

# B.Sc. Botany, SEM-IV (H)

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Economic Botany

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# Morphology, Processing and Uses of Tea

**Tea** is an aromatic beverage commonly prepared by pouring hot or boiling water over cured leaves of the *Camellia sinensis*, an evergreen shrub (bush) native to East Asia. After water, it is the most widely consumed drink in the world. There are many different types of tea; some, like Darjeeling and Chinese greens, have a cooling, slightly bitter, and astringent flavour,<sup>[5]</sup> while others have vastly different profiles that include sweet, nutty, floral or grassy notes. Tea has a stimulating effect in humans primarily due to its **caffeine** content.



# Origins:

*Camellia sinensis* (or tea plant) is used to make most traditional caffeinated teas, including black tea, white tea, oolong tea, and green tea. This plant originated near the southwest region of China as an evergreen forest shrub. The oldest known beverage, tea is native of China in South East Asia. It was known to the Chinese as early as 2737 BC, but attained the status of a popular drink in England in 1664 AD. India is the largest producer, consumer and exporter in tea industry. Tea belongs to the genus *Camellia* and family Camelliaceae.

## Varieties

Two varieties of the tea plant make up some of the most popular types of tea. ***Camellia sinensis sinensis* (Chinese tea)** is native to China and thrives in cool temperatures and high elevations. It is commonly grown on mountain slopes, producing a sweeter, gentler taste indicative to both green tea and white tea.

***Camellia sinensis assamica*** (Assam tea or Indian tea), on the other hand, thrives in the Assam region of Northern India. This plant is considered more tropical than its Chinese variety, growing larger and producing bigger leaves (due to a climate with plenty of rain and warm temperatures). This variety is used for robust teas like black tea, oolong.

## **Morphology:**

*C. sinensis*, a member of theaceae family is an evergreen tree or shrub that attains a height of 10 - 15 m in the wild and 0.6 - 1.5 m when cultivated.

The leaves are light green, short stalked, coriaceous, alternate, lanceolate, serrate margin, glabrous or pubescent beneath, varying in length from 5 - 30 cm and about 4 cm width. Mature leaves are bright green colored, smooth and leathery while young leaves are pubescent.

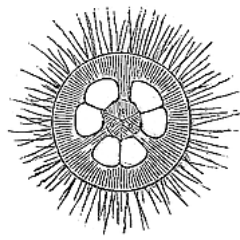
Flowers are white fragrant, 2.5 - 4 cm in diameter, found in solitary or in clusters of two or four.

Flowers bear numerous stamens with yellow anther and produce brownish red capsules (Ross, 2005).

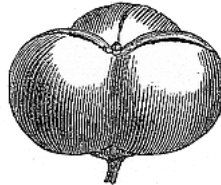
Fruit is a flattened, smooth, rounded trigonous three celled capsule, seed solitary in each, size of a small nut (Biswas, 2006).



*Camellia oleifera.*



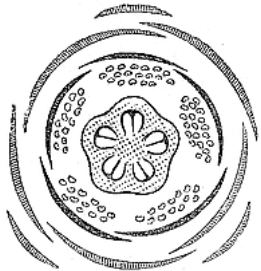
*Camellia.*  
Transverse section of ovary.



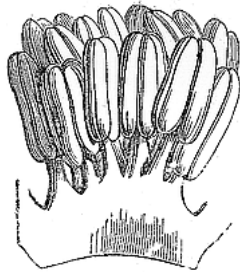
Tea.  
Fruit (mag.).



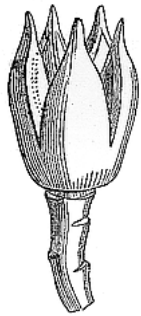
Tea. Seed, entire and cut vertically (mag.).



*Gordonia lasianthos.*  
Diagram.



*Gordonia.*  
Part of androecium (mag.).



*Gordonia.*  
Ripe fruit.



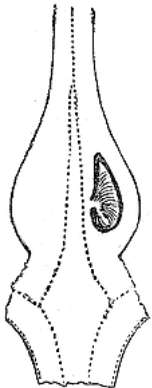
Tea.  
Embryo  
(mag.).



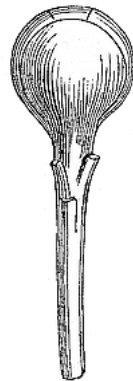
Tea.  
Half-embryo,  
inner face  
(mag.).



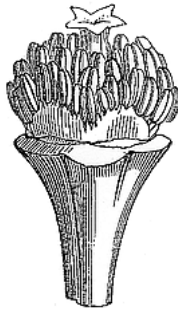
*Gordonia.*  
Pistil (mag.).



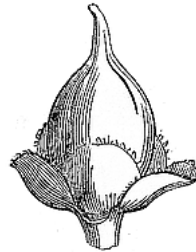
*Gordonia.*  
Vertical section of ovary (mag.).



*Gordonia.*  
Flower-bud (mag.).



*Gordonia.*  
Androecium and pistil (mag.).



*Gordonia.*  
Young fruit.



*Gordonia.*  
Embryo cut (mag.).



# Cultivation

## Climate and soil

Tea is exacting in its climatic requirements. The temperature may vary from 16 to 32°C and annual rainfall should be 125 to 150 cm, which is well distributed over 8-9 months in a year. The atmospheric humidity should be always around 80% during most of the time. It is grown in plains in North Eastern States but in South India, it is grown in hill ranges from 600 to 2200 m above M.S.L.

Tea is a calcifuge crop requiring comparatively low amounts of calcium but high quantities of potassium and silicon. Optimum pH range is 4.5 to 5.0 and soil depth should be 1.0 to 1.5m.

## Propagation

Tea can be propagated by seed and by cuttings. Seeds collected from the fruits of seed berries are soaked in water and only heavy seeds, which sink, are alone used for sowing in beds. At the seedling stage they are carefully lifted and transplanted in polythene sleeves. They will be ready for planting in 9 months.

## Planting

The land is cleared of the roots of the fallen trees and drains are taken at suitable intervals depending upon the slope to conserve the soil. In the olden days, up and down system of planting at 1.2x1.2m are followed. Presently, contour planting either in a single hedge or double hedge system is followed.

Sr. No.	Type	Spacing	Population/ha.
1.	Up and down	1.2 x 1.2m	6,800
2.	Contour planting single hedge.	1.2 x 0.75m	10,800
3.	Contour planting double hedge.	1.35 x 0.75 x 0.75m	13,200

The last method has many advantages over the first two viz., early and high yield, better soil conservation, less weed growth in the hedge and efficient cultural practices. Planting season normally coincides with June/July and September/October for SouthWest monsoon and North East monsoon areas. Pits of 30x30x45cm size are dug and plants of 12-15 months old are planted by removing the polythene sleeves. Immediate after planting, plants are staked to prevent wind damage.



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### **After care:**

Immediately after planting, the soil surface around the plants should be mulched, usually cutgrasses of gautemala are employed for this purpose. About 25 tonnes of grass is required to mulch one hectare. Care must be taken to keep the mulch materials away from the collar region last they may cause collar diseases. This subsoil irrigation helps to minimise the causality besides encourages developing deeper roots.

### ➤ **Shade management:**

Tea requires filtered shade and if it is exposed to direct sun, its growth is affected. Shade is hence essential and beneficial to tea as

- It regulates the temperature.
- It minimises the effects of drought and radiation injury.
- It increases the soil fertility
- It helps in recycling of nutrients.
- It helps in getting even distribution of crop.
- It serves as windbreak.
- It reduces the incidences of pests.
- It generates additional income by way of timber and fuel.

## **Training and Pruning**

In the young tea, when it has established well, centering i.e. removing the growing point leaving 8 to 10 mature leaves from the bottom, is done to induce secondaries. When the secondaries reach more than 60 cm, they are tipped at 50-55 cm height by removing 3 to 4 leaves and bud to induce tertiaries. Therefore, plucking at mother leaf stage is continued for better frame development. It takes nearly 18 to 20 months from planting to reach regular plucking field stage.

### **Pruning is done in tea**

to maintain to convenient height for plucking

to induce more vegetative growth

to remove dead and de funct wood and

to remove the knots and interlaced branches.

Pruning is normally done 4 to 6 years interval depending upon the altitude of the garden, nature of the materials etc.

Tea bushes are grown from cuttings or seeds. They take about four years to mature. When they are six to 18 months old they are planted in a the plantation and when they get a little bigger they replanted into their permanent spot in a row at the plantation about four feet apart. About 3,000 plants grow in hectare of land.



Tea grows best on sloping terrain. Tea plants on mountains and hills rest on carefully constructed terraces that trap water and prevent erosion. Sometimes trees are planted for shade and windbreaks. Plants grow in low regions are ready to harvest after three years. Plants grow in high regions are ready to harvest after

## Tea Harvesting

Tea picking Tea is almost exclusively hand picked. In most parts of the world the work is done by women. Tea leaves have to be picked carefully. If they too big they are too tough; if they are too small they are not economically viable

The tea pickers pluck new and tender "flush" (two leaves and a bud). These flushes appear every seven or eight days in hot climates and around twice that long in cooler climates. Generally the buds near the end of a branch are considered to be the best quality. Lower quality one are found further down the branch. The flushes are flung over the shoulder of the pickers into baskets strapped onto their heads and backs. Good pickers pick around 160 pounds of leaves a day, from which about 40 pounds of finished eta is made.

Freshly picked leaves weigh about twice as much as correctly dried tea leaves. Skill and experience are needed to accurately judge their condition. It is difficult to produce a high quality tea. Some that do pick just one bud and two leaves from a single twig (many companies remove more leaves to increase production) and pick the leaves between 9:00am and 3:00pm when the leaves are in the best condition.



# Tea Processing:

## Withering

The first processing step after the leaves are harvested is a very basic one. Since *Camellia sinensis* leaves are thick and waxy on the plant, **they must be softened, or withered, to make them pliable for crafting. The leaves are laid out on fabric or bamboo mats, and left to wilt.** Modern tea farmers control the variables in this process with great precision. **The withering process reduces the water content of the leaves by as much as half.**

## Bruising

After the leaves are withered, crafting methods for different styles start to diverge. Oolong teas, black teas, teas usually undergo some sort of bruising process. **This means the leaves are rolled, twisted, or otherwise crushed.** The purpose of this step is to break down cell walls in the leaf, and facilitate the next step: oxidation.



Manually bruising a large batch of tea leaves was once the most demanding step in processing tea. **Leaves must be thoroughly and evenly bruised to produce a consistent batch of tea.** Some dark teas, with high levels of oxidation, must go through multiple rounds of bruising and oxidation. It's really no wonder that black tea producers began chopping leaves to speed up the process for the mass market.



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## Oxidizing

After bruising, leaves intended for oolong or black teas are left to oxidize, or turn brown. Again, the leaves are laid out and left to wither. **Now that the cell walls have been broken, an enzymatic reaction turns the leaves brown, just like a cut apple.**

**Leaves must be carefully monitored during this process.** For oolongs, in particular, missing the correct moment can mean ruining the tea, or crafting something entirely different than what was intended. Again, heat and humidity are carefully controlled, and trays are rotated to ensure even oxidation.

**This browning process is the primary differentiating factor between different styles of tea.** Green tea crafting skips these steps entirely, creating a tea that is by definition, unoxidized, and therefore still green in color. A black tea is defined as fully oxidized, without any green color left to the leaf. Pu-erh, or “post-fermented” tea, lies outside this spectrum. Pu-erh teas usually undergo bruising, but skip the wilting that creates oxidation.





## 5. Fixing

**To stop the oxidation process, the tea leaf is heated.** Just like baking an apple, the application of heat denatures the enzymes responsible for oxidation and stops the leaf from continuing to turn brown.

This step is applied to all tea styles except black tea, where the final drying step is used to slowly halt oxidation instead. **This fixing step is sometimes called the *kill green*, but it actually serves to preserve whatever green color is still left in the leaf at this stage.**

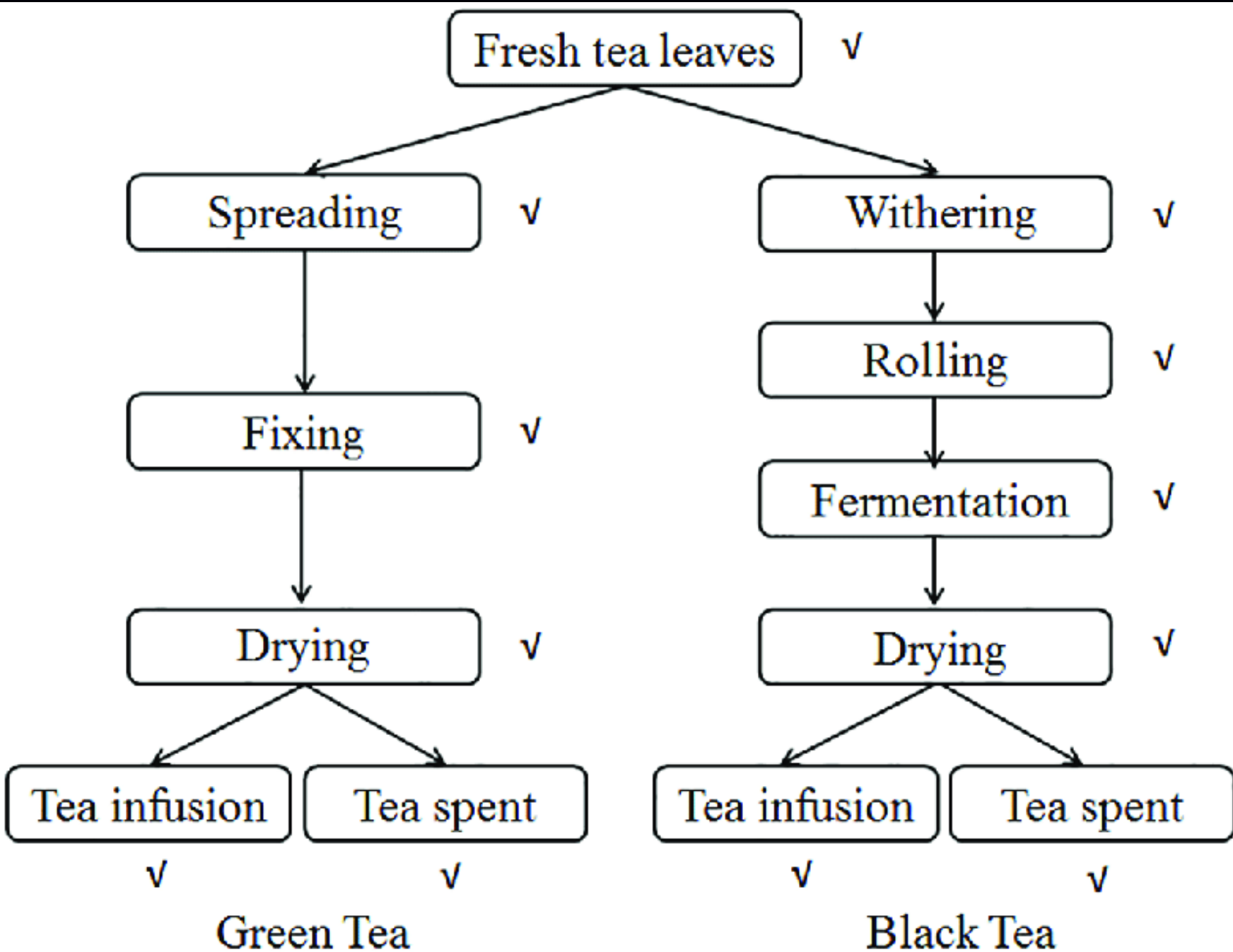


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## Drying

**Finally, all tea must be dried to remove any residual moisture and create a shelf-stable leaf.** Again, the method of heating can dramatically change the flavor of the tea. This effect is most commonly seen with charcoal roasting, which imparts a distinctly rich quality to the flavor during this step.

By contrast, the drying process can also be very gentle, to avoid imparting any flavor changes. White tea, for example, is usually given a very gradual bake, which replicates traditional sun-drying. After it's dried, the tea is ready to be packaged and shipped all over the world.





White  
Tea



Green  
Tea



Oolong  
Tea



Black  
Tea



## APPLICATIONS OF TEA

Tea is the most popular beverage consumed all over the world. In recent years its consumption is much higher due to its preventive effects against certain human diseases. Tea and its polyphenols have evidence based role in number of diseases (Dalluge and Nelson, 2000).

### ❖ **Antiaging properties:**

Free radical theory of aging suggests that oxidative stress and increased free radical generation leads to functional deterioration and degeneration e.g. neurodegeneration which is solely due to phenotype changes. Furthermore, green tea also decreases the level of a marker for oxidative DNA damage, 8-oxo-deoxyguanosine (8-oxodG) in liver kidney and cerebrum.

### ❖ Anticancer effects:

Main chemopreventive agents in green tea are complex flavonoid structures like EGCG, EGC, ECG and proanthocyanidins (Robbers and Tyler, 1999). Recently green tea catechins have gained significance in cancer prevention due to their structure similarity with chaperones and their interactions with target molecules.

### ❖ Cardiovascular effects:

Epidemiological studies show that a high flavonoid intake from tea may reduce incidences of coronary heart disease (CHD) as it improves vasomotion (Yaniv and Bachrach, 2005).

### ❖ Anticaries effects:

Green tea extract is effective in preventing dental caries because of its dual effect, that is, its flavonoid compounds are antibacterial while polyphenols possess an antiplaque activity.

### Antiparkinson's property:

Enzyme dopa decarboxylase which has key role in biosynthesis of biogenic amines. Enzyme is of high interest while developing drugs for hypertension and Parkinson's disease. Bertoldi et al., (2001) demonstrated green tea polyphenols EGCG and EGC both bind to the active site of enzyme and behave as irreversible inactivators of dopa decarboxylase following a pseudo first order kinetic at fixed concentration of EGCG (Bertoldi et al., 2001).

### Antibacterial activity:

Tea polyphenols show antibacterial activity, however, it is not determined precisely which species are inhibited by antioxidants. For example, polyphenols can inhibit clostridia and *Helicobacter pylori* but are ineffective against intestinal lactic bacteria.

### Activity against HIV:

The fact that green tea can be used as adjuvant therapy to AIDS is still hypothetical (Ernst et al., 2006).



# Thank You