PROCESSING OF TEA

Introduction

The most widely consumed ancient beverage is the Tea. *Camelia sinensis* is the botanical name of the tea plant. Processing of tea involves various steps like plucking, withering, crushing, drying, rolling and shaping of tea leaves through which the leaves are made ready for brewing. Tea consumption was originated in ancient China and reached the European continent in the 16th century. In India, tea was cultivated in Assam in the 19th century. Chinese variety (*C. s. Sinensis),* and Assamese variety (*C. s. Assamica)* are the two basic varieties of tea from ancient time. The practice of steaming fresh tea leaves and drying them for further storage and consuming it by decocting with other herbs was followed in China.

1. Tea Plant

Generally, the tea plant grows to height of 35 feet in tropical and subtropical climates. The plantations are cultivated at altitudes at 2460 m above sea level. For the ease of plucking and pruning the bushes are maintained at two to two and half feet height, so that the bush spreads and grows widely.

2. Processing of Tea

There are different types of tea, varying in colour, smell, taste and appearance due to the minor changes in the processing steps.

2.1. Types of Products from Tea

Products from tea are broadly classified into

i. Conventional teas and
ii. Nonconventional tea products

2.2. Conventional teas comprise of

(a) Completely fermented black tea,
(b) Unfermented green tea
(c) Partially fermented Oolong (red and yellow) tea,

2.3. Nonconventional tea products include

(a) Cold- and hot-soluble Instant tea
(b) Flavored tea and decaffeinated tea.

Canned or bottled teas, soluble tea mixes, tea beverages, frozen tea liquid, and tea tablets termed as convenience products. Liquid tea concentrates, tea mixes, iced tea mixes, and fruit tea mixes are the recent products that has shown tremendous increase in the global market.

3. Conventional Teas

3.1. Harvesting or Plucking

This operation is a significant step in the final quality of the tea. Usually, tender and uniform terminal bud and two shooting leaves or only shoots with three leaves are picked from the tea plant twice a year. Manual picking is done for high quality tea and it highly depends on the skill of the picker but this is a costly method. Mechanical picking of tea flushes and leaves are also practiced but it results in large quantities of broken leaves and partial flushes. However, mechanical harvesting at right time can yield high quality teas. Plucking of coarse leaves is strictly avoided since it interferes in the quality of the tea.

3.2. Withering

The plucked tea leaves are subjected to withering for initial removal of moisture content. Two methods of withering are generally practiced.

3.2.1. Natural method of Withering

The freshly picked tea leaves are spread out in very thin layers on wire meshed racks that are arranged one above the other and further subjected to drying in natural air for a minimum period of 20 to 24 hours.

3.2.2. Artificial Withering

The plucked tea leaves are widely laid in 18 to 20cm layers in tables with wire meshes that are placed in a tunnel in which forced circulation of warm air mixed with fresh air takes place. This method of withering significantly causes a reduced withering time, resulting in approximately 60-62% residual moisture reduction rendering the withered tea leaves suitable for tea processing.

3.3. Breaking Up

Breaking up is the process of rolling the withered tea leaves which is a pre-preparation step. This is done with the use of a circular table with a central cone with lateral slat like arrangement called battens. The top of the table is fitted with a circular jacket with a pressure cap. The table and jacket are made to rotate in opposite directions eccentrically, thereby causing the withered leaves placed in the jacket to twist and roll on the surface of the cone and battens which is almost similar to manual rolling.

3.4. CTC Method (Crushing, Tearing and Curling)

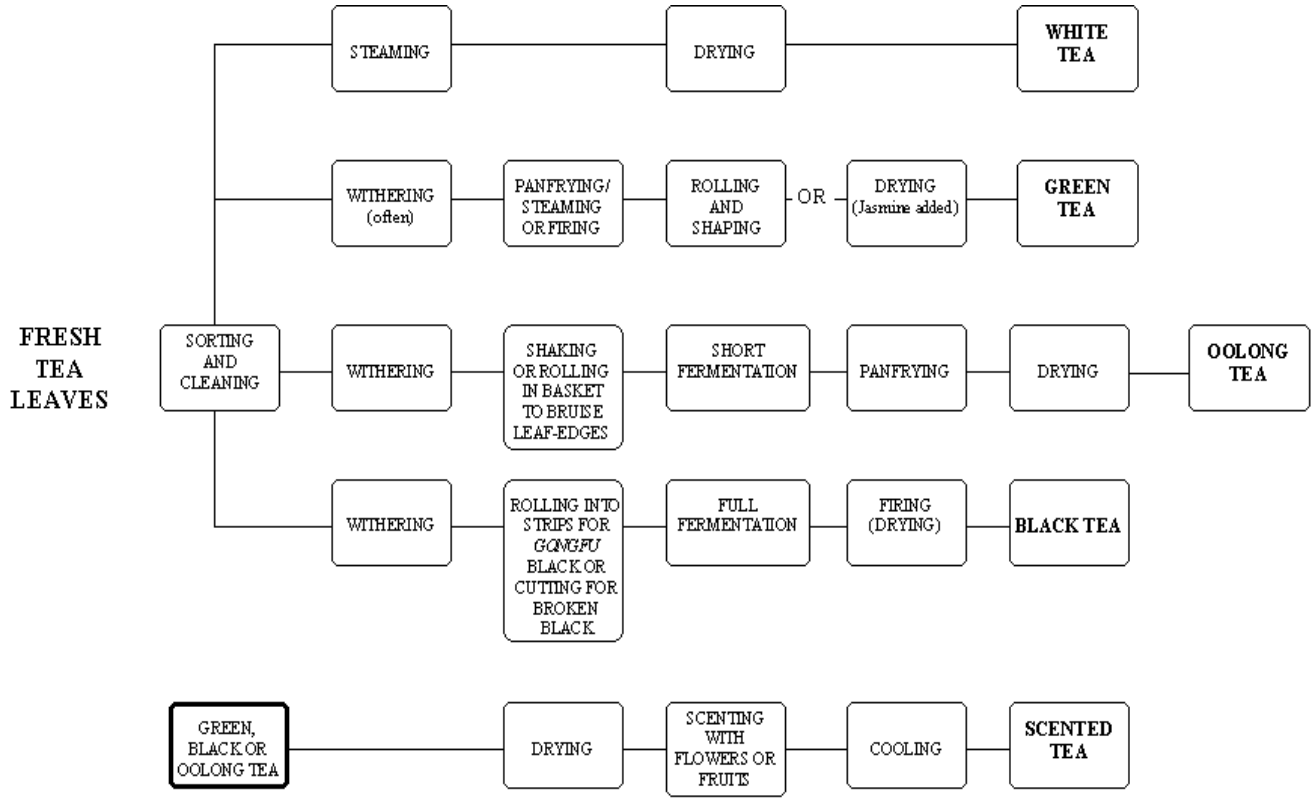
CTC machine comprises of two metal rollers that are separated but placed with minimum distance between each other that revolves at unequal speeds. This movement cuts, tears and twists the withered and broken up tea leaves. As a result the juice from the tea leaves are pressed to the surface of the leaves, which initiates the fermentation process.

3.5. Fermentation

During fermentation, the oxidation process which had begun during rolling is continued. Fermentation takes place in separate fermentation rooms, which need to be kept extremely clean to avoid bacterial infection of the tea. The tea leaves are placed in 3.5 –7.5 cm. layers on aluminium trays. The thickness of the layers depends on the room temperature. As soon as the tea has acquired a copper red color, the correct degree of fermentation has been reached, and the process must be halted by drying. The tannin content decreases during fermentation, from 20% in fresh tea leaf to 10%–12% after fermentation. The formation of aroma compounds is caused due to oxidation of amino acids, carotenes, and unsaturated lipids during the fermentation period.

3.6. Drying or Firing

The drying process carried on a 4 plates system drier. Hot air upto 90 °C, is blown against the leaves, which should have reached 80 °C, by the time has been completed, I order for the polyphenol oxidize enzyme to be properly inactivated. The moisture content should be reduced to 3.5% whereby the aroma becomes established and the leaves take on their typical black coloration.



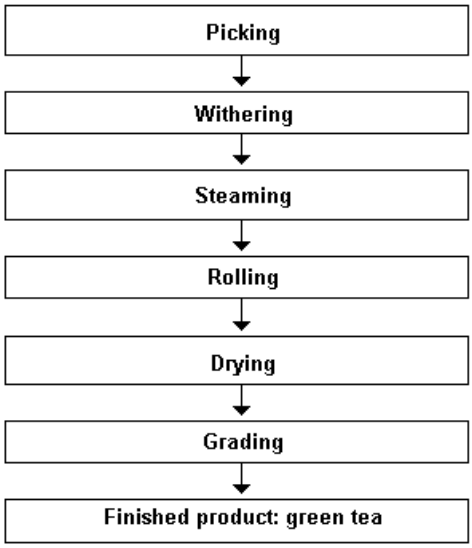
Flowchart 1 : Tea Processing

3.7. Grading and Storage of Fermented Tea

Winnowing is practiced to separate the stalky matter and grading is done by sieving, where from different grades of tea are obtained based on particle size. During the storage of finished tea products various chemical changes take place, leading to the loss of the remaining residual greenness and roughness in 10 to 15 days period. Tea should be stored in moisture and oxygen proof area to retain the flavor and aroma developed in fermented tea. Flavor retention is possible for more than 1 year, under such storage conditions.

4. Green Tea

A bud and two to three leaves of tea shrubs are harvested for Green tea production. Green tea consumption sums to around 21% of total tea production due to larger amounts of catechins and vitamins. Green tea possesses a pleasant taste and aroma, and has light olive green shade color. Since green tea is unfermented, the inactivation of browning enzymes is regarded as a crucial factor. The enzyme is inactivated either by steaming or by roasting the green leaves in a pan. The steps of manufacturing of green tea are similar to fermented tea except for the fermentation step. The steps include are plucking, steaming/roasting, primary heating and rolling, rolling, secondary rolling, drying, refining, firing, sorting, and packing. There are 18 different types of green tea worldwide.



Flowchart 2 : Green Tea Processing

5. Yellow Tea

Yellow tea is much similar to green tea but lies in between black and green tea. It belongs to the unfermented tea variety that is brighter in color on infusion than that of green tea. Yellow tea, yields a milder taste and is highly refreshing with a stronger aroma when compared to green tea. It contains a higher quantity of catechins and vitamins than black tea and therefore is highly stimulative.

A bud and two or three young leaves and tender shoots of the tea plant are used for the production of Yellow tea. Withering should be uniform right from the tender parts of the shoots, the bud, and first leaf to the third leaf and stalk. Withering, roasting, rolling, sorting, and firing are the steps in manufacturing yellow tea.

6. Red Tea

Red tea is a less fermented tea with a delayed enzymatic reaction and chemical processes with a mild taste and a stimulating aroma. Withering, rolling, roasting, firing, sorting, and final firing the steps involved in the production of red tea.

7. Dark Tea

An unfermented tea traded only in Chinese internal market is known as Dark tea. It is brownish yellow or brownish red after infusion. It yields a mild aroma and it is highly vulnerable to fermentation by microbes. One bud leaf, and four to six leaves united with stalks are subjected to withering and rolling followed by piling and drying continued by steaming, and then further compressed to obtain the Dark tea. Piling is an important quality determining factor; because of this fact the tea leaves are kept at high process temperatures and humidity for long periods of time to enable the natural growth of microorganisms such as *Aspergillus glaucus, Saccharomyces* etc. Piling causes oxidation of polyphenols due to the combined action of moisture, heat, and the microbes. When compared to yellow tea, dark tea contains no chlorophyll, and the concentrations of catechins and free amino acid are much lower thus resulting in a mellowed flavor of dark tea.

8. White Tea

A fermented type of Chinese tea meant only for export is White tea that gives light orange-yellow tea when infused. One fresh bud with one to two leaves with intense hairs or only buds containing moderate content of polyphenols undergoes the process of withering and firing. Thus obtained white tea is sorted, and packed. Withering is done for a period of three days during which amino acids content increases, and decrease in sugar and polyphenolic components levels is seen.

9. Nonconventional Tea Products

9.1.Instant Tea

The process of dehydrating the infusions of either black tea or green tea yields a highly hygroscopic product called Instant tea. Instant teas are available in different types namely hot-soluble and cold-soluble depending on consumer preferences.

9.1.1. Technology

Different raw materials which are used for Instant tea preparationare Green tea,black tea etc. Apart from processed tea, the low-grade tea, crude tea leavesand dust tea waste are also used as raw material. Quality control of ingredients for Instant tea preparation is mandatory to produce best quality Instant tea.

9.1.2. Extraction

Extremely good quality water is used for infusing tea for extraction. Generally co-current or counter-current methods of extraction are followed by continuous removal of moisture by dewatering. The combination of leaves used for extraction is mixed with hot water in varying ratios of tea leaves and water. As an alternate method the tea leaves are consecutively subjected to extraction in different stages and the resulting extracts so obtained are received in a tank and mixed thoroughly immediately before the final stage of concentration. In the countercurrent method, the tea leaves and the concentrated extracts are in opposite directions causing a gradual accumulation of solids in continuous extractions, up to nearly 10% level. To obtain a quality product it is usual to add a portion of the first extract finally before spray drying that makes up the flavor loss.

9.1.3. Decreaming and Cream Solubilization

At room temperature, the tea brew is cooled and forms a hazy layer termed as cream. This is due to a caffeine-polyphenol-protein complex formation which affects the organoleptic characteristics of tea beverages that are both hot-soluble and cold-soluble. Hence, a step called decreaming is practiced to remove the cream, by subjecting the extract to centrifugation or passing it through filtration membranes. Tea cream may also be solubilized by chemical methods or enzymatic methods.

9.1.4. Aroma Stripping and Aromatization

Steam or inert gases are used for the aroma stripping process immediately after extraction and just prior to concentration. The concentration is carried out at low temperature and pressure conditions and they are added again in the final tea concentrate.

9.1.5. Concentration

The tea extract is concentrated from 10% to 30% of solids either in a vacuum concentrator or in other evaporators like falling film evaporator or rising film or thin film evaporator. This is a crucial step for aroma retention. Usually the process is employed at very low temperatures and short entraining times of the tea extract in the concentrators. Permitted fillers are added to increase the solids concentration to 30%, to enhance the speed of the drying operation.

9.1.6. Drying

Spray driers, freeze driers or vacuum driers are used to dry the extract .The commonly used method is spray drying because the other methods involve high processing temperatures which causes high flavor losses. In order to increase the bulk density of the product either carbon dioxide or ammonium carbonate is added or the extract is subjected to agglomeration which is followed by spray drying. Anti-caking agents are added to the product since it is highly hygroscopic in nature.

9.1.7. Chemical Composition

The chemical composition of instant tea ranges as follows in percentages of: 40.5–49.0% of tannins, 55.2–89.4% of total catechins, 3.5–5.1% of caffeine. The total amino acids ranges from 7.0–8.0% with total nitrogen from 2.9 to 4.0%.The total protein nitrogen of the instant tea vary from 0.14–0.40%.

9.1.8. Blending

Blending of instant tea is done to enrich other teas varieties. Instant tea is added to regular tea to improve the constituents of extract from 40% to 70% which includes polyphenols, caffeine etc, thereby increasing the nutritive value. Since low-cost tea is used for the manufacture of instant tea, addition of 15% instant tea to any grade of regular tea does not affect its taste or flavor but yields high profit.

9.1.9. Flavored Teas

Flavoured teas are produced by incorporation of various natural or nature-identical flavors in processed teas. Flavored black tea, green tea, Oolong tea, instant tea, decaffeinated black tea, and decaffeinated instant tea are available worldwide. Incorporation of natural flowers or flower petals or skin peels of citrus fruits is done after the firing step in factories. Spiced teas with ginger, cardamon, clove, cinnamon or scented teas with lemon, orange, mint, bergamot, and rose are popular and consumed widely in all parts of the world. Essence of apricot, banana, apple, raisin, currant, date, prune, and fig is also added to impart the fruity flavor to tea.

9.1.10. Flavour Incorporation Techniques in Tea

Alternate layers of tea leaves and fragrant flowers are spread in a chamber to incorporate natural fragrance to tea. This chamber is subjected to heating in baskets for nearly 2 hours, which render the flowers crisp. The flowers are removed by sieving and the tea thus separated is packed. This tea is mixed with unscented teas in the ratio of 1:20.

Concentration of extract of liquid teas with spices like ginger, cardamom, clove, cinnamon, coriander, and cumin are done by adding them at the brewing stage itself.

There are two standardized diffusion methods that are generally practiced. The first direct method involves the mixing of flavor component in a small quantity to the desired grade of tea directly and then this blend is remixed with the bulk stored tea. In the second indirect method,

the flavor is sprayed on a ball of cotton or paper that comes into indirect contact with blend, where only vapors are in contact with tea.

In the third spraying method, tea is spread in layers of uniform thickness in trays, placed in specially constructed rooms. Automatic spraying devices are used for flavor incorporation on these layers. Flavor losses can be reduced by adding encapsulated flavours.

9.1.11. Decaffeinated Teas

For consumers who are concerned about the health effects of caffeine intake, decaffeinated teas are produced. About 60% to 90% of the caffeine is separated from the black tea by a process of solvent extraction, which is called decaffeination. This step reduces the caffeine content from 0.2%to 0.8%. Chemical or enzymatic treatment is employed to remove bound caffeine.The involved in the process are: (a) Increasingthe initial moisture contentfrom 10% to 40%; (b) organic solvent treatment for 12 to 18 hourswhich extracts 97% of the caffeine; (c) live steam treatment forthe removal of allresidual solvents; and (d) final drying for the excess moisture removal.

10. QUALITY STANDARDS AND SPECIFICATIONS

Physical, chemical, sensory, and microbiological specifications are the parameters assessed for the quality of black tea, decaffeinated black tea, and flavored tea.

In physical characteristics grades, particle size, bulk density, color, and appearance are assessed. For chemical quality polyphenols, total solubles, and extraneous matter are checked within the ISI and PFA standards.

Microbiological parameters are important in speciality liquid tea products like carbonated beverages, canned or frozen tea concentrates.

10.1.Physical Characteristics

Stalks, fiber, and foreign matter are removed from processed teas. They are graded into, leaf grade, brokens, fannings, and dust, based on the colour, particle size, and infusion qualities.

10.2. Chemical Quality of Tea

The quality of tea is governed by the presence of chemical substances like polyphenols including tannins, caffeine, pectins, theaflavins [TFs] and thearubigins [TRs], noncaffeine nitrogenous compounds, sugars, minerals, and lipids. Tannins are present upto 10% levels only in processed black tea in comparison to green tea that possesses 18%–20% of tannins.

10.3. Blending of Teas

The final moisture content of the graded teas is less than 3% moisture level. This graded tea is packed in tea chests, lined with aluminum foil in controlled humidity conditions. Tea with different characteristics are blended together to produce best satisfying quality product in the

consumer market on the basis of parameters like quality, flavor, strength, body, size and style of leaf.

10.4. Tea Tasting and Sensory Quality of Tea

The combined effects of nonvolatile solids extractable from tea leaf to about 0.30% to 0.45% solids concentration under normal brewing temperature determines the quality of tea. Infusion is made by adding boiling water of 0.142-L capacity in which a graded or blended tea sample of 2.83g is kept. After 5–6 minutes the brew containing 2% solids is assessed by a specialist characteristics like color, quality, strength, briskness, flavor etc.

11. Storage and Packaging Aspects

Different storage conditions are used to store manufactured black teas for a time period of 3 to 6 months before they reach the consumer market. Black tea is stored for 300 days, with flavor retention at 32% relative humidity, 20. Suitable packing materials, both unit and bulk packing, is essential to protect tea from moisture and oxygen.

To conclude this session let us recall the concepts of tea processing right from harvesting, withering, CTC Processing of tea leaves, fermentation, drying and packaging. Apart from conventional tea products, currently there is continued research in new product development, value-added products, convenience products, and development of compatible flavors to satisfy customer requirements.