

A Primer on Coffee Harvesting and Processing

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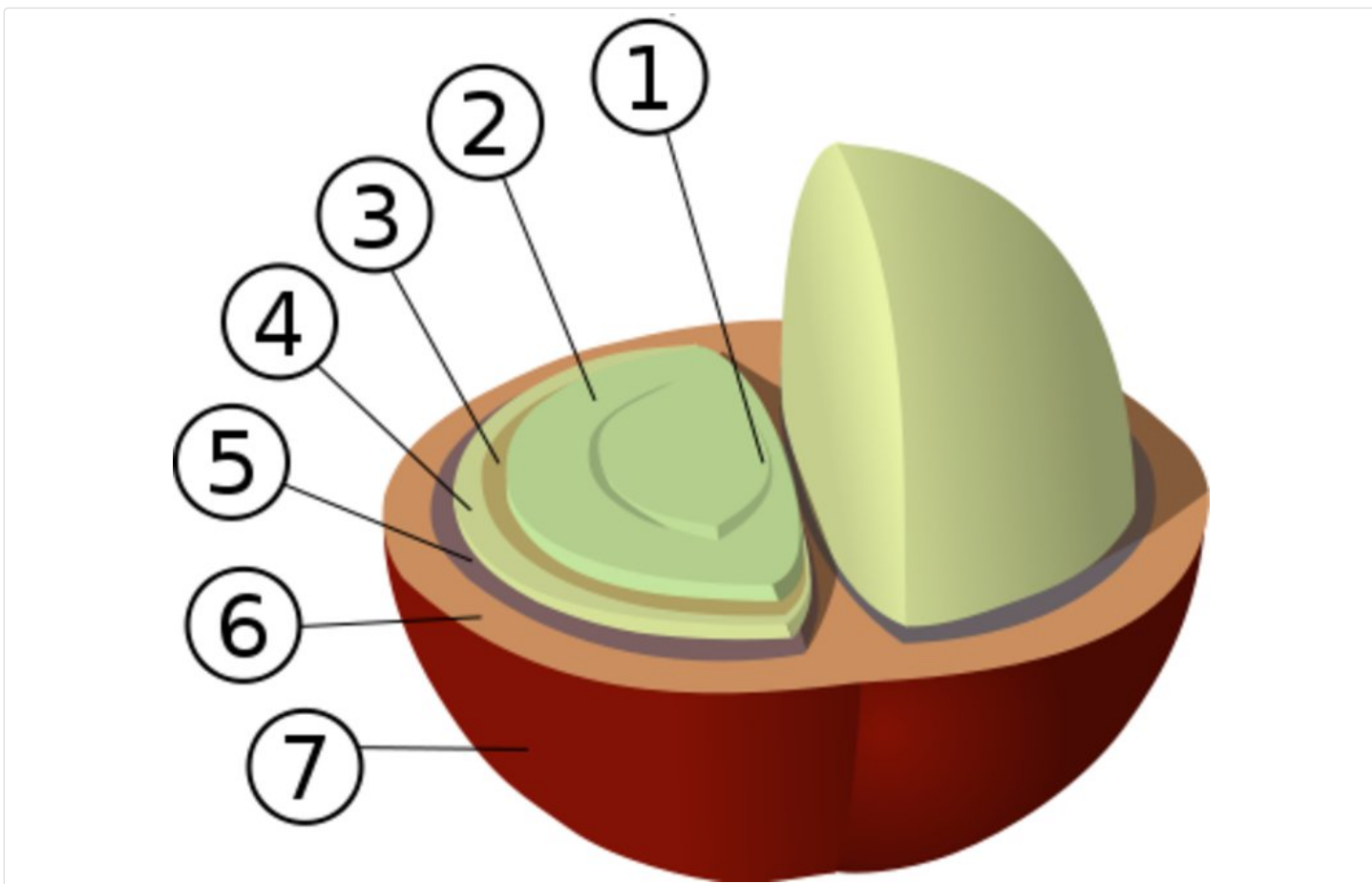
Introduction

Processing methods for coffee can drastically change the quality and taste of the final product, for better or for worse. By choosing a method that positively impacts quality, flavor, and cost, a coffee producer can optimize the coffee's potential, at the same time optimizing a farmer's income from that higher-quality coffee. Using an improved method to remove the coffee bean from the coffee cherry is one of the most effective ways to increase quality.

Each location throughout the world has its own unique characteristics and environmental factors (known as "terroir") that, in turn, give distinct qualities and add value to niche, high-quality crops and products such as coffee, wine, chocolate, cheese, etc. The rising Specialty Coffee market seeks unique, single-origin coffees that can add to the experience of the coffee consumer. There is no "ideal" way to process coffee, so long as a high standard of quality is achieved. However, in order to make choices that will optimize quality and income within your particular context, you first need to understand the foundation of coffee quality and processing.

Key areas that comprise the foundation of coffee quality and processing include cherry selection; fermentation; and moisture content. Each step in every method of coffee processing aims to improve or impact one of these three components. Let's look at them one-by-one, after first defining a few terms.

Some Definitions and Parts of the Coffee Cherry (Figure 1)



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Figure 1: The coffee cherry is made up of the following layers: 1) Center Cut; 2) Endosperm; 3) Silver Skin (Spermoderm); 4) Parchment (Endocarp); 5) Pectin Layer /Mucilage (Inner Mesocarp); 6) Pulp (Mesocarp); 7) Outer Skin (Exocarp). (TORCH Coffee, 2015)

Cherries: Coffee bean is still inside of the coffee cherry





































Pulp: The coffee cherry once removed from the seed/ bean

Parchment: Coffee dried to 12% but still inside the parchment

Green Coffee: Coffee that has been dried to 12% but not yet roasted.

Cherry/Bean Selection

Selection of coffee cherries begins at the coffee tree; harvesting is the last stage of farming, but is also considered the first stage of processing. Choosing the right cherries at the right time can contribute to sweet and full-bodied coffee flavor notes, rather than sour or bitter notes. The color of ripe cherries will differ between coffee varieties, so be sure to research and test the specific variety with which you are working. Several tools can guide farmers and coffee processors in cherry selection. Large color charts displaying coffee cherries at different stages of ripeness are posted at the loading bays of many coffee processing plants, to insure that farmers know what level of ripeness is expected (Figure 2).

Arabica coffee varieties		Semi-Mature		OverRipe	
		Immature	Mature		
1	Catimore 5175-1				
2	Red Catuai				
3	F1 Hybrid of Catimor and Tall Mokka (5175-1 xMA2-7)				
4	Maragogipe				
5	Tall Mokka MA 2-7				
6	SL28				
7	Typica				
8	Yellow Bourbon				
9	Yellow Catuai				

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Figure 2: High-throughput metabolic profiling of diverse green coffee arabica beans. (Setoyama, 2013)

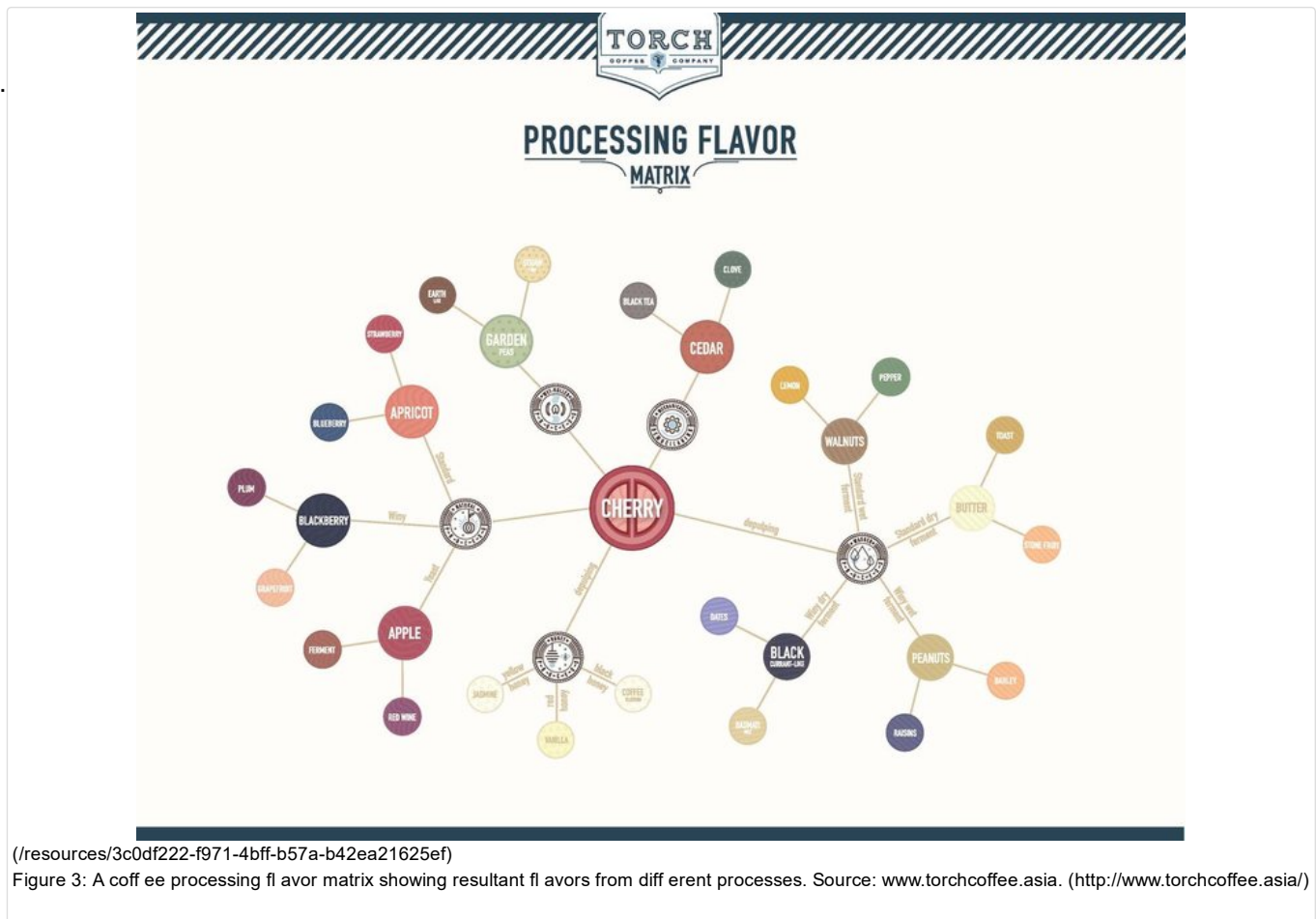
Ripeness boards can also be used to measure how many cherries out of 100 are ripe, with payment then incentivized accordingly. Hand picking cherries as they ripen is the best possible way to pick them, but tends to be highly labor intensive and thus very expensive.

When processing coffee, you want to control each step of the process in order to make sure you have a quality product. Immediately after cherries are harvested, they are briefly submerged in water to remove 'floaters' [the cherries that float to the top, which are immature or defective]. Rinsed and sorted cherries should be processed as soon as possible. Fermentation begins as soon as the cherries are picked, so the length of time the cherries spend sitting in the field or being transported to their processing location will affect the flavor of the coffee.

Processing

There are three main ways to process coffee: the washed process; the dry natural process; and the pulped natural, or “honey,” process. Within these three main methods, many variations are used to increase production quantity and/or to develop flavor, depending on the unique contexts and coffees encountered (Figure 3). The three main processes are discussed below.

1. **Washed Process.** This method refers to coffee that is



processed in a wet mill, which is a series of machines that remove the coffee skin, pulp and mucilage while the berries are submerged in water. First, coffee is depulped mechanically with a pulper machine. Then the mucilage is removed, by fermentation, by mechanical means (a de-mucilage machine), or by a combination of both.

The washed process allows cherries and green coffee beans to be submerged in water multiple times before the drying process begins. Each time, defective coffee beans float to the top and can be removed; as a result, this process is a good choice for farms wanting to systematically improve the quality of the coffee beans that are produced.

Once the washing process is complete, the coffee beans (still in the hull/endocarp) are dried to 12% moisture content. Farmers around the world dry their coffee many different ways; some farmers dry beans in the sun either on the ground or on raised drying beds with a mesh surface to promote air flow. Within the coffee industry, these are referred to as African Raised Beds. A mechanical dryer can also be used. There are two types of mechanical dryers used: a flat table-like dryer that blows hot air above or below the coffee and a tumble dryer which is a drum that is heated and turned. At night, cover the beans with plastic (top and bottom) to prevent the coffee from reabsorbing moisture from dew as the temperature drops. The washed process offers two major advantages. First, it enables farmers to process their coffee more quickly with industrial machines. Secondly, because the cherries have been removed from the bean, the coffee dries faster than the whole cherries. Thirdly, less space is needed for processing; the seeds/beans with pulp removed take up less space than whole coffee cherries. However, the washed process uses machines that require more capital and/or partnerships with local coops.

2. Dry Natural Process. The dry natural process is used predominantly in Ethiopia, Brazil, and Yemen, and generally with Robusta coffees. The coffee bean is dried in the cherry until it reaches 12% moisture content (see the section below for more on moisture content); then the dried cherry is removed mechanically with a dry mill. During this process, the sugars in the coffee cherry create unique flavors, making the end result suitable for the specialty coffee market. The coffee cherries take longer to dry and require more drying space than just the beans, but the only machine used is a dry mill, so very little capital is needed.

3. Pulped Natural or “Honey Process”. This processing technique is a middle option between the “Washed” and “Dry Natural” processes. Coffee cherries are processed in a wet mill, like that used in the washed process. However, the coffee beans are dried with the mucilage still intact, and dried to 12% moisture in the parchment, similar to the dry natural process. At its best, using this process allows you to lower the number of defective beans (by removing the ones that float), but still retain sugar (in the mucilage) to improve the flavor during the drying process.

Fermentation

Regardless of the initial processing step you use, fermentation is a critical aspect of coffee processing. Fermentation is a metabolic process during which sugars are converted to acids, gases, or alcohol. Yeast and bacteria are most often involved in the process. If you manage the fermentation process well, you can maximize the taste of (and the net return from) the resulting coffee. If you allow fermentation to run rampant, you will produce coffee that is unpleasant to drink, resulting in lower quality and profitability.

Fermentation starts already when the coffee cherries are just past ripeness on the tree, and lasts until the beans have been dried to 12% moisture for storage. The rate and length of the fermentation process is influenced by a number of different variables, including temperature, sunlight/ shade, air flow, oxygen or lack thereof, and sugar content. These variables will either encourage or discourage the production of bacteria, yeast, and/or mold, which influence fermentation and thus impact the quality and flavor profile of the resulting coffee.

Bacteria abound in the natural environment, with the potential to impart both good and bad qualities through fermentation. Far fewer kinds of yeast grow naturally; however, the ones that do are more likely to positively affect the taste of coffee. Mold, easily detected by the human eye and nose, is never good for coffee. To prevent mold, prevent fermentation from happening for extended periods of time by drying the coffee in the sun or with mechanical dryers, and protect coffee beans and/or cherries from nighttime temperature drops and dew so that they do not pick up moisture again. If you see or smell mold, take immediate action to speed up the drying.

The type of container used as a “fermentation tank” can influence microbial growth. Containers with coarse, rough surfaces are more susceptible to bacteria and mold growth and are more difficult to clean. Often metal, plastic and cement tanks are used when fermenting coffee.

Bacteria, yeast, and mold differ in their optimal growth conditions. Bacteria grow best at the beginning of the drying process, when the moisture content of the cherry is high. As the moisture content drops, conditions favor yeast growth. As the beans/cherries continue to dry, mold growth is more likely. You will want to experiment with small batches of coffee to learn about naturally-available yeasts. For example, in natural processed coffees, you could pause the cherry-drying process by removing any drying agents (such as the sun and air) at any step within the drying process (if you want to grow yeast, you might wait until the coffee bean/cherry has lost 50% of its original weight). Then, to evaluate what kind of bacteria and yeast are growing, you could place the cherries in a fermentation tank (a container of any size that can be sealed shut and that is made of food grade material), with or without water. Yeast usually produce a sweet winy or jelly smell. If the smell becomes sour or bitter, you are most likely starting to grow mold; you will need to remove the beans/cherries from the fermentation tank and continue the drying process. While fermenting, coffee should be monitored several times a day in order that any sign of over fermentation can be acted upon quickly. Over-fermenting for one hour or half-a-day will not impact the coffee as drastically as over-fermenting for one to three days. Evaluate the coffee often at the farm level by roasting and tasting it, to ensure that processing methods are producing the desired results.

Fermentation is also used to break down and loosen the pectin layer (mucilage) from the coffee bean after the coffee cherry has been pulped in the washed process; then the mucilage can easily be removed by washing the beans. This kind of fermentation can be done aerobically (also known as dry fermentation—without water) or anaerobically (wet fermentation—in water). The wet fermentation process creates another opportunity to remove any immature and underdeveloped beans that float to the top. However, it also requires large amounts of water and a water treatment plant, because the water tends to become very acidic in the fermentation process, and may harm plants and the environment if it is discharged untreated.

Moisture Content

Proper fermentation is important for good quality coffee; reducing the moisture content is another key step when seeking to produce optimum quality coffee. A freshly picked coffee cherry has a moisture content of roughly 50%. Regardless of the method used (washed or dry natural process), the moisture content must be reduced to 12% and kept there consistently. Correctly dried coffee will taste better; it will also last much longer in storage. Below are some ways to optimize moisture content and coffee quality.

Coffee should be dried in the sun or with a coffee drying machine. Indoors, coffee will be susceptible to mold and uncontrolled fermentation. Drying on the ground can give inconsistent results, because the earth or concrete will change temperatures drastically between night and day. By contrast, drying on a raised bed (using trays made of screen mesh) can help regulate airflow and temperature. Cover the coffee every night, top and bottom (for example with a waterproof bag), because as the temperature drops, the air condenses and creates moisture. It does not need to be airtight; however, it should be completely wrapped. You do not want that moisture to be reabsorbed by the beans; if it is, it will break down the cell structure and make the coffee turn stale more quickly. Stale coffee usually has flavor notes that are described as woody or wood-like.

Moisture content of coffee cherries or beans can be measured with a moisture meter, or you can use basic math to roughly determine the moisture content. For the latter, separate a 12 kg amount of coffee from the rest, but dry it in the same manner as the rest of your crop. Weigh that sample of coffee every day and night to determine the moisture loss/gain. Regardless of the process you use, you will want to dry the beans until they are at 12% moisture. However, the final weight will

vary depending on your process. For the pulped natural process, the final dry-cherry weight should be 4 kg if the initial fresh cherry weight was 12 kg (33 kg if initial weight was 100 kg). For washed process coffee, the final weight should be 2.2 kg if the initial fresh cherry weight was 12 kg (18.3 kg if initial weight was 100 kg). Please note that the weight of the natural processed coffee does not correspond with the weight of the washed process coffee because the natural processed coffee is being weighed with the cherry still intact.

Finished coffee should be stored off the ground (for example, on a pallet). If possible, store coffee in warehouses that are well-maintained, with tall roofs that protect from rainfall and that insulate the coffee from the heat of the sun. Consider using Grain Pro bags (<http://grainpro.com/gpi/> (<http://www.grainpro.com/gpi/>)), which are essentially very large re-sealable bags that keep the relative humidity out but still let the coffee breathe. Parchment coffee that has been dried to 12% moisture should be stored at a relative humidity (RH) of 60-70% or less. Check that your RH is at 70% during your lowest temperature of the day, because a drop in temperature will increase the RH.

Green coffee that is not dried down to 12% moisture can deteriorate due to growth of unwanted bacteria, mold, or yeast. This is especially true if the seed is killed. As long as the seed remains alive, enzymatic activity will ensure that cupping quality remains high. Lower your coffee's moisture content to below 12% soon after harvest to ensure that the seed remains alive. If you reduce the moisture content below 10%, the beans will become brittle and may be damaged during hulling. This being said, the sweet spot for bean moisture of dried green coffee is between 10-12% moisture.

Conclusion

Smallholder coffee farmers who wish to optimize their harvest and receive the best prices for their coffee must choose coffee processing techniques that are appropriate for their given local resources (e.g. space, water, sun), that minimize defects, and that suit the coffee variety's specific flavor potential. There is no one "right" way to process coffee. Encourage and equip farmers to harvest ripe, intact cherries, so that they can receive the best price. Test and try various processing techniques to see what is best for your specific context and market. Proper harvesting, processing, and storage can result in high value coffees for the world's ever-growing specialty coffee market.

References & Resources

The author attended a coffee processing class hosted by Torch Coffee Lab in Pu'er China, taught by Dr. Mario Fernandez of the Coffee Quality Institute. TORCH Coffee <https://www.facebook.com/torchcoffeelabyunnan> <http://www.torchcoffee.asia/> (<https://www.facebook.com/torchcoffeelabyunnan>)

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