

THE COFFEE FERMENTATION

FLAVOR

CONTINUUM

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The Coffee Fermentation Flavor Continuum

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Preface

While coffee flavor is dependent on myriad factors from cultivar to roast degree to brewing style and beyond, primary coffee processing – fermentation – is responsible for the creation of major identifiable flavors in basically every coffee.

If you were to set two coffees in front of a trained taster, one tasting like ripe blackberries and the other tasting like fresh orange and caramel, the taster would likely predict that the berry-flavored coffee was a natural and the citrusy coffee was traditionally washed. In a world where traditional styles of processing are the only ones available, that taster would likely be correct.

With the advent of unique fermentation techniques, however, our flavor palate has expanded and overlapping styles of processing may create uncommon, unexpected, or simply unpredictable flavors that defy easy categorization.

However, it's still probably true that traditionally processed washed coffees will produce the mildest flavors. Container-loads of generic 82 point washed coffees tasting like caramel, cacao, nuts, and only the vaguest of fruits are loaded onto trucks and ocean liners every day of the year. This is true in part because processes like depulping, fermenting, and washing coffee were originally utilized as means to an end – a functional step that aided efficiencies in preservation and shipping.

Yet, because of excitement – much of it fairly new to our industry – around the flavor potential of fermentation, the line of excellence and failure has been blurred with respect to flavors which fifteen or twenty years ago would have been rejected as “overly fermented.” If the coffee tastes boozy and winy without cup variation, and was crafted with intent, then we can generally accept it as successful (even if we might individually find it unpalatable). Our open mindedness at the cupping table is spurred by the thought that there is surely also a market for some coffees like these, on the far reaches of the fermentation flavor spectrum.



A coffee tree flowering

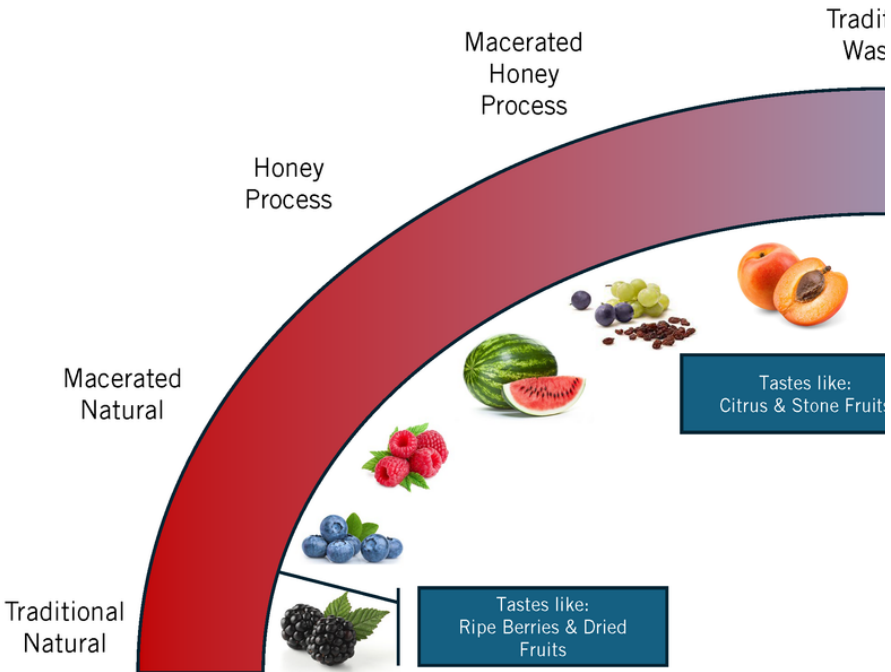


What is Fermentation?

Fermentation itself is a vast and widely misunderstood process that takes on different definitions depending on the one who might be defining it. Biochemists are fairly strict about the parameters, whereas in food production our definition is a little more flexible.

Fermentation, chemically, is metabolically and enzymatically induced energy extraction from carbohydrates, in the absence of oxygen.

The Coffee Fermer



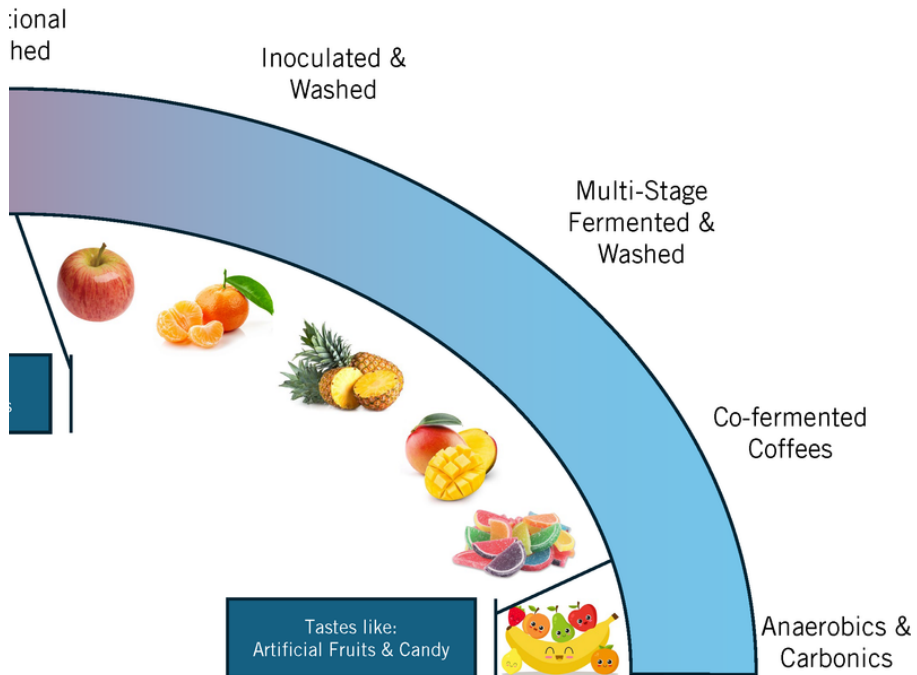
*Minimally Processed
with Spontaneous
Fermentation*



Fermentation, in the context of food and beverage, is a process in which microbes – usually bacteria or yeasts – **bring about changes in what we eat and drink**. Typically, microbes will consume sugars and produce alcohol and organic acids.

A small population of microorganisms (often a single strain, species, or type) can be referred to as a **culture**. Cultures of certain microbes may be used as starters to **inoculate** (or control a microbe population's exclusivity) a specific type of food or beverage.

Flavor Continuum



→ *Maximally Processed with Controlled Fermentation*



Did you know?

We can split the most-used fermentation microbes into two broad, basic types: bacteria and fungi.

- **Bacteria** – single-cell microorganisms, bacteria live in us and all around us. Some keep us healthy, some make us sick, some contribute to industries from agriculture to pharmaceuticals to mining. Many are useful in food production, and there are two basic types we typically find in fermentation cultures.
 - **Acetic Acid Bacteria** – responsible for producing **vinegar**, primarily, and – in a Symbiotic Culture Of Yeasts and Bacteria (SCOBY) – **kombucha**. These bacteria are aerobes (they thrive in the presence of oxygen). We typically experience acetic acid fermented foods as being **sour**.
 - **Lactic Acid Bacteria** – the primary agents in creating **yogurts, cheeses, kimchi, sauerkraut**, and utilized sometimes in the production of certain specific types of beer and wine. Lactic acid bacteria are anaerobic. Lactic acid fermented foods run a wide gamut of flavors, and can be lightly sour or **tart**, and are often **salty** (as a salt brine encourages the bacteria to form in an environment hostile to other microorganisms).
- **Yeasts** (and other fungi) – we eat certain types of fungus (like mushrooms), refer to foods spoiled by other fungi as molded, and rely on some to help us fight disease. There are a number of specific fungi which have been harnessed to produce popular fermented foods.
 - The most common fungal genus used in food and beverage production is *Saccharomyces*, including many of the species which we refer to collectively as **yeasts**. Yeast is responsible for fermenting most **wine, beer, and bread**, and is frequently found in **mixed culture** fermentations with other microbes.
 - Other genera of fungi are employed to produce foods like **miso, tempeh, and soy sauce**. We typically favor these types of fungal fermentation when they produce **savory** foods.



Submerged coffee is washed and sorted for density in grading channels in southern Ethiopia

Photo by Evan Gilman



What about coffee Fermentation?

Is coffee fermented?

The answer is almost always yes. Immediately after harvesting, coffee fruits ferment prior to further processing and export.

Traditional coffee processing can be split into two primary categories – usually referred to as **washed** and **natural** – which ferment in different ways and result in different flavors.

There are also various innovative fermentation methods, many of which are relatively new to coffee, which impact tasting notes significantly. There's also a **sensory defect** known as “ferment.”

Traditional Natural Coffee Fermentation

Natural coffees undergo minimal processing, drying the coffee fruit whole around the seeds (beans).

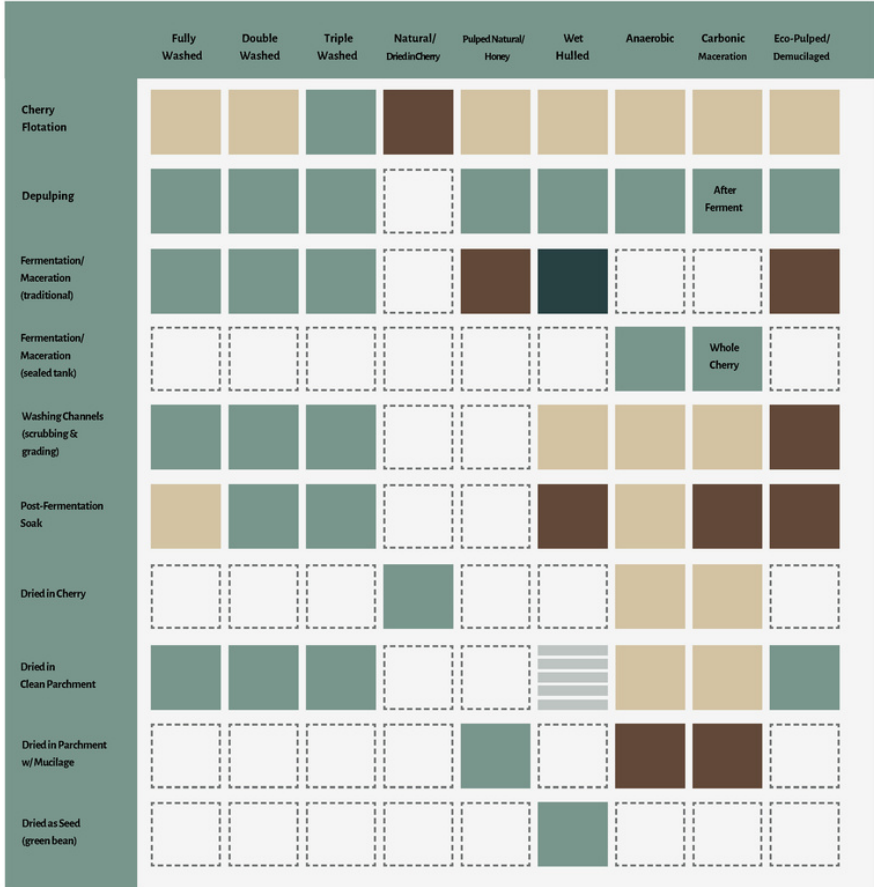
Microbes native to the environment where coffees grow will feed on the fruits as they're drying.

Fermentation here occurs spontaneously, uncontrolled, and generally unobserved. Very little research has been done into the specific types of microbes responsible for natural fermentation, but we can be fairly certain it will be a mixed culture of bacteria and yeast, with specific species likely varying by region.

Natural coffees are expected to taste fruity as a baseline flavor; some may range from delicately peachy to bombastically berry-like. Cuppers usually avoid overly nutty and bland naturals on the one hand, and winey, boozy, vinegar-like, or composty natural on the other.



FIGURE 1.
COFFEE PROCESSING TYPES



Infographic designed by Chris Kornman, Evan Gilman, and Jeremy Leff
 This version was first published in *Green Coffee: A Guide for Roasters & Buyers*
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Coffee cherries are drying on a bed at Fatima Estate in Mexico



Coffee cherries are processed in the pulping machine at Homa Cooperative, Ethiopia



Traditional Washed and Fermented Coffees

Washed coffee seeds are stripped of their fruit (“depulped”) and then fermented semi-formally prior to the eponymous washing step in processing.

Usually, fermentation will occur in an uncovered tank, either piled dry or submerged in water. Researchers and scientists have traditionally categorized this as a mixed culture of predominantly lactic acid bacteria and yeasts. While fermentation in washed coffees has traditionally been intentional the culture, the culture will likely be impacted by the spontaneously occurring native microbes of the local environment.

While monitoring variables such as temperature, sugar content, and pH is possible, traditional controls are usually limited to the duration (usually brief, eight to 48 hours may be the most common length, depending on regional trends and temperatures), and to whether or not the depulped coffee is submerged in water during the process. “Wet” fermentation has some advantages – it homogenizes the process and may limit the fermenting microbe population to more beneficial types.

Washed coffees represent the majority of specialty coffee produced in the world, and are expected to taste clean, mild, and sweet. A typical generic specialty-washed coffee from Central America might be caramelly and nutty, while African-washed coffees are frequently thought of as being more citric and floral. Generally, traditional washed coffees may taste fruity but rarely dive deeply into berry-like flavors, tasting closer to stone fruit and citrus types of fruit flavors. Regional and processing idiosyncrasies, as well as myriad other factors such as cultivated plant variety, may alter flavor substantially.

The Ferment Defect

While washed coffees are intentionally fermented, and natural coffee cherries ferment spontaneously until they are dried, all coffee may be impacted by a nefarious defect cuppers are trained to detect known as **ferment**.



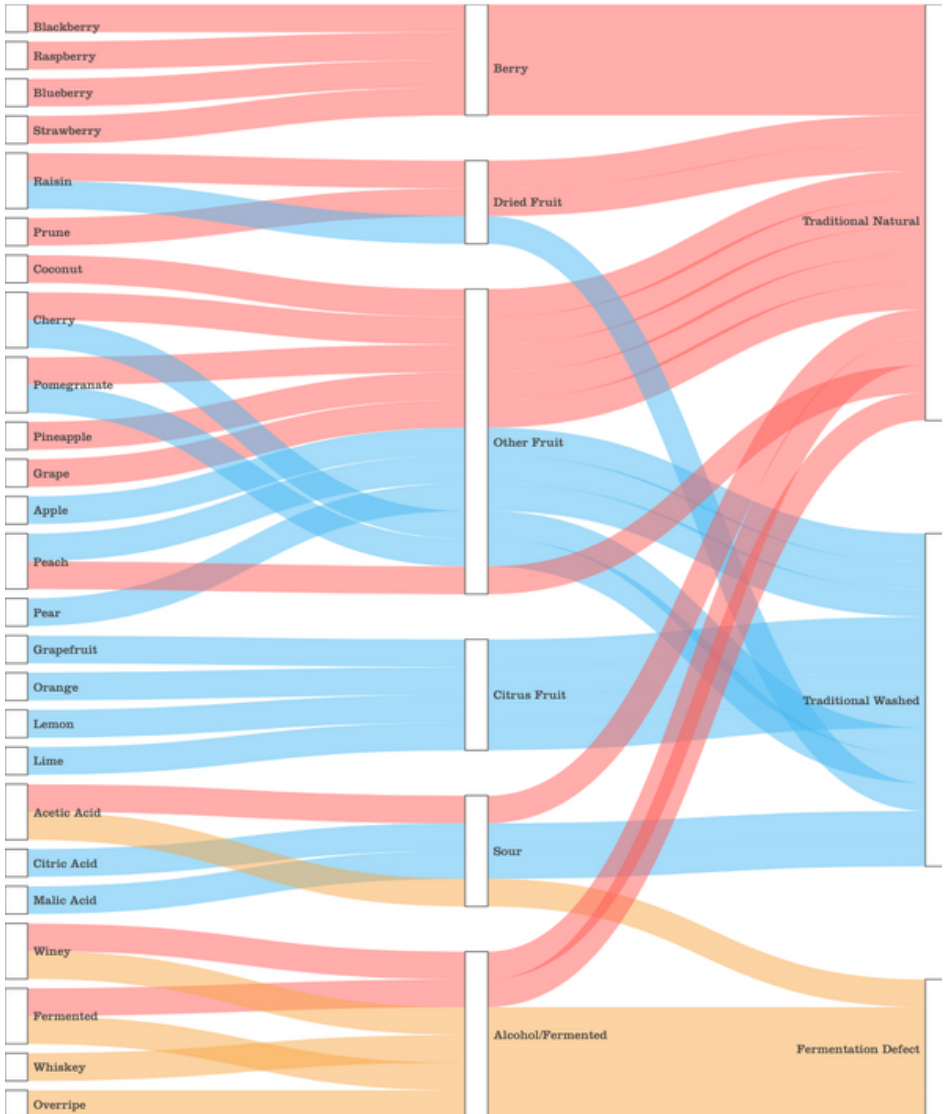
This sensory defect, typically represented by inconsistent cups (though in severe cases affecting entire lots), presents with overly fruity tasting notes, or even flavors of vinegar, rotting fruit, or compost. It may affect any style of processing but is most associated with washed coffees which spend too long in the fermentation tank, have insufficiently cleaned fermentation facilities, or simply are macerated by “bad” microbial actors.

Recent studies indicate that the ferment defect, or the “over-fermented” flavors, could be considered as a microbial “attack on the bean” itself, rather than simply fermenting the fruit surrounding the seed. Certain scientists have proposed chemical definition of this defect, rather than a sensory one, which might include a threshold of detection of certain ethyl esters responsible for the off-flavors.





Mapping The Flavor Wheel to Process



Flavor

Category

Process



New Frontiers in Coffee Processing & Fermentation



Pulped natural coffee, or “honey” process, dries on Fazenda IP near Carmo de Minas, Brazil

Photo by Chris Kornman

Honey Process

In the early 1990s in Brazil, the first of what would eventually become known as “**Honey Process**” coffees were being created and eventually made available in small volumes for roasters to buy.

Honey Process, also known as “**Pulped Natural**” and sometimes “**Semi-Washed**,” is an in-between method, whereby a producer depulps coffee fruits and dries the coffee in mucilage without intentionally fermenting. The spontaneous fermentation is much like that of a traditional natural, except that instead of fermenting a whole unprocessed cherry, fermentation only affects the remaining fruit pulp clinging to the seed.



Honey process coffees sometimes include a color – on a scale from least amount of fruit remaining to most, that scale might read: white honey (with almost no fruit left on the seed), yellow, red, purple, and finally black honey (with all but the skin of the fruit left to ferment on the seed).

As you might imagine, the flavor of honey processed coffee, depending on how much fruit is removed, will vary on its own continuum. White honey coffees may be almost indistinguishable from traditional washed coffees, while black honey coffees can echo aspects of traditional naturals – usually tasting like raisins and grapes. Yellow and red honeys often have a “pulpy” ripe cherry or plum character, without being as overtly fruity as their darker-colored counterparts.

Multi-Stage Fermentations

One innovative step certain producers choose to make might be to use extra steps in their fermentation process to impact flavor.

The most common multi-stage fermentation is probably the **post-fermentation soak**, commonly employed in most specialty grade washed East African coffees (sometimes referred to as “**double washed**”). After the coffee parchment is fermented and washed, it will be kept overnight, or for a day or two, submerged in clean water. Scientists have confirmed that there is still microbial activity during this stage, and so the coffee is undergoing a slowed-down secondary fermentation step. Coffees like this might be extra clean tasting or have especially complex acidities, for example.

We’ve also seen multi-stage fermentations take place before the washing step, where (for example) a coffee might ferment or macerate briefly in whole cherry before depulping and fermenting in parchment, or producers might follow a dry fermentation with a submerged stage. Sometimes these coffees are called “**double fermented**.” We often think of these types of coffees as having increased complexity to their sweetness and being slightly fruitier than traditional washed coffees.

“**Fermented** (or **macerated**) **naturals**” employ some similar techniques. Coffee cherries may ripen in a sealed bag or on a raised bed under tarps prior to drying. Sometimes these are called “**winey**” process coffees because of the tendency for the flavors to resemble the bigger, boozier characteristics of a California cabernet.



Coffee producer, Edwin Noreña, and his fermentation tanks in Colombia



Fermentation barrels



Edwin Noreña's fermentation lab



Anaerobics & Carbonics

The popularity of oxygen-deprived fermentation environments in recent years has been hard to ignore. These coffees, typically characterized by over-the-top fruitiness and artificial sweetness like bubble gum, fruit candy, or sweet dessert wines, can be created in a variety of ways but the single unifying factor is that producers use a controlled environment to seal off the coffee. Often using stainless steel fermentation tanks, these fermentation chambers usually require a one-way valve for off-gassing.

Carbonic Maceration is a phrase lifted directly from the wine industry, and when used in the context of coffee it typically indicates whole-cherry fermentation in a sealed tank, usually dried with some or all the fruit remaining on the seed afterwards.

Anaerobic fermentation is more broadly applied to any sealed tank used during fermentation and offers no clarity as to whether the coffee might resemble standard processing or be something truly unique in processing steps. In many cases the coffees are depulped prior to anaerobic fermentation... but not always!

Increasingly, we've observed anaerobic techniques applied to otherwise "traditional" washed coffees, simply replacing the ad hoc fermentation with a more controlled environment. In some cases, the coffee may not even taste much different, and might not even be called "anaerobic" despite the extra processing details.

Because of the control no-oxygen environments offer over microbe populations, it's common to see fermentation duration extended well beyond the usual timeframe that might be common in most traditional practices. While open and uncontrolled environments might be at risk for "over-ferment" defects and bad microbial actors, the sealed tank helps to mitigate that risk.

Co-fermented Coffees

Sometimes called "infused" coffees, experiments in fermentation have begun to incorporate additional ingredients (besides the usual coffee, water, and microbes). Frequently co-fermented with fruits, spices, or other food ingredients, these coffees showcase an entirely new and flavorful addition to the fermentation continuum.



Co-fermentation may be controversial in some circles, but there's no denying that the flavors it can produce are something startling and new. Enzymatic transfer of flavors occur when microbes are actively macerating more than one substance together, so it is possible to have strawberry, cinnamon, or even chili-pepper flavors in the resulting coffees without using traditional post-roasting “artificial flavoring” methods.

Inoculated Coffees

Inoculation, in the food and beverage industries, is a term that indicates the intentional use of specific bacteria or fungi to control a fermentation's microbial population. In common practice, we often use the phrase “starter culture” to denote the same practice.

In traditional, at-scale winemaking, most fermentations are inoculated with specific yeasts that have been developed to highlight the flavors of particular grape varieties we easily recognize, such as Sauvignon Blanc or Pinot Grigio. In coffee, this is a fairly rare practice, though there are indeed yeast suppliers who are actively developing coffee-specific strains.

Some producers use existing champagne or other wine yeasts, our friends at Catracha project used a kombucha SCOBY for inoculation in recent years, and it's not unheard of to see coffee designated as “Lacto-fermented.”

Inoculation has the advantage of providing a stable and predictable microbe population, which reduces risk for safety concerns like molds or product quality concerns like the ferment defect. Claims of increased cup score, however, remain verifiable only on a case-by-case basis and inoculation should not necessarily be taken as a guarantee of better tasting coffee than traditional native-microbe fermentation.



Honey process coffee drying on raised beds at Finca Campo Hermoso in Quindío, Colombia

Photo by Edwin Noreña



What Does the Future Hold?

What's the next step for coffee fermentation?

On the one hand, commercial scale operations in some areas of the world may be at increased risk for drought or unpredictable water supplies due to climate change. Coffees produced in these regions will likely begin to trend towards processing and fermentation types more conducive to water conservation, such as honey processing, dry fermenting for washed coffees, or ecopulping. Changes to processing style will affect fermentation, and therefore flavor.

On the other hand, we've entered a uniquely creative period in coffee's processing history in which innovative and creative producers are employing new technologies and techniques to coffee fermentation, with flavor as the driving factor rather than an afterthought. It's unlikely that we've seen the last of these types of inventiveness, though it may prove hard to predict what comes next.

Will sauerkraut, kimchi, and pickle brine coffees be the next wave? Will sourdough process, miso style, and parmesan coffee make it to barista competitions and Cup of Excellence auctions? Or will the pendulum reverse its course, refining the current "experimental" techniques into a new set of best practices, where the best washed and natural coffees alike employ anaerobic or inoculation techniques?

And, as we often forget to ask ourselves, how will our customers respond to these changes?

The answers to these questions are only beginning to be written.





Royal Coffee

Royal Coffee is a family-owned and operated importer of specialty green coffees, serving the international roasting community. Founded in 1978 by Bob Fulmer and Pete McLaughlin in a tiny office on Hollis St., the company began with the purchase of a single bag of coffee that Bob and Pete used as a desk until they found a buyer for it. They turned the proceeds of the first sale into two more bags, and the rest is history.

We now import the finest coffees in the world, from over 30 countries of origin and a vast network of producing partners. Royal supplies some of the top roasting houses around the globe, from warehouses in Oakland, Seattle, Madison, Houston, Shanghai, and Vancouver. Our humble roots continue to inform our day to day operations though, as many of our clients get their start with us buying a single bag of coffee.

Regardless of how you buy from Royal, we hope that you will stop by The Crown: Royal Coffee Lab & Tasting Room to experience our favorite coffees, thoughtfully prepared. Join us for a class, event, tasting or cupping in the heart of Oakland. We offer cutting-edge original workshops, CQI courses & guest curricula by the industry's thought-leaders.

Chris Kornman

Chris Kornman is a seasoned coffee quality specialist, writer and researcher, and the director of education at The Crown: Royal Coffee Lab and Tasting Room in Oakland, California.

He has extensive experience with coffee grading, roasting, sourcing, traveling and tinkering. He is the author of *Green Coffee: A Guide for Roasters & Buyers*.

