A SHEAF OF BEANS

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Abstract. In this essay, I will give a brief commentary on the artistic chain of coffee production. We ignore technical details and focus on the steps for building bean's flavor.

"Details make perfection, and perfection is not a detail" - Leonardo da Vinci (well, supposedly)

We will maintain the viewpoint that coffee brewing is a topic of subjective taste rather than quantitative repeatability throughout our essay[1]. But at the same time, the variables are important numbers that may result in a bad or good cup of coffee. Anyhow, a barista, or at least a *connoisseur* of coffee, should know the journey of a crop to cup in order to extract much and explore their art of coffee making. I am not an expert, but I know how and why to appreciate a 'seed to sip' journey.

Our focus is on specialty coffee. Specialty coffee gives us more control over the variables of a cup of coffee, and hence, its characteristics are more distinguishable than the commercial ones. The theoretical possible exception being dark roasted beans, where different coffees tend to become *same* in the characteristics at that roasting level.

We begin with discussing the *key* player of coffee and its production, namely the farmers. A farmer does not choose an arbitrary production of coffee; it depends very much on the socio-economic situations, environmental constraints, their knowledge about coffee production, market demands, and their access to resources. Although this is the key and principal component of our coffee production, it relies heavily on the farmer's decisions. For example, coffee arabica is favored at high altitudes where it thrives in a cool climate. We must note that higher altitude slows the cherry maturation due to a cooler environment, but it has a more meaningful flavor (but higher acidity) to it due to slow ageing. Also, the shade management is crucial (shade grown versus sun grown) and how the coffee environment interacts with the

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[1]Also see the point made in this [1]

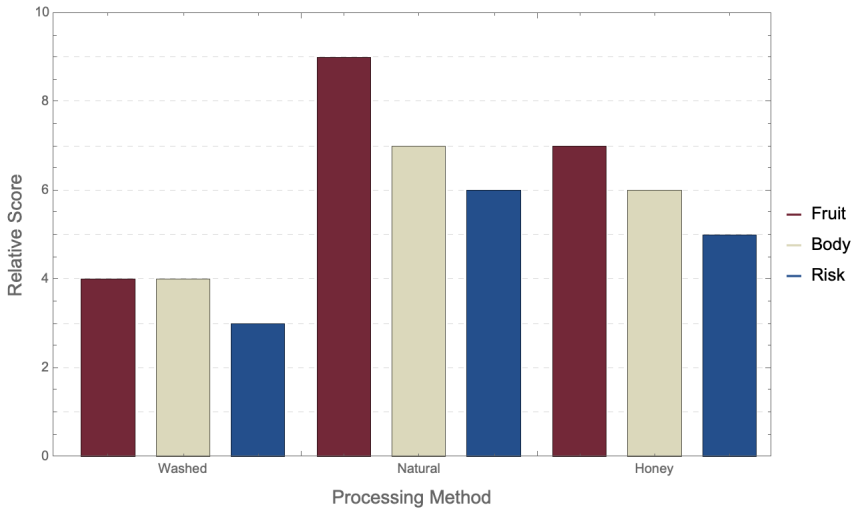

FIGURE 1. Processing method and their relative score on fruit, body, and risk.

biodiversity. Indeed, such decisions affect the maturation of the beans, their flavor complexity, and net coffee production during harvest.

There is a technical term often used in coffee products called 'terroir'. The term is borrowed from viticulture and refers to the set of factors that affect an environment, which determines the flavor and the taste of a cup. For example, soil, altitude, sunlight (as we briefly alluded to above about how shade management affects coffee quality), rainfall patterns, and micro-climate variations. In essence, it is a *romantic* term which has a regional attribute to it for coffee.

Let us comment briefly on the coffee processing. After the cherries are picked (which can be either done manually or using a machine), they go through the processing. All of these processes use fermentation. During processing, the green beans pick up moisture of about 10-12%, and this water is later pushed out during the roasting process. There are three main processes that are carried out in the culture.

(1) Natural Processing
(2) Honey Processing
(3) Washed Processing

Natural processing is the old traditional approach of drying the entire coffee cherry intact. Note that a cherry is made up of two seeds, and there is sticky mucilage outside the seeds. This can be done by putting the coffee on the ground or at some level. This processing method enhances the flavor profile of the bean since

the decomposing fruit pulp provides sugar and flavor compounds during this long process. The profile is of a fuller body and lower acidity. One can also have a wine-like flavor and chocolatey taste [2]. However, this method has a high risk as it requires a lot of labor and care for the cherries during the process. They must be constantly turned to prevent unnecessary fermentation or molds, which result in bad beans, and the farmers would have fewer rewards. But this is also a highly rewarding method, for the profile is quite flavorful.

The washed process is a quicker and gives cleaner profile; in fact, one could argue that it has the purest expression of the cherry's character. In this process, every fruit pulp and mucilage is removed using water and fermentation. The presentation is, of course, lively and bright.

The honey process acts as an intermediate of both processes and has a higher level of control over the variables in the character of the cherry. We decide on the amount of mucilage (honey) left on the bean as it dries, and that is why it is called the honey process. Hence, we get to choose this variable and land in a color-defined spectrum of Black/Red honey, Yellow/White honey. The flavor profile is then a spectrum decided by the amount of mucilage on the bean. When the mucilage content is higher, we get to see the tone of Black honey with fuller body and balanced acidity. If the mucilage is very little on the bean, then we get to see a cleaner profile, like that of the washed process. Since this is on the middle ground of washed and natural coffee, the producers get to showcase both attributes in one single cup by balancing the profile.

After the processing, the producers typically send the green beans to roasters. At this point, the importance of storage and management is critical; however, we will not comment on that in this essay. I believe that there is more to science than art in roasting. Whatever has been developed by the farmer and processor, namely the cherries and beans, gets their potential into a product[2] in roasting.

Coffee roasting is a process of heating green beans at high temperatures, causing physical and chemical reactions which develop the aroma, color, and flavor of beans. The 'choice' of roasting enables one to significantly affect the flavor profile of coffee. Thus, a roaster's job is much more scientific, and they must understand the cellular structure of each bean type and, of course, the thermodynamics of coffee seeds.

The first stage is to heat the green beans, which evaporates the water available inside them. This is recommended for an even roast. A roaster should be careful, as

[2]Because one cannot drink green beans as it is dense, raw, and grassy. The flavors are still raw in green beans, and no aroma whatsoever

they would not want to hamper the flavor profile that was carefully worked upon by the producers.

After drying, which might take more time in a naturally processed coffee, the beans go under heat and CO_2, which changes the colors of the green beans to yellow and then to brown. The reaction that gets carried out is called the Maillard reaction, which brings an interesting interaction between amino acids and sugars, which develops many complex compounds, adding to the taste profile and aroma. The color change of the green bean is due to the Melanoidins produced during the Maillard reaction.

Following this, CO_2 and pressure from steam make the beans double in size and lose some weight (approximately 5%) and then crack open, which creates an audible experience. This is called the *first crack*. The time that we spend after this in roasting is additional work on the coffee because one may end the process of roasting here. This brings yet *another* spectrum of flavor.

When we immediately stop at the first crack, the beans get a brown color and less to no oil on the beans' surface, which gives us a flavor profile of beans close to the intrinsic characteristics. This results in a more acidic, fruity flavor and a lighter body. This is called *light roast*. If one wishes to respect the producers' work on the beans, then a light roast is an appropriate roast choice. However, if the balance between acidity and body is required, the roast should be continued, which allows more sweetness but carefully retaining much of the original bean's characteristic. This is called the *medium roast*. If one continues to roast the beans to the beginning of the 'second crack', then we see oils appearing on the bean's surface and acidity removed. The flavor is heavily dominated by the chemical reactions of roasting. This is called *medium-dark roast*.

If one wants a consistent profile, which is somehow required in mass production and export, then that is achieved by *dark roast*. One leaves the roasting well past the second crack. They are very oily, and the flavor is bold with no acidity. In the commercial approach, dark roast is preferred for a consistent tone, which is what the brand advertises. But, roasters[3] may also try to roast lighter in order to give more respect to the bean's intrinsic flavor [3]. From here, one turns to the consumer as different roast is used in different brewing methods. For instance, for a pour-over or French press, one would go for a lighter roast, but for an espresso, dark roasts are preferred.

[3]These roasters are very careful about their source and producers.

In roasting, one has to be very careful, as a slight difference in time and temperature causes a major and noticeable change in the bean's profile. This is why a roaster's job is that of precision and care [3].

One can not immediately brew the roasted coffee since a lot of CO_2 is present inside the beans, which causes an unfavorable flavor. It is required for beans to 'rest' and degass, which is called coffee degassing. This takes a few weeks of releasing carbon dioxide, and so one is advised not to rush with 'fresh' coffee ideas. One should also not brew a coffee that has too little CO_2 as it does not have a lively body, and typically carries dull flavors [4]. We need to find a 'sweet spot' where the carbon dioxide has escaped but the beans have not aged very much. The goal is not to allow all CO_2 to be released, but some considerable amount so as not to interfere with brewing. Moreover, dark roasts require less time for degassing as it is more porous, while lighter roast requires more degassing time.

Brewing is a crucial art, but it depends on the consumer[4]. Our essay is not about brewing, and I trust that many people are more experienced than I am in brewing. But before brewing, a coffee bean had its journey. From being cropped with 'care' by a farmer, to being processed with 'care', to being roasted with 'care', it had its careful journey. The idea is to realize what a cup of coffee contains, more than flavor and caffeine. This art of producing coffee must be kept alive and sustained at all the levels of farming, production, and roasting, as humanity could never make a finer chain of artisans, each solving for the beauty and flavor of the story in *seed to sip*.

References

[1] https://intelligence.coffee/2024/01/coffee-farmers-income-subjective-taste/.
[2] https://jamescoffeeco.com/blogs/james-coffee-blog/coffee-processing-101-from-washed-to-honey-how-your-cup-gets-its-flavor-buzz.
[3] https://www.fiveelephant.com/blogs/stories/7564430-our-coffee-roasting-philosophy.
[4] https://berto-online.com/the-science-of-coffee-degassing-understanding-its-impact-on-flavor/.
[5] J. Hoffmann, *The world atlas of coffee*. Hachette UK, 2018.

[4]Just to remind that one needs to grind these beans in order to brew. See [5] for a good exposition with more details.