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A review on specialty coffees

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Abstract
Coffee (*Coffea arabica* and *Coffea canephora*) is the most popular beverage consumed across the globe. Unique taste, aroma and flavor of coffee is mainly depend on the coffee growing regions, agronomic practices and different processing methods. Normally coffee is processed in two ways *i.e.*, wet method/parchment coffee and dry method/cherry coffee. After processing, method of brewing also plays an important role in obtaining different tastes of coffee. Some of the special methods of processing are employed which gives the coffee that differ from regular coffee and has unique flavor, aroma, taste and chemical composition which are also known as speciality coffees. It includes decaffeinated coffee, monsooned coffee, instant coffee, Kopi luwak, Black ivory coffee and steam treated coffee. Decaffeinated coffee is having lesser caffeine content, monsooned coffee is the speciality coffee of India produced by exposing coffee beans to moist monsoon winds (Produced only in India), instant coffee is devoid of insoluble compounds and steam treated coffees are less irritants to the stomach. Kopi luwak and black ivory coffee are the most expensive coffees of the world which are produced through digestive bioprocessing of civet cat and elephant respectively. Other than these, India has some special coffees grown in different regions known as coffees of India including Monsooned Malabar AA, Mysore nuggets extra bold, Robusta kaapi royale, Annamalais, Coorg, Brahmaputra, Wayanad, Pulneys, Araku valley, Baba budangiris, Shevaroys, Manjarabad, Nilgiris, Travancore and Biligiris. Coffee possesses many health benefits including antioxidant, antiviral, anti-inflammatory, antimicrobial and anticancer properties.

Keywords: Speciality coffee, flavor, aroma, caffeine

1. Introduction
Coffee is the second most consumed beverage in the world next to the tea. India being eighth major country to produce coffee in the world. It holds an area of 379,697 ha with the production of 334,000 MT. In India, Karnataka is the largest state producing coffee which holds an area of 79,855 ha with the production of 248,020 MT. It accounts for 71 percent of total Indian coffee. In India, states like Karnataka, Kerala and Tamil Nadu are the traditional coffee growing areas whereas, Andhra Pradesh, Orissa and North-Eastern states are non-traditional coffee growing regions (Coffee board of India, 2022-23).
Coffee is considered as Ethiopia's gift to the world. A goat herder in Ethiopia, name called Kaldi, found one of his goats was hyperactive. So, he went in search of reason behind it and he came to know his goat has eaten coffee berries. By this he know these berries have stimulating effects and he told this information to the monks and monasters. Through monks these berries reached Arabia (National Coffee Association, USA). First coffee shop was established in Mecca at the end of 15th century (Farah, 2009) [2].
A sufi saint, Baba budan brought 7 viable arabica coffee beans from Arabia to India. He planted those beans in Chandragiri hills of Chikmagaluru district of Karnataka in 16th century. In 18th century British has started commercial coffee cultivation in India.

2. Coffee processing
Coffee processing involves conversion of coffee beans to the cup. Mainly there are two types of coffee processing *i.e,* Wet method/Parchment coffee and Dry method/Cherry coffee (Vincent, 1987) [21]. Wet method of processing involves harvesting of ripe and fully mature berries and defective berries should be discarded. Then pulping of harvested berries has to be done *i.e,* removal of outer coverings and mucilage.

These berries are soaked in water and allowed to ferment upto 30-60 days depend on weather conditions. During fermentation, various enzymatic reactions will occur and number of chemical compounds will develop which is responsible for superior cup quality. Then fermented berries are washed where the silver skin is removed and dried upto 10-12% moisture content. Dry method of processing involves harvesting of ripe and fully mature berries and then spread on a floor for drying (sun drying/mechanical drying). Then unripe, disease and pest attacked and defective berries are cleaned out. Then pulping, removal of outer coverings and mucilage is done. Hulling, removal of silver skin is done. After this clean light brown/skin colour beans are left. Roasting is done by two methods *i.e*, drum roasting, where beans are in direct contact with hot surface and takes 15 min for roasting and fluid bed roasting, where beans are in contact with hot air and takes 12 min for roasting and considered as best method. The greatest aroma formation rates during roasting were found at the medium stages of product dehydration (Schenker *et al.*, 2002) [16]. Roasting will takes place till the temperature rise upto 210-230 °C. From 0-130 °C evaporation/ loss of moisture will occur and at 130 °C caramelization of sucrose will takes place and the beans colour change to brown. When temperature is raised to 160 °C series of exothermic and endothermic reactions will occur and volume of beans will increase, colour turn to light brown colour. When temperature increased to 190 °C Millard and Strecker reactions occur where the proteins, aldehydes and other compounds will turn to melanonoids (humic acid). At this temperature, compounds responsible for flavor and aroma like pyrizins, furans *etc*., will start developing upto 210-230 °C (Wei and Tanokura, 2015) [22].
There is a close correlation between the kind of post-harvest treatment and the contents of fructose and glucose. Washed coffee beans (wet processing) has lower amounts of these both hexose while in unwashed coffee beans (dry processing) sugars were significantly higher (Knopp *et al.*, 2006) [8].

3. Specialty coffees

Specialty coffees are the coffees which differ from regular coffee and has unique flavor, aroma, taste and chemical composition. These have gained immense popularity for its unique flavor and improved quality. There are large varieties of coffee trending every day due to the widened demand. Still, specialty coffee holds its place for its distinct processing methods. These are also considered the most expensive due to coffee varieties with novelty in processing which leads to limited availability and less productivity (Raveendran and Murthy, 2022) [14]. Some of the specialty coffees are decaffeinated coffee, monsooned coffee, kopi luwak, instant coffee, black ivory coffee and steam treated coffee.

3.1 Decaffeinated coffee

Caffeine is removed from the beans prior to roasting. It is reduced from 1-2 percent to 0.02-0.3 percent. Drinking regular coffee results in arise of blood pressure, a fall of heart rate and an increase of plasma catecholamines. De-caffeinated coffee only induces as light increase of diastolic blood pressure and so the circulatory effects of regular coffee are mainly brought about by the caffeine load (Smits *et al*., 1985) [17].

Caffeine removal is done by mainly three methods (Katz, 1987) [7]:

1. **Solvent decaffeination:** This is a semi-continuous process, green beans are passed through steam to raise the moisture level upto 40%. Then beans are transferred to extractor columns where the temperature will be between 50-120 °C and methylene chloride is added which extracts 95-98% caffeine from the beans. Then solvent and beans are separated. Wet beans are put into dryer to reduce moisture content. At last dry decaffeinated beans are obtained. This whole process lasts for 10 h.
2. **Water decaffeination:** In this method, water is used as solvent. Water will extract the caffeine content from the beans in extractor columns. Caffeine rich water is treated with methylene chloride at 80 °C to remove caffeine from water. Wet decaffeinated coffee beans are obtained and these are dried and cooled.
3. **Super critical CO_2 decaffeination:** In this method super critical CO_2 is used for decaffeination. Beans are kept in moisturizer to raise the moisture level upto 30-50%. In extractor chamber CO_2 removes the caffeine present in coffee beans and then dried in drum dryer. At last dried decaffeinated coffee beans are obtained.

After the process of decaffeination, beans will loose coffee aroma thus aroma is added after the process. US FDA allows up to 10 ppm of residual solvents in roasted coffee.
Caffeine less coffee plant was developed by RNA interference technology. Transgenic coffee plant is developed by repressing the gene encoding for theobromine synthase (CaMXMT1) and caffeine synthase (CaDXMT1) by RNAi (Ogita *et al*., 2003) [13].

3.2 Monsooned coffee

It is produced only in India during the month of June-September. Dry processed coffee beans are packed in gunny bags and exposed to moist monsoon winds prevailing in the west coast of southern India (Malabar coast) for 12-16 weeks. By this beans swell in size, change colour to light yellow and acquire an intensely mellow and musty flavor. *Aspergillus niger* was found to be the dominant fungus colonising the beans prior to monsooning, whereas A. ochraceus was found dominant during the course of monsooning. The other commonly encountered fungi were species of *Aspergillus*, *Penicillium*, *Absidia*, *Syncephalastrum*, Mucor and Rhizopus occuring at low numbers (Ahmad *et al*., 2003) [1]. The protein and reducing sugar content increased steadily while the tannin content decreased beyond the detectable limit during monsooning. The monsooned coffee beans had different mycoflora and varied biochemical composition compared to non-monsooned coffee beans (Tharappan and Ahmad, 2006) [19].
For preparing monsooned coffees only dry processed Arabica and Robusta beans are used. The coffees are mainly used in blends to mellow and impart richness to rougher, more acidy coffees. The best grade in monsooned coffee is Monsooned Malabar AA. A decrease in content of methoxypyrazines and an increase in 4-vinylguaiacol and isoeugenol resulted in a dominant spicy note of monsooned coffee. These phenolic compounds exist partly as their glycosides, and their release from the bound precursors during monsooning accounted for their higher content in monsooned coffee. A considerable decrease in astringent

chlorogenic acid as a consequence of hydrolysis to bitter caffeic acid was noted in monsooned coffee (Variyar *et al*., 2003) [20].

The monsooned coffee is unique specialty coffee in terms of physical and chemical characters. For the first time, antioxidant and antimicrobial activity of the water-soluble extracts of monsooned coffee have been reported. The fractions responsible for antimicrobial activity were identified as quinic acid and spinasterol (Murthy and Manonmani, 2009) [10].

3.3 Kopi luwak

It is also called as civet coffee. Civet cat is fed with coffee berries and in digestive system the outer coverings and mucilage is digested whereas, bean along with silver skin is left. The droppings of civet cat are collected, washed and processed. Coffee beans obtained from civet cat will have low caffeine, low pH and less bitter. Natural fermentation process in the civet stomach changes the chemical composition of the coffee beans and can improve the quality of the taste of coffee because, in addition to being at the optimal fermentation temperature, it is also assisted with enzymes and bacteria present in the digestion of the civet (Muzaifa *et al.*, 2019) [11]. It is recorded in the Guinness Book of Records as the 1st excellent and most expensive coffee in the World. Single cat will produce 14 kg/ season of droppings. Kopi luwak is most popular in Indonesia.

Significant differences in chemical characteristics between Kopi Luwak and regular coffee were observed. Caffeine content and protein content of Kopi Luwak were lower compared to regular coffee due to proteolytic enzymes present in digestive system break protein chains from coffee fruit and result in free amino acid. Whereas, acidity, fat and fatty acid of Kopi Luwak were higher than regular coffee due to lactic acid fermentation which results in the production of more aliphatic acids like butyric acid, acetic acid *etc.* (Ifmalinda *et al.*, 2019) [5]. The concentration of caffeine in Kopi Luwak coffee beans was lower and that of chlorogenic acid was higher than those in other coffee beans. The low caffeine concentration in Kopi Luwak coffee beans may reduce the chances of causing stress on the central nervous system and developing cardiac diseases. Chlorogenic acid is known for its taste-modifying property, inhibition of the elevation of blood glucose level, sugar absorption, and anticancer and anti-aging properties. Kopi Luwak coffee beans may possess higher function than those of other coffee beans (Nishiguchi *et al*., 2017) [12].

3.4 Instant coffee

In 1901, the first successful technique for manufacturing a stable powdered product was invented in Japan by Sartori Kato, who used a process he had developed for making instant tea. Five years later, George Constant Washington, a British chemist living in Guatemala, developed the first commercially successful process for making instant coffee.

It is made from arabica coffee beans. Roasted beans are finely ground and then water is added at temperatures of 155-180 °C. Concentrate the coffee solution to about 15-30% coffee by mass then dry the concentrate using either vacuum evaporation or freeze drying. Freeze drying is expensive, but results in higher-quality product. Then clarification is done by filtration and centrifugation where the insoluble compounds present the coffee powder are removed. Recently instant coffee cubes are also emerged in market which also contain sugar. Directly adding these cubes in a cup of milk makes the coffee ready (Farah, 2009) [2].

3.5 Black Ivory coffee

Coffee beans are fed to the Asian elephants, outer coverings and mucilage will get digested sometimes in the digestive system of elephant. Elephant dungs are collected and the coffee beans are handpicked. Those beans are washed and dried under the sunlight. Coffee made from these beans will have very smooth taste without the bitterness of regular coffee. The coffee cherries are initially digested and fermented with various other ingredients inside the elephant's gastrointestinal tract for 12 to 70 h. After elephant excretion, the individual cherries are hand-picked by the elephant caregivers and are then washed and dried under sunlight with a certain percentage of moisture (Thammarat *et al.*, 2018) [18]. It is mainly produced in Thailand.

The elephant dung coffee samples had better results of antioxidants, total phenolic content, total flavonoid content and volatile compounds relative to other treatments. In the digestive system of elephant, various bacteria and yeast cause a spontaneous fermentation, results in production of different acids, alcohols and enzymes which is mainly responsible for the higher antioxidant, phenolic content and flavonoid content in elephant processed coffee beans. Furans and pyrazines are the major compounds responsible for flavor and aroma of coffee. Furans were found highest in wet processed coffee beans and pyrazines were found highest in elephant processed coffee beans with not digested pulp. Regarding the roasting conditions, light roasting could be considered the best to have higher amounts of antioxidant activity, Total Phenolic Content and Total Flavonoid Content in the coffee extracts (Mesfin *et al.*, 2020) [9].

3.6 Steam treated coffee

Coffee beans will undergo steam treatment prior to roasting for 3-30 min where chlorogenic acid is lost which makes this coffee as stomach friendly.

In steam treated coffee, pH was increased when the steaming time was increased from 0 min to 80 min due to loss of various organic acids during steaming process. Total phenolic and antioxidant activity was reduced with increase in steaming time because these compounds are very susceptible to damage by high temperature, thus dissolve in water vapour. Caffeine content was also reduced with increase in steaming time because caffeine is soluble in water due to separation of bond between caffeine and chlorogenic acid. Panelists found the bitterness of coffee after 40 min of steaming whereas they found acceptable colour at the beginning of steaming itself. They found no significant difference among all the steaming times with respect to aroma. Aftertaste and overall liking (5.18 and 5.68 respectively) has highest score at 60 min of steaming. Changes in almost all attributes in the coffee samples after 40 min steaming was observed. Based on the consideration of changes in all the attributes, it is recommended that 60 min steaming is the most optimal duration for implementation (Riyan *et al.*, 2020) [15].

The bioactive compounds content in roasted steamed coffees were higher in conditions that combined a more drastic steam treatment (8 bar/29 min) with a shorter roasting process, or a mild steam treatment (2 bar/3 min)

with a longer roasting process. Steam treatment with longer times and low pressures should be avoided to prevent the loss of bioactive compounds (Kalschne *et al*., 2019) [6].

3.7 Coffees of India

1. **Monsooned Malabar AA (Only monsooned coffee in the world):** Exposing the AA grade coffee beans to the moist monsoon winds. Many years ago, coffee beans from India were accidentally monsooned over a long voyage, Monsoon winds caused the beans to swell to one-and-a-half times their normal size and take on a purer and paler colour. Something magical seemed to have happened to the coffee and consumers around Europe loved its unique flavour. Today, India has perfected the art of deliberately monsooning coffee at special curing works along the Malabar Coast, creating the world's most exotic specialty coffee. In the cup, Monsooned Malabar has medium strength and a mild, mellow, sweetish taste.
2. **Mysore nuggets extra bold (Premium coffee that represents the best quality coffee from India):** It is made from arabica bold beans grown in the regions of Chikmaglur, Coorg Biligiris, Bababudangiris and Shevarays. The beans are very large, uniformly bluish green in colour and have a clean, polished appearance. In the cup, the coffee exhibits full aroma, medium to good body, good acidity and fine flavour with a hint of spice,
3. **Robusta kaapi royale (India's flagship washed robusta brand):** It is made from robusta coffee beans grown in the regions of Baba budangiri, Chandragiri and Coorg. Indian washed Robustas are nearest in taste to that of Arabicas and make for great standalone brewed coffee. The beans appear to be bold, round with pointed ends and are gray to bluish gray in colour. These intensely aromatic coffees have a soft, mild taste with a chocolatey note.
4. **Annamalais:** Mainly arabica coffees are grown in this region where coffee plantations are intercropped with pepper and orange.
5. **Coorg:** It is the largest coffee growing region in India.
6. **Brahmaputra:** It is the home of organic coffee where chow-chow is grown as shade for coffee.
7. **Wayanad:** Exclusively robusta coffee is cultivated.
8. **Pulneys:** It is the highest coffee growing region in India.
9. **Araku valley:** Arabica coffee is grown under the shade of mango, jackfruit and silver oak.
10. **Baba budangiris:** Birth place of coffee plantation in India. It is one of the oldest coffee estates in India.
11. **Shevaroys:** It has unique flavor due to rich bauxite soil, perennial water and higher elevation
12. **Manjarabad:** Both arabica and robusta are grown as intercropping with pepper, cardamom, orange, arecanut and banana.
13. **Nilgiris:** It is the plantation of home to fine high-grown arabicas, including the exotic kents.
14. **Travancore:** Robusta coffee is cultivated along with pepper, ginger, vegetables and medicinal plants
15. **Biligiris:** Arabica coffee is grown along with orange, banana and pepper

5. Conclusion

Specialty coffees differ from the regular coffee in their s chemical constituents, taste, aroma and flavor. Instant coffee is devoid of insoluble compounds which give strong flavor to the coffee. Decaffeinated coffee is having mild flavour and aroma with less amount of caffeine which is considered as the best one. Mansooned coffee is having antimicrobial and anti-oxidant properties. Civet and black ivory coffee are having higher phenols and flavanoids. Steam treated coffee is less stomach irritant because of reduced chlorogenic acids.

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