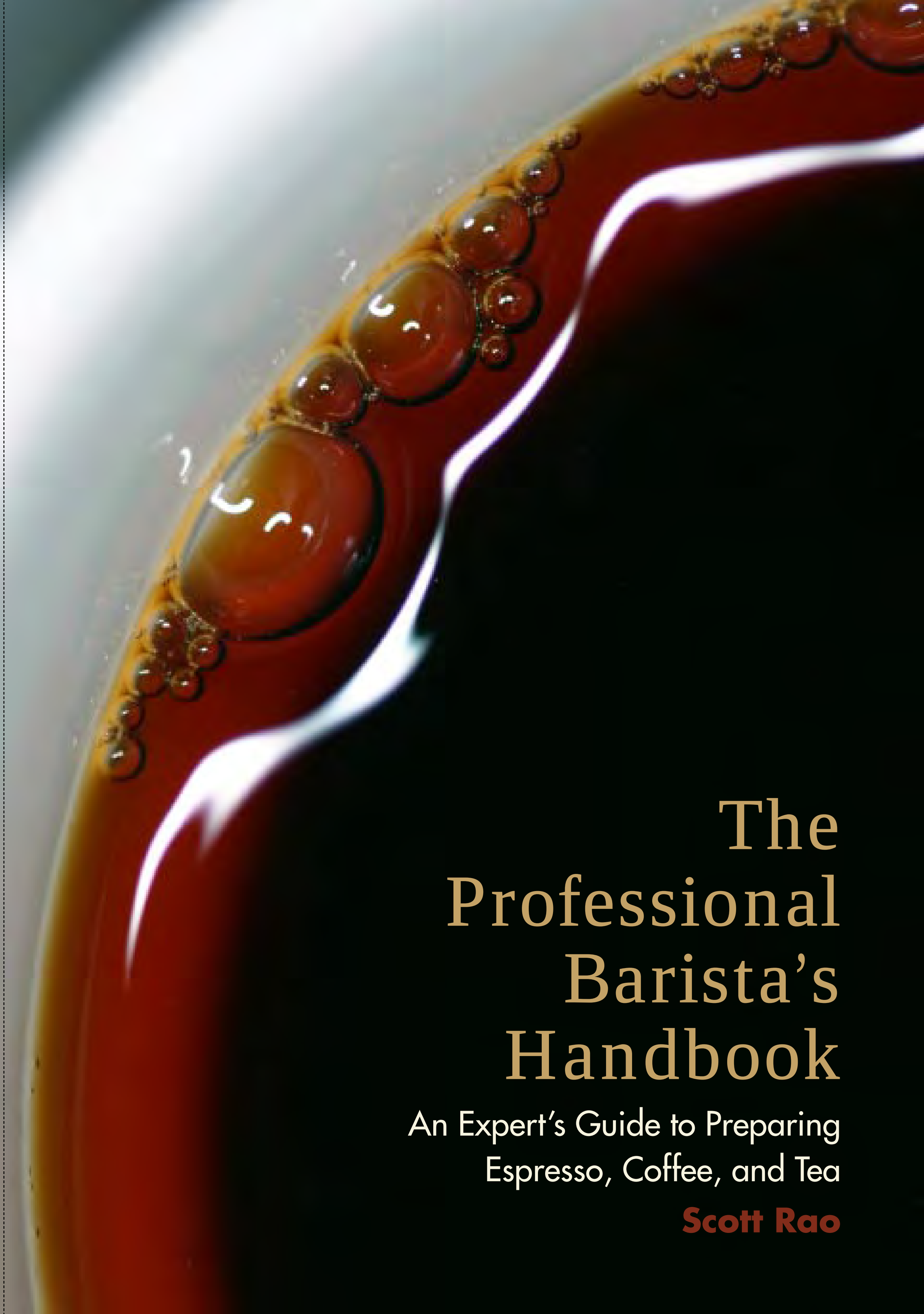

The Professional Barista's Handbook

An Expert's Guide to Preparing Espresso, Coffee, and Tea

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Introduction

When I began in the coffee business fourteen years ago, I read every book I could find about coffee. After reading all of those books, however, I felt as if I hadn't learned much about how to make great coffee. My coffee library was chock-full of colorful descriptions of brewing styles, growing regions, and recipes, with a few almost-unreadable scientific books mixed in. I would have traded in all of those books for one serious, practical book with relevant information about making great coffee in a café.

Fourteen years later, I still haven't found that book. I know many other professionals as well as some obsessive nonprofessionals would like to find that same book I've been looking for. This book is my attempt to give it to them.

The Basics

Espresso is produced by the percolation of pressurized hot water through a tightly packed bed of finely ground coffee. The water erodes solids and oils from the surfaces of the coffee particles as it flows through the coffee bed and deposits the solids and oils in the cup.

The flow rate of the water through the grounds is determined primarily by the amount of pressure applied by the machine, the mass of the grounds, and the fineness of the grind. Higher pressure, up to a point, increases the flow rate; beyond that pressure, flow rate decreases. A larger dose or a finer grind produce greater flow resistance and a slower flow rate.

Water always follows the path of least resistance through the coffee bed; it is the barista's job to create not only the proper amount of flow resistance, but also to form the coffee bed such that it provides uniform resistance to the water. A poorly formed coffee bed is vulnerable to the creation of a *channel*, an area of high-velocity flow through the coffee bed.

Channels are detrimental to brew strength and flavor. The large volume of water flowing through a channel dilutes the shot and causes the grounds along the channel to *overextract*,* increasing bitterness. Because less water passes through the denser areas of the coffee bed, those areas *underextract*,* resulting in underdeveloped flavors and lower brew strength. To minimize channeling, a barista should prepare a bed of grounds so it has a smooth and level surface, forms a tight seal with the wall of the portafilter basket, and is of uniform density.

Evidence of channeling can sometimes, but not always, be seen when using a bottomless portafilter. Channeling is indicated when extract flows more rapidly or yellows more quickly from some areas of the basket than others.

The Barista's Role

When preparing an espresso, a barista's basic goals should be to:

- Create a dose of consistent mass every shot.
- Choose the grind setting that will provide the desired flow resistance.
- Distribute the dose evenly to provide uniform resistance to the water.
- Tamp with enough pressure to eliminate void spaces within the coffee bed and to seal the surface of the bed.
- Ensure the brewing water is of the desired temperature.
- Complete all of these tasks efficiently.

The Grinder's Role

The grinder is the most important piece of equipment in an espresso bar. Grinders are usually overshadowed by more expensive, flashier espresso machines, but

* The terms "overextract" and "underextract" are subjective; by using them I do not mean to imply there is a universally agreed-upon ideal level of extraction for coffee, tea, or espresso. Instead, the reader should interpret overextraction as a general reference to extracting more than the intended amount, usually to the point of excessive bitterness or astringency. Underextraction is meant to indicate less extraction than intended, usually such that the resulting beverage has insufficient flavor development.

The yellow extract on the left indicates channeling.

grinder quality is arguably the single most important factor in preparing a great espresso.

A quality grinder must:

- Produce the proper particle sizes to provide adequate flow resistance.
- Create a *bimodal* or *trimodal* distribution of particle sizes. (See "Grinding for Espresso" in Chapter 2.)
- Cause minimal heating of the grounds during grinding.
- Limit the production of fines.

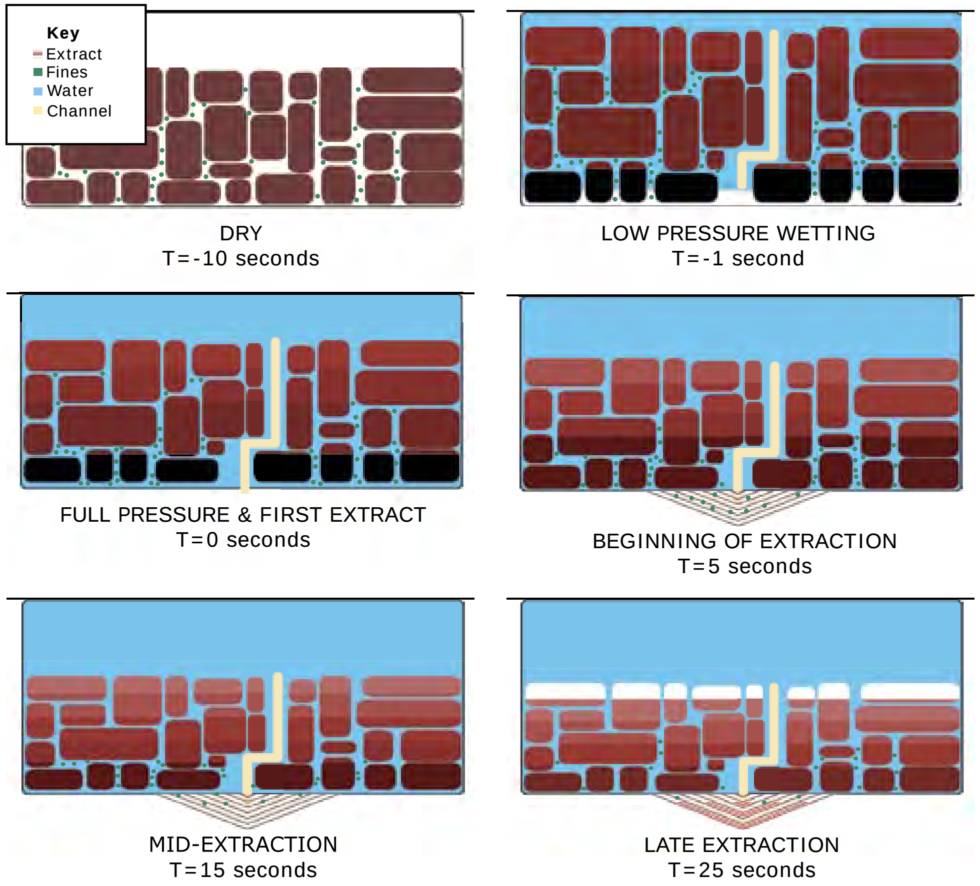
Fines play many important roles in espresso percolation; these will be discussed in detail in Chapter 3. For now it is important to know that the brewing water can transport and deposit fines lower in the coffee bed during percolation, a phenomenon known as *fines migration*. When fines and large insoluble protein molecules are deposited at the bottom of the coffee bed they can form a *compact layer*,[1] or densely packed solid mass. A compact layer clogs holes at the bottom of the filter basket and can result in obstruction of flow paths, uneven resistance to flow, and channeling. It is desirable to have some fines, but too many fines or too much fines migration can damage espresso quality.

The Espresso Machine's Role

The espresso machine's task is to deliver water to the grounds in a predetermined pattern of temperatures and pressures. These patterns are known as *temperature profiles* and *pressure profiles*.

A quality espresso machine should be able to produce consistent temperature and pressure profiles every shot, even under heavy use.

THE DYNAMICS OF ESPRESSO PERCOLATION AND EXTRACTION



The color of the grounds (represented by the stacked rectangles) in the first frame is deep red, indicating they are concentrated with coffee solids. The lighter reds in later frames represent lower solids concentrations.

T = -10 seconds: *The dry grounds just before the pump is engaged.* The grounds are packed with solids, and fines are scattered throughout the coffee bed.

T = -1 second: *The coffee bed near the end of preinfusion.* The water has percolated through almost all of the coffee bed but extraction has not yet begun. The grounds have absorbed water, swelling the coffee bed. A channel, represented by the yellow line, has formed through the middle of the coffee bed. The upper layers of the coffee bed have lost solids, while the lower coffee bed has gained solids. Fines have begun to migrate down the coffee bed.

T = 0 seconds: *The first extract appears.* The first extract appears at the outlet of the channel. Fines and solids have concentrated in the lower layers of the coffee bed. The coffee bed contracts as pressure increases.

T = 5 seconds: *Early extraction.* Solids and fines are rapidly removed from the coffee bed. The coffee bed is further compressed as full pump pressure is applied.

T = 15 seconds: *Mid-extraction.* The coffee bed shrinks as it loses mass. The upper layers of the bed are almost depleted of extractable solids. The bulk of fines and solids are concentrated in the lowest layers of the bed.

T = 25 seconds: *Final moments of extraction:* The upper layers of the bed are completely empty of extractable solids. The coffee bed has lost about 20% of its original dry mass.

According to the research done with large percolator columns, diffusion does not occur until coffee particles are:

1. "Satisfied with bound water." Coffee particles can hold up to about 15% of their dry weight as bound water.[16]
2. Saturated with free extracting liquid.[7]
3. Free of gases.[7]

The typical espresso extraction time is probably too short for all three preconditions of diffusion to be met. Therefore, it is likely that espresso extraction is accomplished entirely by the washing of solids from the outer surfaces of coffee particles, as well as by the emulsification* of oils.[9] Diffusion plays little, if any role.

Flow Progression

The initial extract from the flow of a well-prepared shot should be viscous and dark.‡ As the flow progresses the extract becomes more dilute and the color gradually lightens, eventually turning yellow. Cutting off the flow when it yellows, or

* The emulsification of oils seems to be enabled by the pressure of espresso brewing. It is arguable that the emulsion is the aspect of an espresso most responsible for differentiating it from a very concentrated cup of coffee.

‡ The color of the extract is believed to be darker when it has a higher concentration of caramelized solids or a lower concentration of CO_2, though there may be other factors that influence color.

Begin by pouring the milk into the center of the crema. Pour quickly enough to prevent separation in the pitcher but slowly enough to keep the crema intact.

Maintain a consistent, moderate flow rate throughout the entire pour. To do this, you must accelerate the tipping motion of the pitcher as the amount of milk in the pitcher decreases.

Rock the pitcher back and forth once the white cloud appears.

Continue rocking the pitcher to create a zigzag pattern. It is critical to resist the urge to raise the pitcher away from the surface of the beverage. It may be counterintuitive, but keep the pitcher as low as possible while pouring and constantly accelerate the tipping of the pitcher to maintain the flow rate.

Back the pitcher toward the edge of the cup while zigzagging. Once you reach the edge of the cup lift the pitcher a couple of inches and drizzle a small stream of milk back across the centerline of the zigzags.

Ecco!

How to Pour Latte Art

To pour latte art you must have a fresh shot of espresso with a reasonable amount of crema and properly textured steamed milk. The milk should look creamy and glassy, with no visible bubbles.

The most common mistakes beginners make are pouring the milk too slowly and lifting the pitcher away from the surface of the beverage while pouring. Pouring milk too slowly can cause it to separate in the pitcher, causing less-aerated milk to pour into the beverage and more-aerated milk to remain in the pitcher. This makes pouring latte art difficult and also results in an under-aerated beverage. Raising the pitcher away from the surface of the beverage causes the milk to dive under the crema rather than resting on top of the crema and forming a design.

Raising the pitcher while pouring prevents the milk from resting on the crema because the flow of the milk is accelerated by gravity. Raising the pitcher is analogous to diving from a high board: just as the milk dives to the bottom of the cup and hardly disturbs the crema, the diver cuts through the surface of the water with hardly a ripple and submerges deeply. On the other hand, pouring with the spout of the pitcher kept very close to the surface of the beverage is analogous to diving from the edge of a pool: the milk skims the surface of the beverage just as the diver merely skims the surface of the water.

The Spoon Method

The spoon method is common in New Zealand, but I've yet to see it practiced elsewhere. The benefits of the spoon method include delaying froth separation in the cup and allowing control over the texture of the milk while pouring. The disadvantages of the spoon method are it takes more time than free-pouring, requires the use of both hands, and is harder to master.

The spoon method works best with a round bell or vev pitcher with a beveled edge. The wide mouth of the bell pitcher provides a better view of the milk texture while pouring and allows easier spoon access and control.

To execute the spoon method, steam the milk, groom it if necessary, and use a tablespoon as a gate to control the flow and texture of the milk as it is poured. The details are different for each drink, but the basics are the same.

1. Begin the pour with the spoon tightly restricting all but the densest, least frothy milk. Some baristi use the spoon to pull back (away from the pouring edge) the frothiest milk several times before restricting the milk and starting the pour.
2. Pour into the center of the espresso at a moderate rate to prevent breaking up the crema.
3. While pouring, lift the spoon slowly to allow frothier milk into the cup.
4. The surface of the finished drink should be glassy and can be finished with a design if desired.

How to Milk-Share

Transfer about ⅓ of the milk from the large pitcher to the small pitcher.

Spin the large pitcher to check the milk texture before pouring.

Free-pour the cappuccino milk using the large pitcher.

Combine remaining milk in the small pitcher.

Spin the milk in the small pitcher. Groom if necessary.

Pour the café latte.

The Basics

It is common knowledge that brewing water should be carbon filtered and have no "off" flavors. But that is only the starting point for quality brewing water. To get the most out of your coffee (or tea or espresso), the water needs to have a neutral *pH* and appropriate levels of *hardness*, *alkalinity*, and total dissolved solids (TDS).

The following water chemistry terms are relevant to coffee making.

Total Dissolved Solids (TDS): The combined content of all substances smaller than 2 microns in any dimension dispersed in a volume of water. Measured in mg/L or ppm.

Hardness: Primarily a measure of dissolved calcium and magnesium ions, though other minerals can contribute. Measured in mg/L or grains per gallon.

pH: A measure of acidity derived from the concentration of hydrogen ions; 7.0 is neutral.

Acid: A solution with pH lower than 7.0.

Alkaline: A solution with pH greater than 7.0.

Alkalinity: A solution's ability to buffer acids. Measured in mg/L.

The terms and measurement units used to describe water chemistry often seem designed to confuse. For simplicity I have left out numerous alternative units of measurement and will measure TDS, hardness, and alkalinity in mg/L (milligrams per liter, or parts per million).

A solution can be very alkaline but have low alkalinity, and vice versa. As an analogy, think of alkaline as the solution's location on the political spectrum. Let's say alkaline refers to being on the right, and acid refers to the left; alkaline denotes being conservative, acid denotes liberal. (No political commentary intended!) Alkalinity, on the other hand, is analogous to stubbornness and resistance to becoming more liberal. Of course, one can be at either end of the spectrum (acid or alkaline) and still be resistant (have high alkalinity) or amenable (low alkalinity) to becoming more liberal.

Terminology

The terms alkalinity and alkaline do not refer to the same thing. "Alkaline" refers specifically to a solution with a pH between 7.01 and 14. "Alkalinity" refers specifically to a solution's ability to buffer an acid or, less technically, its resistance to becoming more acidic.

The relationship between hardness and alkalinity also needs clarification. Hardness is derived from calcium, magnesium, and other cations (positively charged ions). Alkalinity is derived from carbonate, bicarbonate, and other anions (negatively charged ions). A compound such as calcium carbonate contributes to both hardness and alkalinity, because it has calcium (hardness) and carbonate (alkalinity). On the other hand, sodium bicarbonate contributes to alkalinity but not hardness. Common water softeners work by replacing the water's calcium with sodium. This decreases hardness but does not affect alkalinity.

Boiler *scale* is caused by the precipitation of calcium carbonate when hard water is heated. Precipitation of scale decreases the hardness and alkalinity of water. Over the long term, scaling can seriously damage your espresso machine. In the short term, scaling can quickly clog small valves and passageways; gicleurs and heat exchanger restrictors are particularly vulnerable.

Espresso machine manufacturers routinely recommend using water softeners to protect espresso machines. A softener will protect your machine but might ruin your espresso. (See "Water Treatment Options" later in this chapter.)

Brewing Water Standards

I recommend the following water standards for brewing coffee, tea, and espresso.

WATER FOR COFFEE, TEA, AND ESPRESSO			
TDS	PH	HARDNESS	ALKALINITY
120–130 ppm (mg/L)	7.0	70-80 mg/L	50 mg/L

Most industry recommendations call for slightly higher levels of hardness and TDS than listed above; using those industry standards yields marginally better coffee, but I cannot recommend them for espresso because they increase the risk of scale formation.

In theory, water with hardness a little greater than 80 mg/L will not create scale at typical espresso brewing water temperatures. In reality, machine temperatures and the hardness yielded by water treatment systems fluctuate, and I'd rather err on the side of caution. Caution is especially important when using gicleurs or heat exchanger restrictors. Small amounts of scale can dramatically alter the performance of these tiny orifices.

Please note: Hardness of 70 mg/L will create scale at typical steam boiler temperatures. The only way to protect the boiler and still have great brewing water is to install two separate lines with water of different hardness levels feeding the espresso machine.

How Water Chemistry Influences Coffee Flavor

To put it simply, the less "stuff" already dissolved in brewing water, the more "stuff" the water will dissolve from the grounds. If TDS levels are too high, water is a weaker solvent and will not extract enough solubles from the grounds. Coffee brewed with very high TDS water will taste dull and cloudy. Very low TDS water can produce coffee with edgy, unrefined flavors and, often, exaggerated brightness.

Hard water does not decrease the potential quality of coffee or espresso; even if the water feeding the coffee machines is very hard, the actual brewing water will not be too hard because much of the hardness precipitates as scale at typical brewing temperatures. Unfortunately, the scale can damage or alter the performance of

Basic Tea-Making Guidelines

To get ideal infusions from a high-quality tea, it is necessary to become familiar with the tea's potential by experimenting with doses, water temperatures, and infusion times. It is also necessary to vary these parameters for successive infusions.

This approach might not be practical for most cafés, so I'll offer the following basic guidelines that will work well with the vast majority of teas.

Dose

For all teas, use 1 gram of tea leaves per 3 oz water. Volumetric dosing (i.e., using 1 tsp per cup) is not reliable because different teas can be of greatly varying densities. Fortunately, dosing by weight will decrease waste in most cafés since most baristi tend to use too large a quantity of leaves. To save time during service, I recommend pre-portioning tea leaves into small containers.

Steeping Time

Optimum steeping time is primarily determined by leaf size. Smaller leaves have more specific surface area and therefore require less steeping time. Larger leaves require longer steeping times; large, tightly rolled leaves need the most time to steep. Generally speaking, teas should be steeped until just before a significant amount of astringency begins to extract. Recommended steeping times range from 30 seconds to 4 minutes.

Rinsing

Some tea types require rinsing, as noted below. To rinse leaves, place them directly in the pot or use a coarse mesh strainer, such that any small tea particles can be flushed along with the rinse water. Fill the pot with water of the proper steeping temperature for about 10 seconds and then discard the rinse water. Gold filters, fine metal mesh filters, and paper tea bags prevent the flushing of small particles and should not be used for these teas.

General Preparation

Leaves should always be steeped in a preheated, enclosed container and be given ample room to fully expand. Tea balls, tea bags, and small strainers that do not allow the leaves to fully expand are not recommended. Teas with a lot of dust or broken leaves due to handling should be briefly rinsed to eliminate small particles.

The number of quality infusions offered by different teas varies. For any given tea the number of times it can be steeped well is influenced by steeping times and the ratio of leaves to water used. Higher ratios and shorter steeping times allow more quality infusions.

Preparation by Tea Type

Black

Steeping time should be carefully managed because overextracted black teas quickly become very astringent. Most black teas offer one or two quality infusions and should be steeped at 200°F–210°F. Black Darjeeling is one exception and should be steeped at 190°F–200°F.

Oolong

Always rinse oolongs before the first infusion. Oolongs can be steeped three to six times. The first steeping is often too bright or unrefined, the second steeping tends to be the most balanced, and thereafter each successive steeping needs a longer infusion time to extract enough flavor and strength. Steep darker oolongs (browner leaves) at 185°F–195°F and lighter oolongs (greener leaves) at 170°F–185°F.

Green

A few green teas, especially ones with rolled leaves or a lot of furry-looking "down," benefit from rinsing; experimentation is required. Due to the enormous variety of green teas and processing methods, ideal steeping temperatures can range from 150°F–180°F. Most green teas offer one to three quality infusions.

White

The delicate, subtle flavors of quality white teas are easily damaged by excessively hot water. Ideal steeping temperatures are 160°F–170°F, and most white teas offer two to four quality infusions. Whites generally do not require rinsing unless they have a lot of down.

Herbal

To prepare herbal infusions for optimal flavor, steep for 1–4 minutes. For the most potent medicinal benefits, steep for at least 10 minutes in an enclosed container. Steep most herbals in boiling, or nearly boiling, water.

Other Teas

Some teas, such as matcha, pu-erh, frost teas, yerba mate, and various aged teas require unique steeping methods and temperatures. These special cases are beyond the scope of this book, and I recommend that baristi research further before preparing them.

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About the Author

Scott Rao was bitten by the coffee bug in 1992 when he discovered City Bean Coffee in Los Angeles. Scott had always loved coffeehouses, but until that first cup of Java Blawan from City Bean he had never enjoyed the taste of coffee. That cup changed his life, and Scott immediately decided he wanted to learn everything he could about coffee and open a coffeehouse.

In 1994 Scott founded Rao's Coffee in Amherst, Massachusetts, and sold it in 2001. In 2006 Scott founded Esselon Café in Hadley, Massachusetts. He left Esselon in 2007. During his career Scott has roasted and sampled more than twenty thousand batches of coffee and made several hundred thousand coffee beverages.

Scott currently does consulting for coffee retailers. He no longer has any formal ties to Rao's Coffee or Esselon Café.

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