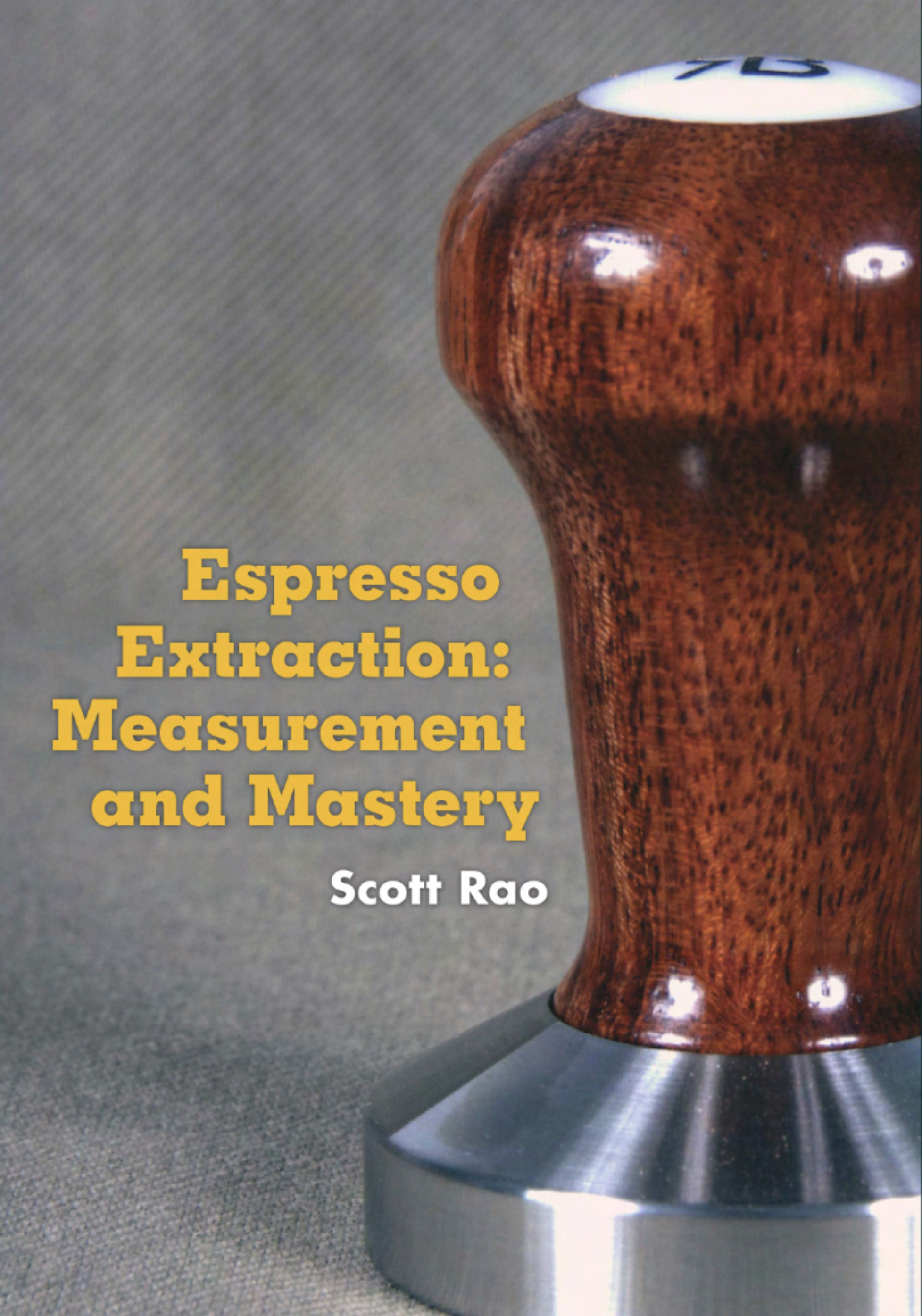


Espresso Extraction: Measurement and Mastery

Scott Rao

Chapter 1

What Is an Ideal Extraction?

Below, I define an ideal extraction based on parameters that are rapidly becoming the industry standards for espresso normale:

Dry Dose

The dry dose should weigh between 14 and 22 g and should approximate the dose a given basket is designed to hold (i.e., within 10% of the basket's intended dose).

Brewing Ratio

Shot weight should be approximately 1.5 to 2.0 times the weight of the dry dose. I consider lower ratios to be "ristretto" and higher ratios to be "lungo" espresso.

Temperature

Water temperature at the group head should be 195°F to 203°F (91°C to 95°C). Generally, the lower temperatures in that range should be used for higher brewing ratios (more lungo), and higher temperatures should be used when brewing with lower ratios (more ristretto). Coffee origin, processing, and roast degree also influence the water temperature the barista should use.

Time

Time elapsed from the moment a barista starts flow from the group until the barista stops the flow should be 25 to 40 seconds. Baristi using "flat" pressure profiles should aim for the low end of the time range. Those pulling shots with progressive preinfusion should aim for the middle of the range, and baristi producing extractions using pressure profiling machines should target the top end of the time range. (See <chap>Chapter 11, "Pressure Profiling.")</chap>

Extraction

Baristi will usually find that extractions in the 19% to 20% range yield the best-tasting shots. Please note three exceptions to this recommended range:

1. Very large burr sets, when sharp, may produce fantastic shots at extractions greater than 20%. However, I do not recommend extractions greater than 20% for baristi who use most of today's popular espresso grinders.
2. Small or dull burrs may necessitate extractions below 19% to avoid excessive astringency and bitterness.
3. A barista seeking a clean, fruit-forward, bright shot may choose to extract in the 15% to 16% range (a.k.a. "the little hump"; see www.jimseven.com/2010/11/08/the-double-hump). Such shots emphasize fruitiness at the expense of caramels and balance and can be interesting and enjoyable as straight espresso. (Please note: Some experts argue that the little hump is merely an artifact of a common extraction calculation error. I am confident that the little hump is real and not the

Chapter 5
Basket Design

I am usually reluctant to endorse particular products, but I do recommend VST baskets. Prior to the availability of VST baskets, no baskets on the market had precise, consistent hole size, area, and shape, and none were checked for quality on an individual basis, using an imaging system. As well, most baskets were not perfectly round and of consistent inner diameter. Misshapen baskets forced baristi to use, perhaps unknowingly, smaller-than-ideal tampers to prevent the tampers from getting stuck in baskets. (Imagine trying to fit a round peg into an oval hole.)

VST baskets have adequate total hole area for use with the larger doses that result from finger-swipe dosing. (Historically, baskets had less hole area because they were designed for use with shallower doses.) Most non–VST baskets are manufactured by mechanically punching out of the holes, leading to incomplete punches and misshapen holes, which result in inconsistent flow rates and extraction levels. I remember struggling years ago to find three baskets similar enough to produce consistent extractions on all three groups of my espresso machine; frequently it was not possible. To guarantee consistency, I recommend baristi use only baskets with precise, laser-cut holes verified using an imaging system.

Hole Area and Extraction

For a given basket diameter, the ratio of hole area to ground coffee weight determines potential extraction. Greater hole area provides less flow resistance, allowing the use of a finer grind or larger dose.

More hole area → decreased flow resistance → finer grind → more extraction

Less hole area → increased flow resistance → coarser grind → less extraction

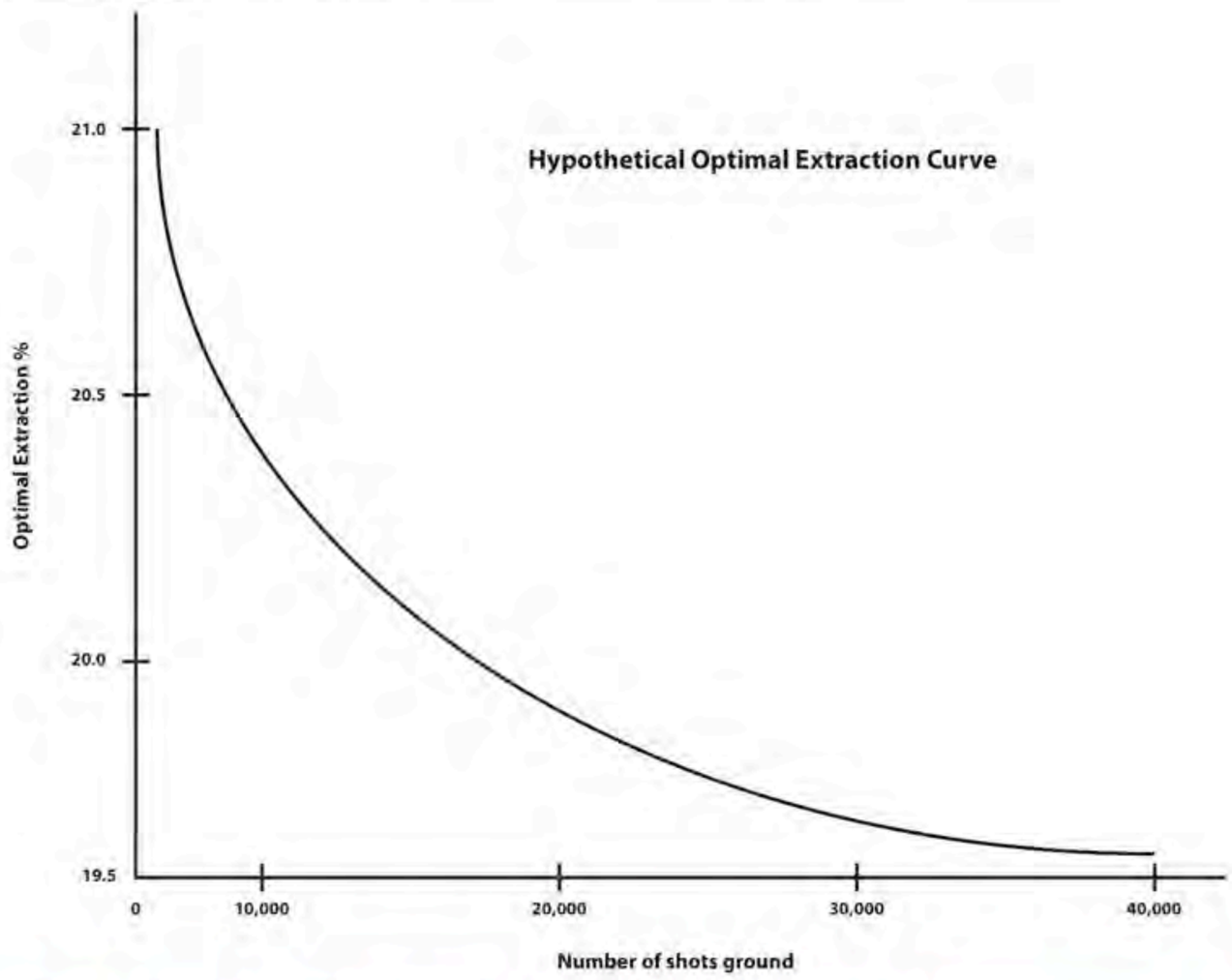
Basket Design and Volumetric Dosing

Even great baristi, paying close attention, will often err by a few grams per shot, resulting in inconsistent brewing ratios. For many years, volumetric machines have had the potential to not only match but exceed the shot-to-shot accuracy of a good barista, while allowing the barista to multitask without sacrificing shot quality. However, poorly made baskets have always limited the consistency of espresso from volumetric machines.

If a barista using a typical, non-precision basket doses accurately, uses a tamper that fits that basket snugly, and uses a programmable volumetric machine, he may end up with consistent results in the cup. If the barista then swaps portafilters among group heads, changing baskets in the process (but still using the same model and brand of basket), the results in the cup may change dramatically due to differences in the baskets' shapes, sizes, or open hole area. Shot volume, flow rate, and brewing ratio will all change if the baskets have different open hole area. Equally important, if the second baskets' diameter is too wide for the tamper, side channeling will occur, causing changes in

Burr Sharpness and Optimal Extraction

Both the maximum and optimal extraction decrease as burrs dull. Therefore, it's too simplistic to say, "This Kenya tastes best at 19.5% extraction." It would be more accurate (but still simplistic) to say, "Using this sharp burr set, the Kenya tastes best at 20.5%, but 30,000 shots later, when the burrs are duller, it tastes best at 19.0%."



This graph represents the hypothetical optimal espresso extraction level (using a constant dose, coffee,roast, brewing ratio, etc.) for a grinder as its burrs dull.

Structural Grinder Problems

I've encountered three structural grinder problems that interfere with grind quality:

1. Divergent burrs: The most common problem I've encountered is non-parallel burrs. Typically, this has happened when a barista replaced the burrs after cleaning them. If even one or two ground particles remain under a burr while a barista is reseating it, those grounds can cause enough tilt in the burr to degrade grind quality.
2. Burrs not lined up with each other: Surprisingly, some professional grinders are not designed to force the burrs to line up perfectly. Reseating burrs in such a grinder requires the utmost care and a little luck. I've owned two such grinders, and both designs relied on the burrs' mounting screws

Chapter 7
Roast Development

The internal structure of a coffee bean is a three-dimensional web of cellulose strands. Coating these strands is the soluble material that provides coffee's flavor. While the cellulose of raw coffee beans is "plasticky" and nonporous, roasting makes it more brittle and porous.[2] Under-roasted, or less developed, sections of cellulose are more plastic, resist fracturing during grinding, and are not porous enough for water to pass through. If water cannot penetrate a chamber enclosed by cellulose, the brewing water cannot extract the soluble material from that chamber.

Underdeveloped sections of beans result in lower total extraction as well as undesirable, savory flavors (See vstapps.com/blog-2/extractmojo/underdevelopment). Therefore, full roast development is necessary for both extraction quantity and quality. Unfortunately, with the recent (and generally welcome) trend toward very light roasting, few roasters consistently achieve full development. This fact (once dismissed as just my cranky opinion) is now verifiable with a coffee refractometer, as underdeveloped roasts yield lower extractions.

A roaster or barista may use the following procedure as a shortcut to evaluating roast development without pulling and measuring numerous shots:

Step 1. Boil water and grind coffee as you would to prepare a cupping.

Step 2. Allow the water to cool to 203°F to 204°F (95°C) before pouring.

Step 3. Pour the water over the grounds, and bring your nose to just above the surface of the brew immediately after pouring.

Step 4. Using a cupping spoon, break the crust of grounds and smell the aroma.

Step 5. Break the crust a few times and agitate the grounds while smelling, to get a firm impression of the aroma.

The more savory the aroma you detect, the less developed the roast. Aromatics reminiscent of broccoli, turnips, or celery usually indicate very poor development. Grass or straw are signs of more modest underdevelopment. This method is not foolproof, as some coffees may have intrinsic savoriness due to defects. Other coffees, such as Sumatras, may be herbaceous without being considered defective.

All else being equal, a roaster will improve development by roasting darker. I am not recommending darker roasting to improve development; however, sometimes roasters need to default to slightly darker roasting while figuring out how to properly develop a coffee at a lighter color.

A Few Notes on Underdevelopment

- Probably the most unusual case of underdevelopment I have witnessed involved a lightly roasted coffee that did not outgas at all after several weeks in a sealed bag. While this case was extreme, it did teach me how dramatically roast development can affect outgassing.
- I have frequently witnessed underdevelopment decrease extraction by 1 to 4 percentage points