

Coffee - from plant to popular beverage

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ABSTRACT

Coffee, one of the most popular beverages in modern world, is obtained from the beans of perennial bush *Coffea*. The distinctive aroma and taste of coffee is obtained by thermal treatment (roasting) of raw coffee beans. There are different degrees of roasting that can be divided according to the color of the grain: easy, medium, dark and Italian. The most famous types of coffee used in the production of beverages are Arabica and Robusta. Raw coffee beans contain a certain amount of caffeine, sugar, essential oil, potassium, calcium and magnesium. Roasting the grains leads to the loss of dry matter through formation of carbon dioxide, water and volatile products of pyrolysis. Coffee also has a moderate healing effect, while in overdoses it causes rapid heartbeat, insomnia, even euphoria.

Keywords: coffee, Arabica, Robusta

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Introduction

Coffee is the most popular beverage in the world and is obtained by preparing grounded beans of the same name perennial shrub (Lat. *Coffea*). It belongs to the family Rubiaceae. The coffee plant can reach a height of 2 to 5 m, if left untreated it can reach a height of 10 m. It benefits from heavy rain and temperatures from 12 to 27°C. It thrives in the lowlands, but it is of higher quality that grows at higher altitudes. Its flowers are needle-like, white in color. The fruit is green in color, and at the stage of ripening it turns a yellowish color which darkens and turns reddish, when the fruit is ready to be harvested (Figure 1). Within this fruit are two grains that are greenish-brown in color. After heat treatment, the beans turn dark brown, bursting and getting a distinctive coffee appearance.



Figure 1. The fruit of coffee (photo taken from Dritan Alsela instagram profile)

Coffee history

The plant coffee is named after town of Kaffa, located in Ethiopia, and it is believed that this plant originates from that region.

From the African plateau, coffee was transferred to Arabia in the ninth century, from where the beverage we know today as coffee, comes from. African natives used coffee beans as food. The coffee beans were ground and mixed with water, spices and animal fat, eaten especially before the battle to gain strength. Two Syrians first brought coffee to Constantinople in 1555. There were cafes where coffee was consumed exclusively. The Venetian merchants brought it to Venice in 1570 and coffee from there, started to spread throughout Europe. First it was luxury, consumed only by the wealthiest class of society. With the increase of coffee imports, it soon spread to all households and became part of the daily routine of common people. Coffee production is today the second largest industry in the world, after oil.

Coffee species

There are many types of coffee, but only two are the most used in the world - Arabica and Robusta. Among the other coffee species, known are: Arabusta, created by hybridization of Arabica and Robusta, Liberica and Excelsa (Liberian coffee), Stenophylla (Sierra Leone coffee), Gallieni, Mogenetii and Bonnierii (caffeine-free).

Arabica originates from the southwestern regions of Ethiopia. It is the first type of coffee used by humans that thrives in altitude from 1300 to 1500 m. Contains about 1.5% caffeine, has a rich and sophisticated taste and less grain acidity. Therefore, it is considered as superior and high-quality type of coffee.

Robusta comes from central Africa. It is better suited for cultivation, but of lower quality than Arabica. Contains about 2.7% caffeine, has strong spicy taste, most commonly used to make instant coffee. Due to its intense bitter-sour taste in coffee production, it is often mixed with Arabica. Coffee containing Robusta makes better foam.

The basic difference between Arabica and Robusta is shown in Figure 2.

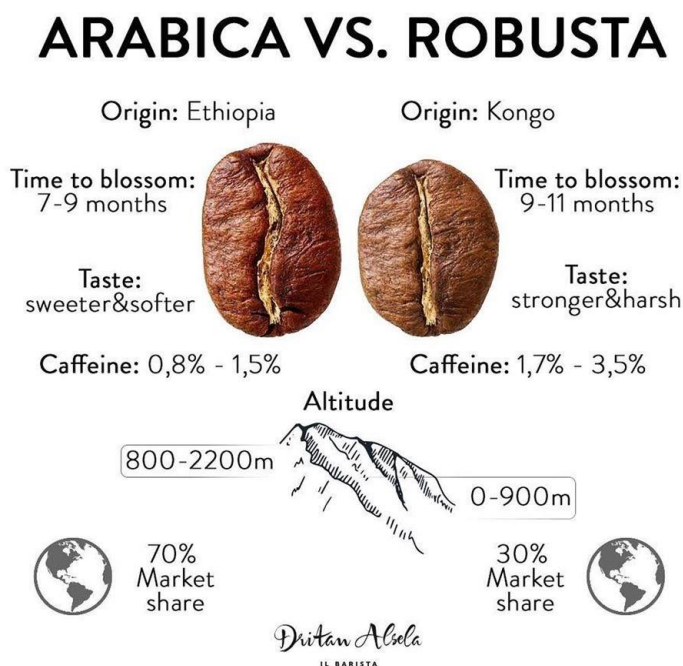


Figure 2. Differences between Arabica and Robusta coffee (photo taken from Dritan Alsela instagram profile)

Coffee chemistry

When roasting coffee beans, the loss of dry matter occurs, transforming in carbon dioxide, water and volatile pyrolysis products, including PAHs. This process degrades polysaccharides, amino and

chlorogenic acids, and increases the content of organic acids and lipid components. The presence of citric, lactic and acetic acid (less than 1%) is observed in roasted coffee, while chlorogenic acid makes up about 7% of the dry matter in Arabica coffee. Caffeine and quinic acid form chlorogenic acid, which is found in many types of fruits, and is found in coffee in the highest concentration. The average chemical composition of roasted coffee is shown in Table 1.

Table 1. Average chemical composition of roasted coffee.

Substances	%
Water	1.3
Proteins	14.0
Lipids	10.3
Carbohydrates	67.7
Ash	4.0

Raw coffee beans contain 0.9 to 2.4% caffeine alkaloids, 10 to 12% fat, up to 40% cellulose, up to 10% sugar, low essential oil, calcium, magnesium and potassium.

The most famous and important ingredient of coffee is caffeine (1,3,7-trimethyl-xanthine), derivative of purine. Caffeine diffuses easily into the cerebrospinal fluid, stimulates the central nervous system (CNS), and thus increases alertness and mood. Caffeine is retained in the blood for about 4 hours. It also acts as a diuretic, having the most active effect on the CNS and skeletal muscle, while it has the least activity on the smooth muscle and the heart (Bogdanović, 1963).

Numerous scientific studies have shown that regular coffee intake helps treat diabetes (type 2) and also reduces the risk of its appearance. Coffee has a positive effect on human health due to the presence of antioxidants such as: chlorogenic, ferulic, caffeic and coumaric acid (Nicoli et al., 1997). In addition, melanoidins (Steinhart et al., 2001), caffeine and phenylalanines (Farah and Donangelo, 2006) are thought to be responsible for the antioxidant activity of coffee.

Green coffee contains more chlorogenic acid than roasted coffee. The antioxidant activity of coffee depends on the polyphenolic compounds, dominantly due to the presence of chlorogenic acid, which exerts high antioxidant activity. Green coffee extracts have the effect of reducing fat and weight (Igho et al., 2011). In addition to chlorogenic acid and its derivatives, caffeine, theobromine, theophylline, caffeine and tocopherols (Stelmach et al., 2015) contribute to this property of coffee.

Because coffee also acts as an antioxidant, it protects cells from damage caused by antioxidant stress and helps prevent the onset of some degenerative diseases (*e.g.* liver cirrhosis, Alzheimer's and Parkinson's disease) (Žikić et al., 2014).

People who enjoy coffee, actually enjoy caffeine, which is a toxic herbal base and is classified as a drug. Decaffeinated coffee does not exist, it is only possible to reduce the level of caffeine in coffee in different ways. One way is to immerse the coffee in acid, reducing the percentage of caffeine, but increasing the acidity of the coffee. The plants did not develop caffeine to help us get through our morning meetings, enjoying coffee. Like many secondary metabolites of plants, caffeine, which is quite bitter, is actually a chemical weapon that can incapacitate or even kill insects that threaten plants.

There are many more molecules that give coffee a distinctive aroma and taste. Pyrazine, for example, gives earthy, and methyl propanol a fruity aroma to coffee. By roasting, bitter chlorogenic acid is converted into various derivatives, making coffee basis for a very pleasant and aromatic drink.

To obtain the true specific and characteristic aroma and taste of coffee, it is necessary to heat the raw beans. The aroma is created from a complex that is a mixture of volatile components, and non-volatile components determining the acidity, bitterness and taste.

The process of roasting coffee is divided into three stages. The first phase is drying of the coffee beans, where the moisture content of the beans is reduced. The aroma and color of raw grains change from green to golden yellow. In the second phase, the grain is twice as small, with the release of a large amount of carbon dioxide and several hundred substances that combine into a unique coffee aroma. This is where the grain gets a dark brown color. Initially, the process is exothermic. The pyrolysis reaction is the most intensive at 220-250°C when the process becomes endothermic and evaporation of volatile components occurs. Reactions become exothermic again at 250°C. During roasting, as a result of pyrolysis, the characteristic aroma and taste of coffee is obtained. Roasting time ranges from 90 seconds to 40 minutes, in dependence of the type of coffee. From the eleventh to twelfth minutes, hundreds of aromas develop, acidity and sugar decrease, and bitterness increases. The third phase is the final phase, and rapid cooling is performed to stop the exothermic reactions. Air or water is used for refrigeration, and the best coffee is considered to be the one, that is suddenly cooled with water.

In various parts of the world, the beverage is prepared from grounded coffee beans, roasted to different degrees, which can also be defined by the color of the beans:

- Easy (light) roasting - at 205°C; the coffee bean color is reminiscent of cinnamon, so this type of roasting is also called "cinnamon" roasting. The coffee roasted in this way has a sweet and slightly sour taste, is coarsely ground and used for "filter coffee";
- medium roasting - at 219°C; the grain is dark brown, used for so-called "Turkish coffee". This kind of grain after roasting is oily and the aroma is pronounced and pleasant.
- Dark roasting - at 240°C; the grain is dark brown to black with a glossy surface that comes from the liberated oil. This method of roasting produces "espresso" coffee, which is why it can be called "espresso" roasting or so called "French coffee". It contains significantly less caffeine than raw coffee, due to intense heat treatment.
- Italian roasting - at 245°C; the grains turn almost black, and the acidity is almost removed.

Various hot drinks are made from coffee, the most popular of which are classic coffee or so-called "Turkish" coffee, espresso, macchiato, cappuccino, latte, affogato, flat white, Americano coffee, Coretto coffee, Ice coffee, Mexicano coffee, Irish coffee and many others.

In addition to coffee that is obtained only from pure coffee beans, there is a so-called surrogate coffee. The surrogate coffee consists of roasted fruits and roasted parts of plants rich in starch, sugars, inulin boiled or dissolved in water. The basic raw material for the production of surrogates, can be barley, rye, wheat, carob, soybeans, *etc.* Most coffee consumed is not entirely made from coffee beans but contains surrogates.

The most expensive and extremely rare coffee is Kopi luwak, originating from the Philippines and Indonesia. This coffee is obtained from the feces of a civet, a small animal from the mammalian family (Figure 3). In Indonesia, civet is called luwak, and coffee is called kopi. The civet is fed with coffee beans, then the beans are boiled and discarded. During brewing, the coffee beans remain intact because only the fleshy part of the fruit is removed. Enzymes secreted by civet during brewing improve the quality and taste of coffee. During the brewing process, the proteins and caffeine content of the coffee

bean is reduced, making the beans less bitter and having a specific aroma. Such coffee beans are dried in the sun and further processed.



Figure 3. Civet with coffee grains

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