalk, which after sorting and grading is called 'fluff', it contains 3.5% caffeine and can be used for the extraction of caffeine. After grading tea is packed in tea chests lined with tin or aluminium foil and paper. It is produced mainly in India and Sri Lanka.</td>
</tr>
</tbody>
</table>

In each of these main classes, the tea is further classified, according to size, and final grades which generally bear fancy names (Table 18.5).
Table 18.5 Different Grades of Tea.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Category</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaf</td>
<td>Orange Pekoe (O.P.)</td>
<td>Bud, first leaf and softer parts of the stalk, the buds are absent. Bold and round leaf with pale liquors.</td>
</tr>
<tr>
<td></td>
<td>Pekoe (P.)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pekoe Souchong (P.S.)</td>
<td></td>
</tr>
<tr>
<td>Broken</td>
<td>Broken Orange Pekoe (B.O.P.)</td>
<td>Contains tips or bud leaf, tips are absent. Leaves are little large than B.P., lighter in the cup.</td>
</tr>
<tr>
<td></td>
<td>Broken Pekoe (B.P.)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Broken Pekoe Souchong (B.P.S.)</td>
<td>These are smaller than B.P., are quick in brewing. The smallest particles excluding 'Fluff' and 'stalk', blended with smaller sized leaves or broken grades.</td>
</tr>
<tr>
<td>Dusts</td>
<td>Fannings or Pekoe (F. or P.)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fannings (F.)</td>
<td></td>
</tr>
</tbody>
</table>

Cuppage from orthodox tea is 200 cups a kilogram of tea leaves.

Legg-cut teas: It is manufactured mainly in the Dooars, Terai, and in some Cachar gardens of North East India. This process eliminates withering, which is often difficult in these humid areas. As the non-withered leaf is difficult to roll, the leaf is cut into small strips by using a chaff-cutter, also known as Legg-cutter, after which these teas take their name. After being cut, the leaf is lightly rolled and allowed to ferment for a short time before being thoroughly 'red'. Although the tea is slightly brownish and stalky in appearance, it is still in demand because of its quick brewing and fine liquorizing qualities.

Brick tea: It is prepared from left-over waste, left after the preparation of black and green teas. It may consist of leaf, stalks and even twigs or mainly coarse tea dust. The bulk is softened with steam and then compressed into blocks or bricks. This type of tea is mostly consumed in Tibet and China.

Leppet-so or Miang: It is pickled tea. In Myanmar, Thailand, and China the boiled or steamed green leaves of tea are preserved in pits. They are used more as pickles or vegetables than as beverages.

C.T.C. Tea: Besides the 'orthodox' method of tea processing, a variation was introduced in the process of manufacturing tea especially in north India. The variation consists of the use of a machine named 'crushing, tearing and curling machine' (C.T.C. in short). The machine consists of parallel stainless steel rollers revolving inward at different speeds. The rollers are about 1 meter long, 15 cm in diameter and are grooved concentrically and spirally. The concentric grooves of one roller are made to inter-mesh with those of the other to varying degrees. The leaf after withering is lightly rolled without pressure. Then the fine leaves are separated and the coarse leaves are fed into this machine 2, 3, or even 4 times. The leaves fed between the rollers get 'mangled'. The time required to pass the leaves through the machine is very short (only a few minutes), therefore the time spent in the rolling room is considerably reduced and this in turn, reduces the whole manufacturing time. The cuppage from C.T.C. tea is 500-1000 cups a kilogram of tea leaves.

Chemical Composition

The main constituents which give tea its distinctive character as a beverage are polyphenols (these are derivatives of gallic acid and catechin, but not tannins). These polyphenols are oxidized by enzyme action during maceration and fermentation to produce ortho-quinones, and these ortho-quinones are changed into:

(i) theaflavins or TF (which is related to brightness of the infusion), and

(ii) thearubigins or TR (responsible for body and strength of tea). Ideal fermentation produces a proper balance of TFs and TRs and these are partially extracted in brewing tea (also see Fig. 18.5).
Epigallocatechin, its gallate, and probably epicatechin

↓ enzymic oxidation

ortho-quinones

↓ dimerization

bis-flavanols

↓ condensation

theaflavins (TF)

condensation

thearubigins (TR)

Fig. 18.5: Biochemical changes during black tea preparation which are partially extracted while brewing (From Eden, 1976).

In addition, the alkaloid fraction caffeine (or theine) is responsible for the stimulating and refreshing effect; a small amount of the allied alkaloid theophylline is also present.

The most important aromatic components are the essential oils (flavou) which give the characteristic aroma and flavour to the tea.

Fresh plucked tea leaves contain:

- Water 75-80% (dry weight percentage)
- Polyphenols 20-30%
- Protein 10%
- Caffeine 2.5-4.5%
- Crude fibre 4%
- Pectin 6%
- Sugars 12 kinds
- Organic compounds 6 types

Fresh manufactured tea contains: (i) about 3 per cent moisture, (ii) about 2.5-4.5 per cent caffeine (twice as much as that of roasted coffee beans - 1.0-2.0 per cent), (iii) the polyphenols concentration is reduced to 12 per cent from 38 per cent, and (iv) several B-complex vitamins and Nicotinic acid.

A cup of tea contains on an average a little under a gram of caffeine and about two grams of polyphenols and provides four calories. When milk is added to tea, polyphenols are fixed by the casein in milk, thus robbing it of practically all its astringency. This sugar added to the tea merely adds to the value of the drink as a food. A tablespoon of milk and a lump of sugar to a cup of tea gives 40 calories. In green tea most of the polyphenols are present in the original form. Green tea does not have as much aroma and flavour as black tea, since fermentation is omitted.

**Box 18.1: Boston Tea Party**

Americans of European descent were primarily tea drinkers. They were so used to their tea that they became angry when the British declared that they had to pay a tax on tea which was brought to their colonies. To show their resentment, the colonists staged the famous Boston Tea Party (December 16, 1773) during which they dumped 342 chests of tea of the British East India Tea Company's cargo into Boston Harbor.

**Uses**

1. Tea has been used as a beverage for 2000-3000 years.
2. Caffeine is manufactured from tea waste.
3. The popular concept that tea is a health promoting beverage has been greatly strengthened by detailed research in humans and animal models as regards the
inhibition of the complex processes leading to coronary heart diseases and various types of human cancer.

**Box 18.2: Tea in India at a glance. (From Jain, 1995)**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area under tea cultivation</td>
<td>4.25 lakh hectares</td>
</tr>
<tr>
<td>Average yield</td>
<td>1752 kgs per hectare</td>
</tr>
<tr>
<td>Production</td>
<td>744 million kgs</td>
</tr>
<tr>
<td>Domestic consumption</td>
<td>80 million kgs</td>
</tr>
<tr>
<td>Export earnings</td>
<td>Rs. 900 crores</td>
</tr>
<tr>
<td>India's share in world production</td>
<td>31 percent in 1992</td>
</tr>
<tr>
<td>India's share in world export</td>
<td>29 percent in 1992</td>
</tr>
<tr>
<td>Tea first discovered</td>
<td>By the Chinese Emperor Shen Nung in 2737 B.C.</td>
</tr>
<tr>
<td>First discovered in Assam</td>
<td>By Major Bruce in 1823</td>
</tr>
<tr>
<td>First exports to Britain</td>
<td>8 Chebs in 1838 from tea grown by tribals</td>
</tr>
<tr>
<td>Research Centres</td>
<td>- Tocklai Experimental Station, Jorhat, Assam; - Tea Research Institute of UPASI, Cinchona, Coimbatore, and Tamil Nadu; - CSIR Complex, Palampur</td>
</tr>
</tbody>
</table>

**SAQ 1**

(i) Why is tea plant often pruned?

(ii) Describe the morphology of tea leaves.

(iii) Differentiate between Assam and China tea.

(iv) Tea bags are manufactured from leaf fibres of which plant?

**18.3 COFFEE**

Botanical name: *Coffee spp.*; *C. arabica* (Arabic coffee)  
*C. canephora* (Robusta or Congo Coffee)  
*C. liberica* (Liberian coffee)

Family: Rubiaceae

Common name: Coffee

n = 11

Origin and distribution

Ethiopia, Africa and most probably the province of Kaffa in Ethiopia are believed to be the area of origin of coffee. There are two botanical varieties of *Coffea arabica* from which 90 per cent of the world's production is obtained.

1. *C. arabica* var. *arabica* (syn. var. *typica*) is considered to be the primitive form.
2. *C. arabica* var. *bourbon* is native to Ethiopia. It gives higher yields than var. *arabica* under favourable conditions and has replaced the latter in Brazil.
C. canephora (Robusta coffee) and C. liberica (Liberian coffee) are used to produce about 9 and 1 per cent respectively of the world's crop. Table 18.6 tabulates the diagnostic features of the Arabian, Robusta and Liberian types of coffee.

It is cultivated 20° North and South of the equator. Annual global production of coffee is over six million tonnes. Brazil is the largest producer of coffee (27.2% of the world's total production). Colombia accounts for 25% of the world's total production. It also grows in Cote D'Ivoire. The headquarters of International Coffee Organisation (ICO) established in 1963, are in London, UK.

In India coffee is grown in Karnataka, Kerala and Tamil Nadu besides the Northern Eastern States, Andhra Pradesh and Orissa. India contributes 3.5 per cent of the world production (2.23 lakh tonnes in 1995-96 and was ranked sixth among the producing countries; the production in 1997-98 was 2.4) lakh tonnes. The Central Coffee Research Institute (CCRI) is in Chikmagalur, Andhra Pradesh.

Table 18.6: Differences between Arabian, Robusta and Liberian coffee.

<table>
<thead>
<tr>
<th>Arabian coffee</th>
<th>Robusta coffee</th>
<th>Liberian coffee</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Plants are less hardy than the other two.</td>
<td>1. Plants are more hardy than the Arabian coffee.</td>
<td>1. Plants are more hardy than Arabian coffee.</td>
</tr>
<tr>
<td>2. Produce less fruits per tree</td>
<td>2. Produce more fruits per tree</td>
<td>3. Produce more fruits per tree</td>
</tr>
<tr>
<td>3. It is a self compatible polyploid (2n = 44)</td>
<td>3. It is a self incompatible diploid (2n = 22)</td>
<td>3. It is a self incompatible diploid (2n = 22)</td>
</tr>
<tr>
<td>4. Better flavor than the other two.</td>
<td>4. Its bitter flavor is preferred in some parts of Africa. It is used in blended coffees or to make decaffeinated or instant coffee where the taste is disguised or changed.</td>
<td>4. Most bitter of the three and is used mainly as a filler in mixtures with other coffees.</td>
</tr>
</tbody>
</table>

Morphology

It is an evergreen shrub or a small tree (4.5-9.0 m height) but is kept low by pruning. Pruning has other advantages as well as it: (a) produces robust and well balanced framework, (b) promotes the periodic rejuvenation of fruiting branches, and (c) protects from wind and excessive sunlight. The leaves (Fig. 18.6) are ovate-elliptic, opposite, glabrous and glossy with undulate margins acuminate tips and interpetiolar stipules. The flowers (Fig. 18.6) are star-like, snow white and small delicately like jasmine flowers. These occur in dense axillary clusters, and are produced in flushes, 3 to 4 times a year. Flowers are short-lived, remain open in the morning and fade by mid-day. The Fruit (Fig. 18.6) is a drupe (1.5 cm long). It is greenish turning crimson red at maturity, i.e., about 6 to 9 months after flowering. The drupe has 3 distinct regions: epicarp or outer thin deep crimson skin; mesocarp is yellowish mucilaginous or fleshy; and endocarp is hard, cartilaginous and parchment like, enclosing two (occasionally only one), ellipsoidal or oval seeds often called coffee beans. Coffee seeds or beans have an outer delicate seed coat called silver skin and the bulk of the seed is composed of a curiously folded cotyledonendosperm enclosing a very small embryo (Fig. 18.6 g).
Agroclimatic conditions

C. arabica grows well in cooler and less humid climate of mountainous regions from 600-1700 m. C. canephora and C. liberica grow better in warm humid low-lands. For healthy growth, plants require an evenly distributed rainfall of over 150 cm per annum; it must have subsoil moisture all the year. Napier grass seems to conserve subsoil moisture in East Africa where the rainfall is below 125 cm per annum. Mulching is also useful in low rainfall areas to increase yield. Average temperature should be around 20°C. Coffee is a soil exhausting crop and grows best on deep, slightly acidic, well drained fertile loams of lateritic or volcanic origin. The ‘terra roxa’ soils (red soils rich in iron and potassium) of Brazil are famed for coffee growing. Earlier coffee plants were grown in shade (Brazil and Hawaii) but there is a growing tendency to eliminate shade. Without shade a substantially higher level of fertilizer application is necessary especially nitrogen. Usually ammonium sulfate is applied which has an acidifying influence on the soil; shortages of individual elements are more quickly noticeable than under shade tree. In highlands, shade has a favourable effect, because it moderates the temperature fluctuations between day and night. In regions with slight rainfall or long dry spell, coffee cannot be cultivated with shade trees, as these would use too much water. The lack of shade can in part be compensated for by a thick layer of mulch (more uniform and lower soil temperature). The optimal pH value is 6-6.5. The quality of coffee is influenced by the growing conditions.

Cultivation

Coffee is largely propagated by seeds. C. canephora and hybrids are mostly or exclusively propagated vegetatively; usually single-node cuttings of unripe wood is used for this purpose. Coffee seeds remain viable for only 2 months, and up to 4 months with storage in moistened charcoal powder. About 8-weeks after sowing the seedlings are transplanted from the seed-beds into nursery beds, or better into plastic bags. The
seedlings are planted (about 2 m apart) in the open, after the development of 6 pairs of leaves and before the appearance of the first side shoot. Fruits are borne when the plant is 2-5 years old. Often coffee is intercropped with bananas or figs for extra economic benefits. In Tamil Nadu it is grown along with Piper nigrum. Coffee trees may live for 50 years or more, but are generally productive only for about 25 years.

Harvesting
Although coffee trees come into bearing 3-5 years after planting, full bearing generally takes place after 6-8 years. The fruits mature (7-9 months after flowering) over a period of several weeks; picking of ripe red berries at intervals of 10-14 days is necessary.

Processing
Coffee berries are processed by anyone of the following methods:
1. **Dry method** is an older method of processing coffee and is practised in Africa and Near East and also in other coffee producing countries where water is scarce. Gathered fruits, also called berries, along with twigs and other extraneous material are spread out in thin layers in the open sun or in hot air driers for 15-25 days. Fruits are turned over to permit uniform and thorough drying. Thereafter they are put in bags and stored in warehouses.

2. **Wet method** fruits are pulped as soon as possible after picking and not longer than 24 hours or they begin to ferment. This method includes the following steps (see Fig. 18.7): Fruits or berries are placed in large tanks filled with water. The well developed fruits sink to the bottom. Thereafter, such ripe fruits are subjected to pulping, fermenting, drying, hulling, polishing, grading and roasting.
   
   i) **Pulping** — brought about by pulping machines which remove the exocarp and part of the fleshy mesocarp. The remaining pulp adhering to the parchment coat of the beans is separated by controlled fermentation.
   
   ii) **Fermentation** — is carried out by enzymes, yeasts and bacteria, that remove the mucilage adhering to the endocarp. This process usually takes 12-24 hours. Fermentation may be hastened by adding enzyme preparations or 2 per cent NaOH.
   
   iii) **Drying** — depulped fruits are dried to a moisture content of about 12 per cent either by exposing to sun or by hot air driers. At this stage the beans (seeds with endocarp) are bluish green and shrink within the parchment shell that appears like a silver skin. The greenish coffee can be stored for a long time.
   
   iv) **Hulling** — removes the seed parchment (endocarp) and also the seed coat or pellicle or testa (silver skin), exposing the coffee seeds.
   
   v) **Polishing** — improves the sheen on the surface of the beans (seeds) and also removes the vestiges of seed coat and parchment.
   
   vi) **Grading** — defective beans are sometimes picked out by hand; at this stage the beans may be bagged and shipped for export.
   
   vii) **Roasting** — polished coffee beans are roasted in coffee roasting machines for 5 min at a temperature of 200-260°C. The seeds become deep brown, porous and crumbly and there is partial sugar caramelization. The beans lose 14-23 per cent of their weight but they increase in size by 30-100 per cent. They also develop the characteristic coffee aroma and flavour (is due to essential oil — caffeine and the terpenoids present in the roasted beans). Raw coffee does not have the flavour or taste associated with coffee. During roasting the main stimulating constituent caffeine is freed from the tannin complex ‘caffetoannic acid’ and it is reduced by half. Also see Table 18.7.
   
   viii) **Grinding** — roasted beans are rapidly cooled in vats and are ready for grinding.
   
   ix) **Packaging** — is done in impervious containers under vacuum or in an atmosphere of inert gas. Powdered coffee loses its aromatic quality and turns rancid if it is not immediately put in hermetically sealed containers. Caffeine is present in ground coffee to the extent of 0.75 to 1.5 per cent.
Fig. 18.7: Diagrammatic representation of steps in the processing of coffee. a) The ripe or fully-ripe beans are hand-picked. b) These are washed with water and later subjected to fermentation. c) Fermented beans are dried after removing the pericarp. d) The green beans can be transported to market. e) A simple roasting machine for roasting beans. Modern machines have automatic feeders and roasting chambers. (From Simpson & Conner-Ogrzylo, 1986).

Instant coffee

This is obtained by vapourising a strong infusion of coffee in vacuum or by the freeze-drying technique. Beans of *C. canephora* are generally used in making instant coffee.

Coffee Flavours

The flavour of coffee depends upon the following:

(a) location,
(b) type of variety,
(c) degree of ripeness of the seed,
(d) method of curing and drying,
(e) practice of roasting, and also
(f) the extent and type of substitutes used.

Professional coffee tasters like tea tasters blend together, in appropriate proportions, coffees from different locations, to produce a particular flavour.
Caffeine-free (decaffeinated) coffee

It is obtained by removing the caffeine from unroasted greenish coffee beans with any of the following methods: (a) using organic solvent, (b) water extraction, or (c) steam extraction.

a) Solvent method

Beans are presoftened with steam and are extracted with an organic solvent such as methylene chloride. The solvent is then drawn off the beans and any remaining traces left in the coffee are evaporated by steam or heat during the roasting process. The caffeine is removed from the solvent with water. About 20 kg (44 lb) of caffeine is recovered from each ton of processed coffee.

b) Water extraction method

Green beans are percolated with water that is saturated with all of the water-soluble compounds in coffee except caffeine. The caffeine is then removed from the extraction water with organic solvents and purified. In this method no toxic organic solvents actually come into contact with the coffee. This is a costlier method.

c) Steam extraction method

The procedure is a well guarded secret.

Table 18.7: Average composition of raw and roasted coffee beans (From Kochhar, 1998).

<table>
<thead>
<tr>
<th>Constituents</th>
<th>Raw (per cent)</th>
<th>Roasted (per cent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ash</td>
<td>3.77</td>
<td>5.79</td>
</tr>
<tr>
<td>Fats</td>
<td>1.42</td>
<td>8.30</td>
</tr>
<tr>
<td>Moisture</td>
<td>8.26</td>
<td>0.36</td>
</tr>
<tr>
<td>Sugars</td>
<td>8.18</td>
<td>1.84</td>
</tr>
<tr>
<td>Gluten</td>
<td>10.68</td>
<td>12.03</td>
</tr>
<tr>
<td>Caffeine</td>
<td>1.10</td>
<td>1.06</td>
</tr>
<tr>
<td>Cellulose</td>
<td>42.36</td>
<td>44.96</td>
</tr>
<tr>
<td>Extractive matter</td>
<td>14.03</td>
<td>26.28</td>
</tr>
</tbody>
</table>

Uses

1. In Arabia, an alcoholic drink is prepared from the dried coffee pulp.
2. 'Coffelite' - a type of plastic material with good insulating properties can be made from coffee beans.
3. The residues from coffee processing are used as fertilizer and mulch.
4. In India the residue is also used as fuel and animal fodder.
5. In Ethiopia, drinks are prepared from dried leaves, and dried and roasted berries.
6. In Indonesia and Malaysia, a tea is made from the coffee leaves.
7. Coffee has a stimulating effect on the central nervous and vascular system.
8. It is also a diuretic and aids in digestion by stimulating the flow of digestive juices and increasing intestinal peristalsis.
9. A cup of coffee contains about three times more caffeine as much as a cup of tea.

Adulterants of Coffee

Roasted peas, beans, cereal grains and roasted tamarind seeds are its common adulterants. Many times use of flavour enhancers like chocolate, liqueurs, orange or almond extract and vanilla, is also made. The most common coffee additive is chicory (Cichorium intybus, Asteraceae) root, which can be considered an adulterant or a flavour enhancer.

SAQ 2

i) Differentiate between Arabian, Robusta and Liberian Coffee?
ii) What type of soils are good for coffee growing?

................................................................................................................

................................................................................................................

iii) How is decaffeination of coffee done?

................................................................................................................

................................................................................................................

8.4 Cocoa

Botanical name: **Theobroma cacao** (from the Greek words theos – God, and brona – food, “Food of the Gods”)

Family: Sterculiaceae

Common name: Cacao, Cocoa or Chocolate tree. The term ‘Cacao’ is often employed for the tree and its parts, and ‘Cocoa’ for the manufactured products.

\[ n = 10 \]

It is believed to have originated in the slopes of Andes, South America. Like coffee, production of cocoa is now highest in areas far removed from its place of origin, but within the same latitudes, between 20° North and South of equator. Since 1988, Cote Divoire is in the lead (680,000 t), followed by Brazil (347,000 t), whereas Ghana (West Africa) now stands in third place (290,000 t). Ghana was the leading producer in 1975, followed by Brazil, Nigeria and the Ivory coast. Other countries that produce cocoa are Dominican Republic, Papua New Guinea, Mexico, Togo, Colombia, Venezuela, Indonesia, The Philippines and Sri Lanka. The production in Southeast Asia has gone due to increase in cultivation in Malaysia (220,000 t), surpassing Nigeria (140,000 t). India, cocoa is mainly grown in the foothills of the Nilgiris and in some parts of Kerala. The subspecies of *T. cacao* and its forms interbreed readily to give fertile FI hybrids; this has given rise to a large number of recognizably distinct local populations.

From commercial point of view, two varieties of *T. cacao* are important: ‘criollo’ and ‘forastero’ (Table 18.8). The ‘criollo’ is mainly grown in Venezuela, Colombia and Central America, whereas ‘forastero’ is grown in Africa and South America, particularly Brazil. This accounts for 80 per cent of the cocoa beans entering the world market. Another variety ‘trinitario’ probably a hybrid of ‘criollo’ and ‘forastero’ is grown chiefly in Trinidad.

Table 18.8: The major differences between typical Criollo and Forastero Cocos.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Criollo</th>
<th>Forastero</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit colour</td>
<td>Yellowish-red, spotted</td>
<td>Greenish-yellow</td>
</tr>
<tr>
<td>Fruit form</td>
<td>Elongated, pointed</td>
<td>Oval</td>
</tr>
<tr>
<td>Fruit surface</td>
<td>Uneven, warty, deeply furrowed</td>
<td>Smooth, shallow</td>
</tr>
<tr>
<td>Fruit husks</td>
<td>Thin and soft</td>
<td>Firm and tough</td>
</tr>
<tr>
<td>Seed size</td>
<td>Large, round</td>
<td>Small, flat</td>
</tr>
<tr>
<td>Number of seeds in a fruit</td>
<td>2-6</td>
<td>30-60</td>
</tr>
<tr>
<td>Colour of cotyledons</td>
<td>Creamish to rose</td>
<td>Purplish</td>
</tr>
<tr>
<td>Aroma</td>
<td>Strong</td>
<td>Weak</td>
</tr>
<tr>
<td>Yield</td>
<td>Low</td>
<td>High</td>
</tr>
</tbody>
</table>

................................................................................................................

................................................................................................................
The cocoa tree grows to a height of 8-10 m, but under cultivation it is kept low by pruning. The root system mainly consists of the tap-roots, reaching about 2 m deep into the soil. The feeding roots arise from the root collar (5-6 m long), and are found in the upper 15-20 cm of the soil. The branching pattern of the cocoa plant is characteristic (Fig. 18.8). The stem grows orthotropically in the first 14-18 months. When a height of 1.2-1.5 m has been reached, it stops growth, and the main stem (chupon) divides into generally 5 meristems. From the meristems arise the plagiotropic fan branches, which have indeterminate growth. This group of plagiotropic branches is called a 'jorquette' or 'fan'. After sometime, an axillary bud develops just below the jorquette into a vertical orthotropic shoot, the 'chupon', which again forms a jorquette a few feet higher up, then another vertical shoot arises just beneath the second jorquette. Thus in the course of years, a number of tiers of plagiotropic branches are formed. Both chupon and fan branches bear flowers and fruits.

The leaves are spirally arranged on the main stem and subsequent chupons but are alternately arranged on jorquette branches. The mature leaves are dark greenish about 37 cm long and 7.5 cm broad, oblong-oval or elliptic-oblong with prominent veins and veinlets. The short petiole has two articulations.

The inflorescences occur on the old leafless wood of main stem (Fig. 18.9) and fan branches. It is much compressed cincinnal or helicoid cyme with branches greatly reduced. These branches originate from buds in the axil of reduced prophylls (minute sessile leaves at the base of branch arising from an axillary bud). Branch does not usually grow out, but its shortened and twisted branches broaden into a cushion. Each cushion may bear up to 50 flowers in one season. Peduncles and bracts are pubescent, i.e., covered with short, soft hairs. When inflorescence is stimulated by a fungal disease (witches' broom), the cushion grows out into a leafy shoot.

The flowers are tiny, white, yellowish or pinkish, pentameric, pedicellate (1.2 cm long) and bisexual. Sepals are 5, pinkish or white, triangular, fleshy, valvate, shortly united at base. Petals are 5, smaller than sepals; base is obovate 3-4 mm long, expanded into a concave, cup-shaped pouch; end of the petal is spatulate (2-3 mm), yellowish, bending outwards and backwards and attached to pouch by narrow connective (Fig. 18.9 a-c). Androecium has 5 outer staminodes with ciliate margins opposite the sepals and they form a ring around the style; the 5 inner fertile stamens bend outwards and the anthers are concealed in the pouches of the corresponding petals. Gynoecium has 5 carpels; ovary is superior, ovule (anatropous) are numerous. At the base of the ovary the placentation is axile and it is parietal above. Style is single, hollow and is shorter than the surrounding fence of staminodes. Stigmas are 5, more or less adherent. Fruit is a drupe, commonly called a pod (Fig. 18.9 d,e). It is borne directly on the stem - this condition is botanically known as cauliflory. The fruit is indehiscent, white, greenish or reddish, variable in size and shade. Pericarp (husk) is usually fleshy and mesocarp is thick. Pods mature in 4-6 months after fertilization including a month for
Economic Botany

ripening. Seeds are usually called beans. Each fruit has 20-60 seeds. Seeds are arranged in 5 rows, variable in size and shape.

Fig. 18.9: Flowers and fruits of coca (Theobroma cacao). A flower and two buds growing directly from the trunk. b) A magnified view of the flower. c) A flower in longitudinal section. d) Two fruits borne directly on the trunk. e) A fruit in cross section. (From Simpson & Corona, 1986).

Box 18.3: Cacao and the acrobat bird.

A small black and grey bird known as acrobat, which was christened *Acrobates ornatus* (cocoa) was first sighted by researchers in November, 1994. The conservation of this bird is a matter of great concern! A Roman poet Juvenal described this bird as "Rara avis", a rare bird on the earth. According to a researcher in Rio’s Federal University, the acrobat is the only example of the ovenbird family in the region; the other members of the family died out after their habitat was dramatically altered by the introduction of the cocoa plantations 200 years ago. The acrobat had survived by adapting to the changes. The cocoa plantations require an extensive forest canopy to protect them from the Sun, and it is in these overhanging shade trees that the acrobat lives. More than 76 per cent of Bahia’s cocoa trees have been afflicted by witches’ broom disease, a killer fungus that has no cure. Once the cocoa plantations are destroyed, the acrobat will have lost its only habitat.

Harvesting

The fruits are produced when the cocoa tree is 3-4 years old, although full production is reached only when the tree is 10 years old. Fruiting occurs throughout the year. As mentioned earlier, fruits reach maturity in 4-6 months, and the crop may be collected in two flushes: (i) from October to February; and (ii) from May to August. Fruits are harvested with a hook-shaped knife so as not to damage the cushion like growth on the trunk, the site for the growth of flowers the following year (Fig. 18.10a).

Processing of Cocoa

Fermentation - Fruits are slit open and the seeds and pulp are scooped out (Fig. 18.10 b) and fermented. In small plantations in W. Africa, cocoa is fermented in heaps or in medium-sized baskets, usually covered with banana leaves to retain the heat. Depending upon the climatic conditions the seeds are left for 7 or 8 days. They may be turned upside down to allow good aeration and to prevent the temperature from rising too high. During microbial fermentation, the sugar in the pulp is converted to alcohol by the activity of the
yeast (Saccharomyces spp.) and finally to acetic acid by Acetobacter spp. Seeds are killed by the penetration of alcohol and acetic acid and become brownish. The cotyledons shrink from the seed coat and separate. This characteristic aroma too develops at this stage, and is due to the presence of an essential oil: 'cacool'. These changes are brought about in the proteins and polyphenols by the endogenous enzymes which get activated by the rising temperature (40-50°C) of the whole mass of seeds. In large estates the fermentation is done in specially built perforated wooden or concrete 'sweating boxes' or 'fermentation bins' measuring 90 x 90 x 90 cm or 120 x 90 x 90 cm (the depth is not to be more than 90 cm). The sweating boxes are built stepwise; these are put on a raised platform to facilitate aeration (Fig. 18.10c). At the Cocoa Research Institute (CRI) in Ghana, fermentation is done in trays of 120 x 90 x 7.5 cm, with slotted bottoms made from palm frond midribs; 10 or more trays can be stacked on top of each other and the last one is covered with banana leaves. In 4 days time fermentation is complete.

**Drying** - after fermentation the seeds are washed and spread on trays and put in natural or artificial driers. The seeds are agitated for uniform drying. The moisture content is reduced to 6 per cent.

**Polishing** (Cleaning) - The seeds are polished either by machine or by trampling the wet seeds with bare feet, a practice known in Trinidad as 'dancing the cocoa'. After the removal of the contaminants such as twigs, stone and dust the seeds are graded and can be exported.

**Roasting** - After cleaning the beans are roasted in iron drums at 125-140°C (Fig. 18.10e). Roasting helps to reduce the acidity and astringency, lowers the moisture content, deepens the colour, facilitates shell removal, and develops the flavour of the seeds. The roasted cocoa seed contains:
Fat (cocoa butter) ... 30-36 per cent
Starch ... 15 per cent
Albuminoids and mineral matter ... 15 per cent
Theobromine ... 3 per cent
Caffeine ... Small quantity

During roasting some of the theobromine from the cotyledons passes into the shell and because of this the extraction of theobromine from the seed residues has become an important industry.

Breasting and winnowing/flanning – The seeds are machine cracked and the heavier cotyledons (also called nibs) are separated from the shell by winnowing. The nibs are ground into an oily paste termed ‘bitter chocolate’ or ‘chocolate liquor’ or ‘cocoa mass’.

Cocoa manufacture – In the manufacture of cocoa powder two-thirds of the fat from the ‘cocoa mass’ is removed by hydraulic pressing and the remaining ‘mass’ (cocoa butter) is pulverised. Cocoa butter is a very stable fat with a storage life of 2-5 years. An alkali treatment is often used to: (a) reduce acidity by neutralizing many organic acids; (b) develop the flavour; and (c) darken the colour. This is also known as Dutching (as this method was developed in Holland).

Chocolate manufacture – (see Fig. 18.10 f) In the preparation of chocolates, extra cocoa butter and sugar are added to the ‘chocolate liquor’. The whole mass is repulverised, flavoured and then cast in small sized bars or bricks. In the manufacture of milk chocolates, the ‘chocolate liquor’ contains more whole milk solids.

Chemical composition
The seeds or ‘beans’ are a rich source of nutrients and flavour. The cotyledons or ‘nibs’ are rich in oil (cocoa butters); starch and protein content are about 15 per cent each. There is up to 3 per cent of the alkaloid theobromine, small quantities of caffeine, and traces of various aromatic oils.

Uses
1. Cocoa is a highly concentrated energy food and is also a very nourishing beverage as it contains fats, proteins, carbohydrates and vitamins.
2. Cocoa is the chief natural source of alkaloid theobromine. It is mainly extracted from seed residues and is transformed to caffeine and much of it is used in ‘colas’.
3. Cocoa powder may be flavoured with spices, vanilla and other natural or artificial flavours and is used for cakes, puddings and iced creams.
4. Cocoa beverages produced in water or milk have a mild stimulating effect.
5. Cocoa butter is used in confectionery, pharmaceutical ointments and toiletries.
6. The cocoa shells are used as livestock feed, fertilisers, mulch, fuel and an adulterant of cocoa powder and chocolate.
7. In the Philippines, some of the raw cocoa beans are still used for chewing.

Adulterant
Powdered mesocarp of the fruit of carob tree, Hindi – Khambh (Ceratonia siliqua), (family Caesalpinaceae), native of E. Mediterranean region, also grown in Punjab is a rich source of protein and sugar and is used as a chocolate substitute/adulterant.

SAQ 3
1. Why is cocoa known as “Food of the Gods”? .................................................................................................................
   .................................................................................................................
   .................................................................................................................

2. What is ‘chocolate liquor’? .................................................................................................................................
   .................................................................................................................
   .................................................................................................................
3. Name an adulterant/substitute for chocolate.

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18.5 SUMMARY

In this unit you have learnt that:

- Beverages (exclusive of soft drinks) can be grouped into 2 heads: (i) alcoholic, and (ii) non-alcoholic.
- Alcoholic beverages are depressants.
- Non-alcoholic beverages like tea, coffee and cocoa are stimulants because they contain chemicals primarily caffeine (alkaloid) and its relatives which cause physiological reactions in our body.
- Tea, coffee and cocoa are tropical crops.
- Tea – Camellia sinensis; family – Theaceae; centre of origin – S.E. China and India. It is an evergreen woody shrub. Leaves are used in the preparation of the beverage. The type of processing of the leaves depends on the final type of tea desired: commercially, tea is fermented to bring about alteration of various chemical constituents of the leaf. Green tea is unfermented. Oolong tea is semi-fermented. Tea is a health promoting beverage if consumed moderately. Adulterant – stalks, dust.
- Coffee – Coffea arabica, C. canephora, C. liberica; family – Rubiaceae; centre of origin – Ethiopia, Africa. It is an evergreen shrub or a small tree. Seeds commonly called beans, are used in the preparation of the beverage. Coffee seeds are processed by either: (i) dry or (ii) wet method. Coffee has a stimulating effect on central nervous and vascular system. Adulterants – dried roots of chicory, dandelion, cereal grains, roasted tamarind seeds.
- Cocoa – Theobroma cacao; family – Sterculiaceae; centre of origin – slopes of Andes, South America. The cocoa tree has a characteristic branching pattern. Seeds (usually called beans) and pulp are scooped out of the fruits (drupe) and fermented, dried, polished and roasted; the cotyledons are ground into an oily paste termed ‘bitter chocolate’ or ‘chocolate liquor’ or ‘cocoa mass’. Cocoa and chocolate are manufactured from the cocoa mass. Cocoa is a very nourishing beverage as it contains fats, proteins, carbohydrates and vitamins. Adulterant – powdered mesocarp of the fruit of carob tree (Ceratonia siliqua, Caesalpiniaceae).

8.6 TERMINAL QUESTIONS

1. Fill in the blanks:
   i) The characteristic aroma and flavour of tea is due to the presence of ..........................................
   ii) The stimulating and refreshing characteristic of tea is due to the presence of ..........................................
   iii) ............................................. are responsible for brightness, body and strength of tea.
   iv) Coffee is often intercropped with ............................................. for greater economic returns.
   v) Decaffeinated coffee is obtained by removing the caffeine from ............................................. coffee beans/seeds.
   vi) The seeds are polished either by machine or by trampling the wet seeds with bare feet, a practice known in Trinidad as .............................................
   vii) Powdered mesocarp of the fruit of ............................................. is a rich source of protein and sugar and is used as a chocolate substitute or adulterant.
   viii) The most common coffee additive is ............................................. which can be considered an adulterant or a flavour enhancer.
   ix) Tea bags are manufactured from leaf fibres of .............................................
   x) The characteristic coffee aroma and flavour is due to .............................................
2. Expand the following terms:
   (i) CTC
   (ii) CCRI
   (iii) CRI
   (iv) ICO

3. Where are the following located:
   (i) Cocoa Research Institute
   (ii) Headquarters of International Coffee Organisation
   (iii) Tocklai Experimental Station

4. What is the difference between Black, Green and Oolong tea?

5. Describe the event called 'Boston Tea Party'.

6. What are CTC, Brick, Leppet-so and Legg-cut teas?

7. How many calories are there in a cup of tea (a) with, and (b) without addition of one tablespoon of milk and one lump of sugar?

8. Sketch and label parts of *Camellia sinensis* leaf.

9. Write the steps involved from the time coffee berries are plucked until drinking coffee powder is prepared.
10. How is instant coffee powder obtained?
...........................................................................................................
...........................................................................................................
...........................................................................................................

11. Which are the coffee growing states in India?
...........................................................................................................
...........................................................................................................
...........................................................................................................

12. Distinguish between 'Criollo' and 'Forastero' varieties of cocoa.
...........................................................................................................
...........................................................................................................
...........................................................................................................

13. Describe the branching pattern of the cocoa plant.
...........................................................................................................
...........................................................................................................
...........................................................................................................

14. Describe the manufacture of chocolate, write all the steps involved from the time the fruits are harvested until the preparation of chocolate bars or bricks.
...........................................................................................................
...........................................................................................................
...........................................................................................................
...........................................................................................................
...........................................................................................................
...........................................................................................................

15. What type of inflorescence is seen in Cocoa tree?
...........................................................................................................
...........................................................................................................
...........................................................................................................

18.7 ANSWERS

Self-Assessment Questions

1. i) The bushes are often pruned to encourage maximum leaf production and also to keep them at plucking height.
   ii) See Fig. 18.2, and Section 18.2.
   iii) See Table 18.3.
   iv) Tea bags are manufactured from leaf fibre of Musa textilis (Musaceae).

2. i) See Section 18.3. Table 18.6.
   ii) See Section 18.3, 'Agroclimatic conditions'.
   iii) See Section 18.3, 'Caffeine-free (decaffeinated) coffee'.

3. i) Cocoa is known as "Food of the Gods" because the Mayans (tribe in Central and South America) thought that cocoa had a divine origin and Linnaeus named a Theo bromacacao (from the Greek words theos - God, and broma - food).
   ii) See Section 18.4, 'Chocolate manufacture'.
   iii) See Section 18.4, 'Adulterant'.

Terminal Questions

1. i) essential oil
   ii) theine/alkaloid/caffeine
   iii) polyphenole
iv) banana/fig/black pepper
v) unroasted/greenish
vi) dancing the cocoa
vii) carob tree/Ceratonia siliqua
viii) chicory/Cichorium intybus
ix) Abacá/Musa textilis
x) caffeol/essential oils

2. i) Crushing, tearing and curling
  ii) Central Coffee Research Institute
  iii) Cocoa Research Institute
  iv) International Coffee Organisation

3. i) Gbela
  ii) London
  iii) Jorhat, Assam, India

4. See Section 18.2, Table 18.1

5. See Box 18.1

6. See Section 18.2.

7. (a) 4 calories
   (b) 40 calories

8. Refer to Fig. 18.2

9. See Sections 18.3.

10. Refer to Section 18.3.

11. Refer to Section 18.3.

12. See Table 18.8

13. See Section 18.4.


15. Compressed cincinnal cyme (helicoid cyme)