

Coffee, *Coffea* spp.



As you sip your morning cup of coffee have you ever wondered where this ubiquitous beverage comes from? *Coffea* is a genus of about 100 species of evergreen shrubs and small understory trees in the madder family (Rubiaceae) native to tropical forests in Africa and Asia. The seeds of these plants are processed to produce the drink people around the world have enjoyed for centuries, as well as for flavoring ice cream, pastries, candies, and liqueurs. It is one of the world's most valuable crops and is an important export product of several countries. The largest producers include Brazil, Vietnam, Indonesia, and Colombia, along with many other Central and South American countries and East Africa.

Coffee comes from a tropical shrub.

Coffea is an attractive plant with glossy, deep green foliage. The woody, evergreen shrubs or small trees have opposite, elliptic-ovate, wavy-edged leaves. The fairly stiff leaves have a prominent leaf midrib and lateral veins. Wild plants will grow 10 to 12 feet high, with an open branching structure, but are easily kept smaller and denser by pruning.



***Coffea* has glossy, deep green leaves.**



***Coffea* produces many fragrant white flowers.**

Fragrant, sweet scented white flowers bloom along reproductive branches in the leaf axils on old wood. The dense clusters of star-shaped flowers can be produced at any time of year, but are most common in our autumn, as coffee is a short-day plant and blooming most profusely when nights are getting longer (daylight of only 8-10 hours). Plants typically begin blooming in 3 to 5 years. Flowers bloom simultaneously, remaining open only long enough to be pollinated – often by bees, although flowers of many species are self-fertile and require no pollinators. Each has a 5-lobed tubular corolla surrounded by a small, cup-shaped calyx.

Flowers are followed by clusters of berries (technically drupes) which mature from green to yellow, red, or purple (depending on the species) over a period of 7 to 9 months. The round to oblong berries, ½



The green coffee berries (L) ripen to red (C and R).

to 1 inch across (depending on the species), are called “cherries” when ripe. Each generally has two ellipsoidal seeds, called coffee beans (although they are not true beans). These seeds consist primarily of a green corneous endosperm and small embryo covered in two membranes – the outer “parchment coat” and the inner “silver skin.”

The two most commonly commercially grown species are *Coffea arabica* and *C. canephora*. They grow best at high elevations in tropical areas that do not experience subfreezing temperatures. Several new species from Madagascar and Camaroon were described within the last decade with interesting characteristics – including caffeine-free beans and self-fertile flowers – that potentially could be used in breeding programs to improve cultivated coffee plants in the future. Many cultivars and some hybrids have been developed with differences in caffeine content, disease resistance and cold-resistance, height, and other characteristics.



Coffee is grown commercially in many tropical areas of the world.

C. arabica, or Arabian coffee, is the most extensively cultivated species (75-80% of the world's commercial production) because it has superior flavor compared to other species. Its beans have less caffeine than any other commercially cultivated species of coffee. This large shrub or small tree is native to mountainous parts of Ethiopia and Sudan and possibly also to the high mountains of Yemen on the Arabian Peninsula – or was introduced into Arabia prior to the 15th century. It does best when temperatures remain around 70F and receives 40-60 inches of rain annually, distributed evenly throughout the year, and prefers to grow in light between 1,300 and 1,500 m. On commercial plantations, the plants can be grown shaded by other trees (often leguminous ones for their nitrogen-fixing abilities) interplanted with the coffee. There is extensive evidence that shade-grown plantations preserve biodiversity and are more ecologically sustainable than non-shade coffee monocultures. It is now grown in the tropics around the world, generally found at altitudes kept trimmed to about 6 feet high to make harvesting easier, although some commercial cultivars can grow up to 5m high. It is self-pollinating.



Shade-grown *Coffea arabica* in Costa Rica, with *Erythrina* sp. trees to provide nitrogen fixation.

C. canephora, or robusta coffee, grows at lower altitudes and in warmer climates where *C. arabica* does not do well as well. As the name suggests, this species is a bit tougher, preferring full sun and being less susceptible to pests (especially the devastating fungal disease coffee leaf rust) than *C. arabica*. However, it requires cross pollination and the beans are not as desirable, having a stronger, more bitter flavor and a higher caffeine content than *C. arabica*.

Depending on where the plants are grown, planting and harvesting may be seasonal or occur year-round. Commercial propagation is often by seed, but budding, grafting, and cuttings are used. Plants start producing fruit a few years after planting, coming into full bearing at 6-8 years and will be productive for 30 to 50 years or more if well managed.

The best coffee is produced from ripe berries; an inferior product results from berries collected when immature or over-ripe. Because the berries do not all ripen at the same time, many plantations pick by hand to better select just the ripe ones. If the berries are harvested mechanically (shaken off the tree onto mats) then both ripe and unripe berries are collected together, lowering quality of the processed product.



The best coffee is either picked by hand or sorted to remove green berries that reduce quality.

The soil, rainfall, temperature and other factors of where the plants are grown, as well as the processing, all contribute to the flavor, body and acidity of the finished product. The raw seeds have no special flavor or aroma, so must be processed to develop this. The harvested cherries must be depulped so they won't start to ferment. The flesh of the berry is usually removed by machine, and then the seeds



Harvested coffee berries are transported to receiving stations where they are cleaned and the processing begins.

are fermented just long enough to remove the remaining slimy layer of mucilage. The beans are then washed and dried. This may be done on special drying tables or in special drying ovens at large processors, but smaller operators may just spread the beans out on a tarp or section of concrete in the hot sun, turning them frequently with rakes. Finally the dried beans are graded for sale as green coffee.



Coffee beans are dried in special ovens (L) or in the sun (C) before packaging for sale as green coffee (R).



The next step in making coffee is roasting, changing the coffee bean both physically and chemically. As the green beans are heated, starches are changed to simple sugars and different aromatic oils are destroyed or developed, creating the characteristic flavor of coffee. During this process the beans also change color, and can then be graded based on the appearance (or measured reflection of the infrared spectrum) to be categorized as light, medium light, medium, medium dark, dark, or very dark. Coffee flavor and body is related to the degree of roast.

Green coffee beans.

Finally, to create a beverage, the beans must be ground and mixed with hot water long enough to extract the flavor (brewed).



Coffee beans are roasted to different degrees to create its characteristic flavor.

Coffea shrubs require a frost-free environment to grow, and most adapt well to container culture, so can be easily grown as a houseplant. As an ornamental, coffee requires a moist but well-drained, humus-enriched growing medium that is neutral to slightly acidic. It does best in full sun to light shade, with regular watering (preferably with rain water). Coffee plants are heavy feeders so regular fertilization during the growing season is important. They may even bloom and set fruit indoors if in the right environment. Plants can be moved outdoors for the summer (being sure to acclimate them gradually to the brighter light so they don't sunburn), but will do best when temperatures are not too high, and should be moved back inside when night temperatures dip into the 40's. During the colder months cut back on watering and fertilization. A container specimen can be pruned by pinching or heading back to keep the plant at a reasonable size and to promote bushier growth. Plants should be repotted every year or two as they increase in size or to refresh the growing medium. The cultivar 'nana' remains much smaller and grows at a slower rate than the species. Many insects and diseases affect coffee plants in plantations, but this plant has few pest problems other than the typical houseplant pests including mealybugs, when grown indoors. Ornamental plants can be propagated most easily from fresh seeds, but also from cuttings of single leaf-buds or by grafting.

– Susan Mahr, University of Wisconsin - Madison

Additional Information:

See a Flash movie on Coffee Bean Development — at www.coffeeresearch.org/agriculture/beandevlevel.htm