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AN IN DEPTH LOOK AT COFFEE BEWING

Brewing coffee is a simple process that has many factors that can impact flavor. There are two major categories of considerations when brewing coffee: the extraction of coffee solids during the brew process (and the variables that affect it), and environmental factors that can impact both how coffee tastes and how coffee is able to extract.

This guide is designed as a longer read to give background and depth to simple step-by-step brew guides. A solid step-by-step guide will help you brew great coffee, but this booklet is designed to help give reasoning and understanding as to how coffee flavor can be affected.

The information here is meant to be applied to any kind of coffee brewing – automatic drip, pour-over, immersion, espresso, etc. When pairing the information from this guide with your favorite brew method, ideally it will help guide you towards making coffee you love to drink.

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EXTRACTION

Extraction is the process in which coffee solids from roasted coffee are dissolved in hot water and pulle out of the coffee grounds. Extraction is the heart of the coffee brewing process. About 30% of coffee is soluble, while the other 70% is insoluble cellulose plant fibers, which is why there are always leftover coffee grounds after you brew.

Roasted coffee has around 400 different soluble flavors and 400 different aromatics: all those different flavor particles dissolve during the brew process at different rates, and those rates are also affected by the five main brewing variables: ratio, grind, time, temperature and agitation.

ACIDS

Coffee is the roasted seed of the coffee berry: there are high concentrations of fruit acids available in roasted coffee which help define the full range of flavors in all different styles of coffee. These fruit acids are very water soluble, and tend to extract quickly.

SUGARS

Roasted coffee contains both fruit sugars from the fruit itself and caramelized sugars from the roasting process. Sugars are more complex molecules than acids, so they tend to take a little longer to dissolve and extract from the coffee.

BITTER PLANT MATERIAL

There are about 40-50 unique plant compounds in coffee that tend to be very dry and bitter tasting. This group of bitter flavor compounds tends to extract very slowly, as most of these flavors come from long molecule chains that need to break down.

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EXTRACTION, CONT.

The brewing process involves water saturating into the coffee grounds, dissolving the soluble material, and then exiting the grounds to form brewed coffee. Each particle has a cellular structure that resembles a sponge: in order for coffee to brew, the water has to saturate through the coffee ground, dissolve the available soluble flavor materials, and then exit out of the particle. The process can be broken down into three main phases, and diffusion.

WETTING
During the wetting phase, coffee particles begin absorbing water. This drives any trapped gases out of the coffee, which we see in the “bloom” during the first part of coffee brewing.

DISSOLUTION
Coffee solids then begin to dissolve into the water and exit the particle into the overall brewed coffee solution, at varying rates.

HYDROLYSIS
Larger, insoluble carbohydrate chains begin to break down into simpler, more soluble ones. This happens later in the brewing process after most of the dissolution has been completed.

DIFFUSION
Diffusion is the process in which high concentrations of solutes move to zones that are less concentrated. This is how the more concentrated brewed coffee solution inside a coffee particle moves to the outside edges where the brew water in a drip method helps carry it into the main solution, or how an immersion method sees osmosis encourage the brewed coffee to exit the particles.

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EXTRACTION SUMMARY

To put everything in more simple terms, there are three main categories of flavors that can be dissolved from coffee: bright tasting acids, sweet tasting sugars, and bitter tasting plant material. These materials tend to extract in that same order – the acids first, the sugars next, and the bitter materials last.

The goal of brewing coffee, then, is to manage your brewing process through wetting, dissolution, and hydrolysis so that you capture all of the acids and all of the sugars while tapering off before too many bitter, dry plant materials are extracted as well.

When brewing coffee, there are five main variables that can influence the progression of the extraction: ratio, grind, time, temperature, and agitation. When looking to use these variables to manipulate your brewing process, it's important to remember that the extraction progression isn't linear: there are many times during a brew cycle that both acids and sugars are extracting at the same time, and the same goes with sugars and bitter plant material as well.

Being able to follow step by step guides that detail the brewing process with a recipe are designed to help best guide you towards brewed coffee that tastes the sweetest and most balanced. Breaking down an understanding of all the variables involved, however, will hopefully give you a breadth of knowledge that can be used to fine tune any brewing process or troubleshoot coffee that doesn't live up to it's expectations.

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EXTRACTION VARIABLES

RATIO

The ratio of coffee to water sets up a consistent recipe for how coffee will brew: not only will the ratio affect how strong, or concentrated, the final brew is, it also sets up the environment in which coffee particles want to extract. The more coffee that is used, the less likely you'll be able to efficiently extract all the acids and sugars out of it. Too high of a dose of coffee, and your final brew will be sour and strong. The less coffee that is used, the more likely you'll be able to extract all the acids, sugars, and bitter compounds easily. Too low of a dose of coffee and your final brew will be bitter and weak. Finding a balanced ratio helps you brew coffee to your preference. We recommend weight as the best way to track consistency in your brew ratios, and weighing in grams is the best measurement. A 1:16 or 1:17 ratio of coffee to water are both good ratios to start with, or if you are using an automatic drip coffee brewer, a ratio of 60g of coffee to 1L of water is the rough equivalent.

GRIND

When you grind coffee, you expose more surface area of each coffee particle to water, for quicker wetting and dissolution. The finer the grind, the quicker coffee will extract. The coarser the grind, the slower coffee will extract. However, the finer you grind coffee, the tighter the particles pack together, leading to longer brew times. The coarser the coffee is ground, the more space between particles there is, leading to quicker draw down times. Too fine of a grind, and the coffee will be strong and bitter while too coarse of a grind will leave the coffee tasting weak and sour. The consistency of each particle is important, too. Spice mills/blade grinders will often leave large chunks mixed in with powder-fine coffee dust: the superfine particles will extract bitterness very quickly, while the larger particles will only allow for sour acids to be extracted, leading to extremely uneven tasting cups. Most brew methods use the same medium grind range, like coarse table salt or sand.

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EXTRACTION VARIABLES, CONT.

TIME

The brew time tracks the amount of time coffee and water spend in contact with each other. The longer that the brew water has contact with coffee, the more there will be extracted. The shorter the brew time, the less will be extracted. Brew times that drag on too long encourage the extraction of bitter compounds, while brew times that are way too short will leave coffee tasting weak and sour. The brew time of a coffee is often a combination of multiple factors contributing to how fast or slow water is moving through the coffee. Pour time is important: either how quickly water is delivered by an automatic drip brewer, or how fast or slow a person pours their pour-over. Grind size will also impact the brew time. It's important to note that recommended brew times are mostly ballpark figures. Depending on how the coffee was ground, some brew times might finish shorter than a general recommendation but still contain a full extraction. Some brew times might seem to drag on longer but still not overextract. It's important to take note of how brew time impacts flavors as you brew and drink coffees – you might find that your sweet spot is slightly faster or slower than recommended times.

TEMPERATURE

The temperature of the water will often affect *what* extracts from the coffee rather than how much. Boiling water constantly cycling through coffee grounds will extract bitterness immediately, while water below 190°F rarely extracts the sweetest sugars in a coffee, leaving it to taste hollow and sour. A stable temperature between 195°F to 205°F allows the other brew variables to extract flavor compounds in the regular progression. Most automatic drip brewers manage temperature poorly: the brew cycle spends 80% of the time under the ideal temperature, and 20% of the time over the ideal temperature. Most expensive auto-drip brewers cost what they do because they manage temperature and brew time very specifically. Manual brew methods, like pour-over and french press, allow for greater temperature control, but also leave room for error as you have to manage all brew variables while brewing.

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EXTRACTION VARIABLES, CONT.

AGITATION

The final brew variable is the most abstract: anytime there is added agitation or stirring to a brew cycle, the coffee will extract exponentially faster. Drip coffee brewing methods, like pour-over or an automatic drip coffee brewer, have agitation built into the brew cycle: as coffee is held in place by the filter, water is constantly running through the grounds, pulling out soluble flavor compounds. With immersion brew methods, like a french press, agitation comes from manually stirring coffee with a spoon or other implement. The more times you stir, and the more aggressively you stir, the quicker the extraction process will be. Because agitation has the ability to greatly affect how coffees brew, the goal, generally, is to create consistency. Automatic drip brewers do this well, while pour-over brewing requires steady pouring, and immersion brewing requires a consistent numbers of times that the coffee is stirred.

SUMMARY

Managing brew variables will lead not only to consistent cup every time you want a coffee, but will create a consistent methodology that allows you to tweak moments to adjust for taste. Ruby recommends starting with a ratio measured by weight, following a basic brew guide, keep temperature and brew times consistent, and first adjusting grind to taste. Once you find a grind size range that nails what you're looking for, try a variety of different ratios to find both the flavor profile and the concentration in the cup that you like the best.

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WATER

There are a few different ways in which water can affect coffee brewing. Not only does the quality of the water matter for how it can impart flavor into your brew, but the chemical makeup can affect how the coffee extracts. Here are a few things to keep in mind.

TASTE

Water has a baseline flavor that comes from the type of mineral content it has and the amount of mineral content it has, combined with additives if from a city water supply. Basic carbon filtration is a great way to remove things like chlorine and other additives to eliminate any off flavors from your water.

MINERAL TYPE

The amount of mineral saturation in water source can affect how easily coffee solids are dissolved into it. Calcium and magnesium both help extract solubles from coffee. Water with higher concentrations of these minerals is categorized as “hard.” Water that is “soft,” which lacks calcium and magnesium, often has difficulty getting coffee solids to extract during brewing.

MINERAL QUANTITY

Water that has excessive hard minerals can also have difficulty extracting coffee solids. Standard filtration can help, but municipal water sources that are too hard sometimes need more than just carbon filtration.

ALTERNATIVE SOURCES

If your tap water is very hard or very soft, you can also look into bottled spring water options, or suppliers like Third Wave Water that manufacture mineral packets to be added to distilled water in order to formulate a more ideal chemical makeup for your brewing water.

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GRIND QUALITY

There are a number of different factors to consider when looking at how coffee is ground, The first step is the comparison between blade grinders (best used for spice grinding) or burr grinders. Burr grinders operate by having a spinning burr and a stable burr. The stable burr is adjustable, meaning you can control how coarse or fine your coffee is, but there are many types of burr grinders with a variety of quality differences. High quality grinders will produce a high percentage of a single grind particle, though most grinders will produce a small amount of extremely find particles and extremely coarse particles, too.

Many handgrinders are produced with high quality, sharp cutting burrs, but most motorized grinders have a larger burr set and more stability to the burrs. The more the rotating burr wobbles during grinding, the more inconsistent the grind will be. The bigger the burrs are, as well, the more specific the distance can be between them, offering greater particle consistency.

No matter what type of grinder you are using, It's important to try various grind sizes when brewing, and tasting the results. Sometimes, a grind profile might look too coarse to the naked eye, but the particles are actually the size you would want to encourage even and consistent extraction. Gaging grind size by brew time can help ballpark into the right particle size range, but doesn't necessarily point to the best grind size for your brewing until you taste your coffee.

Coffee brewing involves a lot of big picture scientific guidelines for how coffee can brew, but the best tool is always your palate: the goal is to be able to brew something you like to drink.

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EVENNESS OF EXTRACTION

Because different flavor compounds will extract from coffee at different times during the brew process, and because even the best grinders will still have a slight variance to the particle sizes, evenness of extraction during the brew process is an important step to consider. In drip methods, if the water pours through one side of the coffee more than another, that side will extract more bitter compounds, leaving the other side underextracted and only giving up the more sour tasting fruit acids. Ensuring even saturation of coffee grounds during the brew process helps mitigate these factors.

With automatic drip brewers, this means choosing a brewer that has a sprayhead that evenly saturates the coffee. Alternatively, a light stirring of the coffee grounds during the first part of the brew cycle can help saturate all the coffee grounds in an even manner. Stirring can also be done during manual pour-over brewing, but since you can control the direction of the steam of water while you pour, it's not as necessary.

It's also important to gauge the size of the filter basket against the amount of coffee in it. Two little coffee in a filter means low resistance against the stream of water, and that water can easily channel through the weak points, while too much coffee creates more resistance, which causes the brew water to flow up and over the sides of the filter, channeling that way. You should aim for about 1-2 inch depth of coffee in your filter, and adjust your brew recipe to accommodate that geometry.

Immersion brewers, where the coffee is fully saturated by the water, extract fairly evenly just by the nature of full immersion of coffee in water. Stirring helps both encourage extraction, and helps with evening out saturation as well.