Artisan Coffee Group dba

Combustion Systems Sales & Service

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Day I. Introduction to Sample Roasting 8:00 – 12:00

A. Definitions

i. Green Coffee Facts

From Wikipedia, the free encyclopedia

Throughout history, coffee has taken on several physical transformations, initially serving as an energy source when nomadic tribes combined coffee berries with animal fat as an early form of an energy bar. Later it was consumed as a tea, then a wine and finally to the beverage we've come to identify today.

Since the beginning, coffee has always been a product of great mystery, having been discovered accidentally in wild forests of Abyssinia (Ethiopia) and consumed in its native cherry form, then later, passed through fire to significantly alter its chemical state. And although coffee has been in existence for thousands of years, it's only been in the past half-century or so, that scientists have been able to truly identify and understand what exactly is contained in this mystical bean. To date, scientists have identified over 1,000 compounds in coffee. Compared to products such as wine or chocolate that are composed of a few hundred, they pale in comparison to that of coffee. Luckily through advancements in technology, much of coffee's chemical make-up has been unlocked and we now have a better perspective on the chemistry contained within this mystical bean.

Coffee

Coffee is a brewed beverage prepared from roasted seeds, commonly called coffee beans, of the coffee plant. They are seeds of "coffee cherries" that grow on trees in over 70 countries. It has been said that green coffee is the second most traded commodity in the world behind crude oil.[1] Due to its caffeine content, coffee can have a stimulating effect in humans. Today, coffee is one of the most popular beverages worldwide.[2]

It is thought that the energizing effect of the coffee bean plant was first recognized in the south west of Ethiopia, and the cultivation of coffee expanded in the Arab world.[3] The earliest credible evidence of coffee drinking appears in the middle of the fifteenth century, in the Sufi monasteries of the Yemen in southern Arabia.[3] From the Muslim world, coffee spread to Italy, then to the rest of Europe, to Indonesia, and to the Americas.[4]

Coffee berries, which contain the coffee bean, are produced by several species of small evergreen bush of the genus *Coffea*. The two most commonly grown species are *Coffea canephora* (also known as *Coffea robusta*) and *Coffea arabica*; less popular species are *liberica, excelsa, stenophylla, mauritiana, racemosa*. These are cultivated primarily in Latin America, Southeast Asia, and Africa. Once ripe, coffee berries are picked, processed, and dried. The seeds are then roasted, undergoing several physical and chemical changes.

They are roasted to varying degrees, depending on the desired flavour. They are then ground and brewed to create coffee. Coffee can be prepared and presented in a variety of ways.

Coffee has played an important role in many societies throughout history. In Africa and Yemen, it was used in religious ceremonies. As a result, the Ethiopian Church banned its secular consumption until the reign of Emperor Menelik II of Ethiopia.[5] It was banned in Ottoman Turkey in the 17th century for political reasons,[6] and was associated with rebellious political activities in Europe.

Coffee is an important export commodity. In 2004, coffee was the top agricultural export for 12 countries,[7] and in 2005, it was the world's seventh-largest legal agricultural export by value.[8]

Some controversy is associated with coffee cultivation and its impact on the environment. Many studies have examined the relationship between coffee consumption and certain medical conditions; whether the overall effects of coffee are positive or negative is still disputed.[9]

Etymology

The term *coffee* was introduced to Europe by the Ottoman Turkish *kahve*, which is, in turn, derived from Arabic: قهوة, *qahwah*. In the languages of Ethiopia, terms such as *bunna* (in Amharic and Afan Oromo) and *būn* (in Tigrinya) are used. The source of the Arabic term is not certain; some have attributed it to the name of the Kaffa region in western Ethiopia, where coffee was first found; but Arab lexicographers described it as originally a kind of wine, derived from *qahiya* "to have no appetite". The English word *coffee* first came to be used in the early to mid-1600s, but early forms of the word (cited by English authors from various source languages) date to the 1590s.

History of Coffee

It is supposed that the Ethiopians, the ancestors of today's Oromo people, were the first to have discovered and recognized the energizing effect of the coffee bean plant. However, no direct evidence has ever been found revealing exactly where in Africa coffee grew or who among the natives might have used it as a stimulant or even known about it there earlier than the seventeenth century. The story of Kaldi, the 9th-century Ethiopian goatherd who discovered coffee, did not appear in writing until 1671 and is probably apocryphal. The earliest credible evidence of either coffee drinking or knowledge of the coffee tree appears in the middle of the fifteenth century, in the Sufi monasteries of the Yemen in southern Arabia. From Ethiopia, coffee spread to Egypt and Yemen. It was in Arabia that coffee beans were first roasted and brewed, similar to how it is done today. By the 15th century, it had reached the rest of the Middle East, Persia, Turkey, and northern Africa. From the Muslim world, coffee spread to Italy, then to the rest of Europe, to Indonesia, and to the Americas.

In 1583, Leonhard Rauwolf, a German physician, gave this description of coffee after returning from a ten-year trip to the Near East:

“A beverage as black as ink, useful against numerous illnesses, particularly those of the stomach. Its consumers take it in the morning, quite frankly, in a porcelain cup that is passed around and from which each one drinks a cupful. It is composed of water and the fruit from a bush called bunnu.”

From the Muslim world, coffee spread to Italy. The thriving trade between Venice and North Africa, Egypt, and the Middle East brought many goods, including coffee, to the Venetian port. From Venice, it was introduced to the rest of Europe. Coffee became more widely accepted after it was deemed a Christian beverage by Pope Clement VIII in 1600, despite appeals to ban the "Muslim drink." The first European coffee house opened in Italy in 1645. The Dutch were the first to import coffee on a large scale, and they were among the first to defy the Arab prohibition on the exportation of plants or unroasted seeds when Pieter van den Broeck smuggled seedlings from Aden into Europe in 1616. The Dutch later grew the crop in Java and Ceylon. The first exports of Indonesian coffee from Java to the Netherlands occurred in 1711. Through the efforts of the British East India Company, coffee became popular in England as well. Oxford's Queen's Lane Coffee House, established in 1654, is still in existence today. Coffee was introduced in France in 1657, and in Austria and Poland after the 1683 Battle of Vienna, when coffee was captured from supplies of the defeated Turks.

When coffee reached North America during the Colonial period, it was initially not as successful as it had been in Europe. During the Revolutionary War, however, the demand for coffee increased so much that dealers had to hoard their scarce supplies and raise prices dramatically; this was also due to the reduced availability of tea from British merchants. After the War of 1812, during which Britain temporarily cut off access to tea imports, the Americans' taste for coffee grew, and high demand during the American Civil War together with advances in brewing technology secured the position of coffee as an everyday commodity in the United States.

Coffee has become a vital cash crop for many Third World countries. Over one hundred million people in developing countries have become dependent on coffee as their primary source of income. Coffee has become the primary export and backbone for African countries like Uganda, Burundi, Rwanda, and Ethiopia as well as many Central American countries.

Biology

Coffea

The *Coffea* plant is native to subtropical Africa and southern Asia. It belongs to a genus of ten species of flowering plants of the family *Rubiaceae*. It is an evergreen shrub or small tree that may grow 5 meters tall when unpruned. The leaves are dark green and glossy, usually 100–150 millimeters long and 60 millimeters wide. It produces clusters of fragrant white flowers that bloom simultaneously. The fruit berry is oval, about 15 millimeters long, and green when immature, but ripens to yellow, then crimson, becoming black on drying. Each berry usually contains two seeds, but 5–10% of the berries have only one; these are called peaberries. Berries ripen in seven to nine months.

Cultivation

Coffee varieties

Coffee is usually propagated by seeds. The traditional method of planting coffee is to put 20 seeds in each hole at the beginning of the rainy season; half are eliminated naturally. Coffee is often intercropped with food crops, such as corn, beans, or rice, during the first few years of cultivation.

The two main cultivated species of the coffee plant are *Coffea canephora* and *Coffea arabica*. Arabica coffee (from *C. arabica*) is considered more suitable for drinking than robusta coffee (from *C. canephora*); robusta tends to be bitter and have less flavor but better body than arabica. For these reasons, about three-quarters of coffee cultivated worldwide is *C. arabica*. However, *C. canephora* is less susceptible to disease than *C. arabica* and can be cultivated in environments where *C. arabica* will not thrive. Robusta coffee also contains about 40–50% more caffeine than arabica. For this reason, it is used as an inexpensive substitute for arabica in many commercial coffee blends. Good quality robustas are used in some espresso blends to provide a better foam head, a full-bodied result, and to lower the ingredient cost. Other cultivated species include *Coffea liberica* and *Coffea esliaca*, believed to be indigenous to Liberia and southern Sudan, respectively.

Most arabica coffee beans originate from either Latin America, eastern Africa, Arabia, or Asia. Robusta coffee beans are grown in western and central Africa, throughout southeast Asia, and to some extent in Brazil. Beans from different countries or regions usually have distinctive characteristics such as flavor, aroma, body, and acidity. These taste characteristics are dependent not only on the coffee's growing region, but also on genetic subspecies (varietals) and processing. Varietals are generally known by the region in which they are grown, such as Colombian, Java or Kona.

Production

Brazil is the world leader in production of green coffee, followed by Vietnam and Colombia the last of which produces a much softer coffee.

Top twenty green coffee producers — Tonnes (2007) and Bags thousands (2007)		
Country	Tonnes[ref 1]	Bags thousands[ref 2]
Brazil	2,249,010	36,070
Vietnam	961,200	16,467
Colombia	697,377	12,515
Indonesia	676,475	7,751
Ethiopia[note 1]	325,800	4,906
India	288,000	4,148
Mexico	268,565	4,150
Guatemala[note 1]	252,000	4,100
Peru	225,992	2,953
Honduras	217,951	3,842
Côte d'Ivoire	170,849	2,150
Uganda	168,000	3,250
Costa Rica	124,055	1,791
Philippines	97,877	431
El Salvador	95,456	1,626
Nicaragua	90,909	1,700
Papua New Guinea[note 1]	75,400	968
Venezuela	70,311	897
Madagascar[note 2]	62,000	604
Thailand	55,660	653
World[note 3]	7,742,675	117,319

Notes

1. ^ a b c Unofficial/semiofficial/mirror data
2. ^ FAO estimate
3. ^ aggregate (may include

References

1. ^ Food and Agricultural Organization of United Nations: Economic and Social Department: The Statistical Devision
2. ^ International Coffee Organization

Ecological effects

Coffee and the environment

Originally, coffee farming was done in the shade of trees, which provided a habitat for many animals and insects. This method is commonly referred to as the traditional shaded method or "shade-grown". Many farmers have decided to switch their production method to sun cultivation, a method in which coffee is grown in rows under full sun with little or no forest canopy. This causes berries to ripen more rapidly and bushes to produce higher yields, but requires the clearing of trees and increased use of fertilizer and pesticides, which damage the environment and cause health problems. When compared to the sun cultivation method, traditional coffee production causes berries to ripen more slowly and produce lower yields, but the quality of the coffee is allegedly superior.[*citation needed*] In addition, the traditional shaded method is environmentally friendly and provides living space for many wildlife species. Opponents of sun cultivation say environmental problems such as deforestation, pesticide pollution, habitat destruction, and soil and water degradation are the side effects of these practices. The American Birding Association, Smithsonian Migratory Bird Center, Rainforest Alliance, and the Arbor Day Foundation have led a campaign for "shade-grown" and organic coffees, which it says are sustainably harvested. However, while certain types of shaded coffee cultivation systems show greater biodiversity than full-sun systems, they still compare poorly to native forest in terms of habitat value.

Another issue concerning coffee is its use of water. According to New Scientist, if using industrial farming practices, it takes about 140 litres of water to grow the coffee beans needed to produce one cup of coffee, and the coffee is often grown in countries where there is a water shortage, such as Ethiopia. By using sustainable agriculture methods, the amount of water usage can be dramatically reduced, while retaining comparable yields.

Economics of coffee

Coffee ingestion on average is about a third of that of tap water in North America and Europe. Worldwide, 6.7 million metric tons of coffee were produced annually in 1998–2000, and the forecast is a rise to 7 million metric tons annually by 2010.

Brazil remains the largest coffee exporting nation, but in recent years, Vietnam has become a major producer of robusta beans. Indonesia is the third-largest exporter and the largest producer of washed arabica coffee. Robusta coffees, traded in London at much lower prices than New York's arabica, are preferred by large industrial clients, such as multinational roasters and instant coffee producers because of the lower cost.

Coffee as a commodity

While coffee is not technically a commodity (it is fresh produce; its value is directly affected by the length of time it is held), coffee is bought and sold by roasters, investors and price speculators as a tradable commodity. Coffee futures contracts for Grade 3 washed arabicas are traded on the New York Mercantile Exchange (NYMEX) under ticker symbol KT, with contract deliveries occurring every year in March, May, July, September, and December. Higher and lower grade arabica coffees are sold through other channels. Futures contracts for robusta coffee are traded on the London Liffe exchange and, since

2007, on the New York ICE exchange. As of 2006 green coffee is the second most traded commodity in the world.

Dry Roasting

Dry Roasting is a process by which heat is applied to dry foodstuffs without the use of oil or water as a carrier. Unlike other dry heat methods, dry roasting is used with foods such as nuts and seeds, which do not contain significant fat or moisture of their own. Dry roasted foods are stirred as they are roasted to insure even heating.

Dry roasting can be done in a frying pan or wok (a common way to prepare spices in some cuisines),[1] or in a specialized roaster (as is used for coffee beans or peanuts). Dry roasting changes the chemistry of proteins in the food, changing their flavor, and enhances the scent and taste of some spices.

Common dry roasted foods include peanut butter, which is made from peanuts that have been dry roasted, tea, which is made from tea leaves that are dry roasted, either immediately after picking or after fermentation,[3][4][5] and coffee and chocolate, which are made from roasted coffee beans[6] and roasted cocoa beans,[7] respectively

Caffeine

For many, coffee drinking is simply a delivery medium for a potent alkaloid we have come to identify as caffeine or technically as 1,3,7--trimethylxanthine. Although caffeine is strongly associated with coffee, its production within the plant kingdom is not exclusive, but is seen throughout several other forms of plant life. Mate, for example, which is traditionally consumed in parts of Uruguay and Argentina, contains less than 1% by weight. Tea (Camellia sinesis) contains almost three times the concentration of caffeine than Arabica; Brazilian mate almost twice that of Robusta coffee. Turns out that Mother Nature was quite generous when it came to distributing caffeine amongst the plant kingdom.

But for humans, caffeine is unique. Thus far we are the only living form on Earth that readily seek caffeine for both its stimulatory and psychological effects. For all other life forms, caffeine is a potent toxin capable of sterilization, phytotoxicity and antifungal properties. As such, scientists believe that caffeine, with its intensely bitter taste, has evolved as a primitive defense mechanism in coffee ensuring its survival in the wild for thousands of years. It's no surprise then, that the caffeine content of the more "robust" Robusta species is almost double that of the more delicate Arabica. The belief is that as insects attack the coffee cherry; they are deterred by the bitter taste of caffeine and simply move on to the next crop. Since Arabica is typically grown at higher altitudes than Robusta, where the attack of insects is reduced, Arabica has evolved to produce less caffeine.

With caffeine playing such an important role in the plants' survival, one may also expect it to play an equal level of importance during coffee roasting. Turns out, the fate of this imperative compound is far from spectacular. Although caffeine has a boiling point (sublimation) of 178[degrees]C (352[degrees]F), model studies has shown that caffeine readily survives the roasting process even at temperatures far exceeding 204[degrees]C (400[degrees]F). Though the reasons for this remain unclear, it is believed that caffeine's strong complex with other compounds within the coffee matrix create a strong retention that prevent it from further sublimation.

One common misconception in coffee is the belief that darker roasted coffee contains a higher level of caffeine than lighter roasted coffee. This common belief is logical and stems from the fact that as coffee is roasted darker, it also increases in both astringency and bitterness. Since caffeine is also bitter, the correlation makes perfect sense, though careful inspection would show otherwise. Lets take a closer look: Lets say we have 100 grams of green Arabica coffee, we can estimate its caffeine content to be roughly 1.2% on a dry basis (1.2g caffeine / 100g coffee x 100). Now, let's assume that we roast this coffee to a light roast and lose 10% by weight in the process. At this point, we no longer have 100g but rather 90g of coffee. Since the caffeine content within each bean has remained the same, our total caffeine content is now 1.33% (1.2g caffeine / 90g coffee x 100). So in reality, although the caffeine content stays the same per bean, from a weight perspective we observe a slight increase. The case for which roast has more caffeine is more a matter of perspective, than science.

Trigonelline

Another less known alkaloid that shadows in the light of caffeine is that of trigonelline. In Arabica coffee, trigonelline concentrations make up roughly 1% by weight with a slightly less concentration (0.7%) found its Robusta counterpart. Although its concentration is slightly less than that of caffeine, it plays a significant role in the development of important flavor compounds during roasting. But unlike that of caffeine, which survives the roasting process, trigonelline readily decomposes as temperatures approach 160[degrees]C (320[degrees]F). Model studies have shown that at 160[degrees]C, 60% of the initial trigonelline is decomposed, leading for the formation of carbon dioxide, water and the development of a large class of aromatic compounds called pyridines. These heterocyclic compounds play an important role in flavor and are responsible for producing the sweet/caramel/earthy-like aromas commonly found in coffee.

Another important byproduct produced during the decomposition of trigonelline is nicotinic acid, or vitamin B3--more commonly known as niacin. Depending on roasting conditions, niacin can increase up to 10 times its initial concentration, providing anywhere between 1mg of niacin per cup for Americano type coffees and roughly two to three times this concentration in espresso type beverages. When one considers that most people in the U.S. consume on average 3.2 cups of coffee per day, according to the National Coffee Association of the U.S. (2008), this makes coffee an ample source of dietary niacin.

So far this is great news for people suffering from an unbalanced diet, but there is another therapeutic benefit to coffee that is even more surprising. Recently, Italian scientists discovered that drinking coffee may lower the incidence of dental caries. According to researchers, trigonelline prevents the adhesion of mucus-like byproducts onto teeth enamel (created during fermentation) that eventually leads to teeth damage. In the end, it looks like drinking a cup of coffee may not only keeps the doctor away, but also the dentist.

Lipids

Lipid production and its subsequent survival after the roasting process play an important role to overall coffee quality. In general, most of the lipids exist in the form of a coffee oil and are located within the endosperm (bean) of the cherry, with only a small percentage deposited onto the outer portion of the coffee wax. Coincidentally, scientists have analyzed and discovered that much of the chemical make-up of coffee oil is very similar to that of vegetable cooking oils. As such, much of the lipid content in coffee remains unchanged and relatively stable even at the elevated temperatures associated with roasting.

In its green form both Arabica and Robusta coffee contain on average 15-17% and 10-11.5%, respectively. But because Arabica contains about 60% more lipids than Robusta, many believe this stark difference is one reason responsible for quality difference between both species. Thus far, the claim has remained unconfirmed, until French scientists recently discovered a direct correlation between lipid content and overall cup quality. It turns out that as lipid content increases within the bean, so does overall cup quality. It's a very plausible explanation when one considers that the majority of important flavor compounds in coffee are also fat-soluble.

Carbohydrates

Carbohydrates make up roughly 50% of coffee's total dry weight by composition. After roasting, remaining carbohydrates in the cup contribute to mouth feel or body, with some studies suggesting they are also responsible for the quality of the foam common in espresso beverages.

Although there are numerous types of carbohydrates in coffee, perhaps the most important is that of sucrose. Sucrose, or more commonly known as table sugar, makes up 6-9% in Arabica with a slightly less (3-7%) amount contained in Robusta coffee. During roasting, sucrose is readily decomposed and studies have shown that up to 97% of the initial sucrose content is lost even at light roasts. Its role during roasting is enormous with a large portion of the available carbohydrates participating in the Maillard (a chemical reaction between an amino acid and a reducing sugar) and numerous other secondary reactions. One class of important byproducts created during roasting are those of organic acids. In its native green form, coffee contains negligible amounts of formic, acetic and lactic acid. Though once roasted, there is an exponential increase in aliphatic acid production, along with a paralleled increase in coffee acidity. Since acidity plays an important role in assessing quality, it's no surprise why we typically see higher levels of perceived acidity in Arabica coffee than Robusta, due in part, to its higher sucrose concentration.

Coincidentally, in the past year, Brazilian scientists have identified a single gene, sucrose synthase, which controls sucrose production in plants and may hold the key for cultivating higher quality coffee for years to come.

Proteins

Protein content for both green Arabica and Robusta coffee vary between 10-13% and exists as free or bound proteins within the coffee matrix. Although actual concentrations can vary, there are a number of factors that can affect free protein content, including improper storage, which may increase free proteins levels and lead to detrimental effects on quality.

During roasting, proteins combine with carbohydrates in what is perhaps the most important reaction for all thermally processed foods--the Maillard Reaction. This set of reactions, discovered by a French chemist in 1910, is what is largely responsible for transforming the mere handful of compounds found in green coffee to the complex matrix that coffee is today.

As temperatures reach 150[degrees]C (302[degrees]F), the Maillard reaction propels free proteins in coffee to combine with reducing sugars, ultimately leading to the formation of hundreds of important aromatic compounds. Of these, pyrazines and pyridines have the greatest aromatic contribution and are responsible for the distinct maize/nutty aromas found in coffee. The reaction also leads to the formation of brown-colored polymetric melanoidins--the compounds responsible for coffee's color. Coincidentally, this is the same set of reactions that give rise to the alluring aromas we generate when toasting a loaf of bread or grilling a piece of steak. Although many of the byproducts created during the Maillard reaction are beneficial to coffee, in other agricultural products, this set of browning reactions can be a serious detriment to quality.

In the cup, proteins also play a role in taste by forming secondary compounds during the roasting process. It turns out that the majority of coffee's "bitterness" is not due solely to caffeine, but rather bitter compounds produced during the Maillard reaction. Caffeine, as intensely bitter as it is, accounts for only 10-20% of coffee's total bitterness.

ii. Environment

- refers to the surroundings of an object.

iii. Momentum

In classical mechanics, momentum (pl. momenta; SI unit kg·m/s, or, equivalently, N·s) is the product of the mass and velocity of an object (p = *m*v). For more accurate measures of momentum, see the section "modern definitions of momentum" on this page. It is sometimes referred to as linear momentum to distinguish it from the related subject of angular momentum. Linear momentum is a vector quantity, since it has a direction as well as a magnitude. Angular momentum is a pseudovector quantity because it gains an additional sign flip under an improper rotation. The total momentum of any group of objects remains the same unless outside forces act on the objects (law of conservation of momentum).

Momentum is a conserved quantity, meaning that the total momentum of any closed system (one not affected by external forces) cannot change. This law is also true in special relativity.

iv. Heat Transfer

Heat transfer is the transition of thermal energy from a hotter object to a cooler object ("object" in this sense designating a complex collection of particles which is capable of storing energy in many different ways). When an object or fluid is at a different temperature than its surroundings or another object, *transfer of thermal energy*, also known as heat transfer, or *heat exchange*, occurs in such a way that the body and the surroundings reach thermal equilibrium. Heat transfer always occurs from a higher-temperature object to a cooler temperature one as described by the second law of thermodynamics or the Clausius statement. Where there is a temperature difference between objects in proximity, heat transfer between them can never be stopped; it can only be slowed.

v. Maillard Reaction

The Maillard reaction (also known as dextrinisation) is a chemical reaction between an amino acid and a reducing sugar, usually requiring heat. It is vitally important in the preparation or presentation of many types of food, and, like caramelization, it is a form of non-enzymatic browning. The reaction is named after the chemist Louis-Camille Maillard who discovered it in the 1910s while attempting to reproduce biological protein synthesis, although it has been used in practical cooking since prehistoric times.

The reactive carbonyl group of the sugar reacts with the nucleophilic amino group of the amino acid, and forms a variety of interesting but poorly characterized molecules responsible for a range of odors and flavors. This process is accelerated in an alkaline environment as the amino groups are deprotonated and hence have an increased nucleophilicity. The type of the amino acid determines the resulting flavor. This reaction is the basis of the flavoring industry.

In the process, hundreds of different flavor compounds are created. These compounds in turn break down to form yet more new flavor compounds, and so on. Each type of food has a very distinctive set of flavor compounds that are formed during the Maillard reaction. It is these same compounds that flavor scientists have used over the years to create artificial flavors.

vi. Sample Roasting/Level

Sample Preparation – Roasting

The sample should be roasted within 24 hours of cupping and allowed to rest for at least 8 hours.
Roast profile should be a light to light-medium roast, measured via the M- Basic (Gourmet) Agtron scale of approximately 58 on whole bean and 63 on ground, +/- 1 point (55-60 on the standard scale or Agtron/SCAA Roast tile #55).
The roast should be completed in no less than 8 minutes and no more than 12 minutes.
Scorching or tipping should not be apparent.
Sample should be immediately air-cooled (no water quenching).
When they reach room temperature (app. 75º F or 20º C), completed samples should then be stored in airtight containers or non-permeable bags until cupping to minimize exposure to air and prevent contamination.
Samples should be stored in a cool dark place, but not refrigerated or frozen.
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vii. Production

Caramelization is the oxidation of sugar, a process used extensively in cooking for the resulting nutty flavor and brown color. As the process occurs, volatile chemicals are released, producing the characteristic caramel flavor. Like the Maillard reaction, caramelization is a type of non-enzymatic browning. However, unlike the Maillard reaction, caramelization is pyrolysis, as opposed to reaction with amino acids. When caramelization involves the disaccharide sucrose, it is broken down into the monosaccharides fructose and glucose.

‘Roasting unlocks and frames a coffee's flavor potential; it is a science and an art that requires loads of experience, concentration and split second timing. Roasting is also the means by which the roaster imprints his/her signature. How bright or muted will the coffee be? How much depth or 'chiaroscuro' should the roaster impart to the coffee’s intrinsic flavor? Should there be a touch of bitterness at the end?

Stage One - During the first stage the green beans are dried by gently vaporizing away stored free water molecules - while using the water’s conductivity to pass heat throughout the bean and begin effective roasting in the second stage, a very fine line! The beans turn from bluish-green to yellow-orange in this first stage and it is easy to singe their surfaces, imparting a bitter aftertaste to the coffee brew, or to bake the coffee, resulting in a flat, lifeless cup.

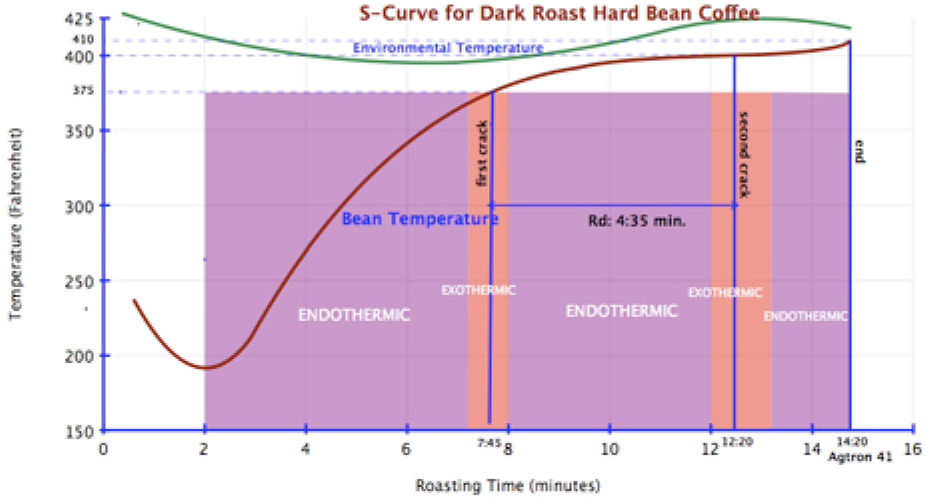
Stage Two - The second stage of actual roasting begins about half way through the roast. As the beans turn from yellow to light brown, going past 320 F, they begin cooking from within; escaping steam and carbon dioxide begin building pressure on the beans’ cell walls. When the beans’ temperature passes 380F, their surfaces, increasingly brittle, begin to expand and crack open along their center lines, emitting popping sounds. Roasters call this moment 'the first pop'. The roast is now nearing the first of several stations where it can be stopped; it is up to the roaster to decide which one, as the beans go from darkening tones of caramelized browns and beyond - to carbonized glistening black.

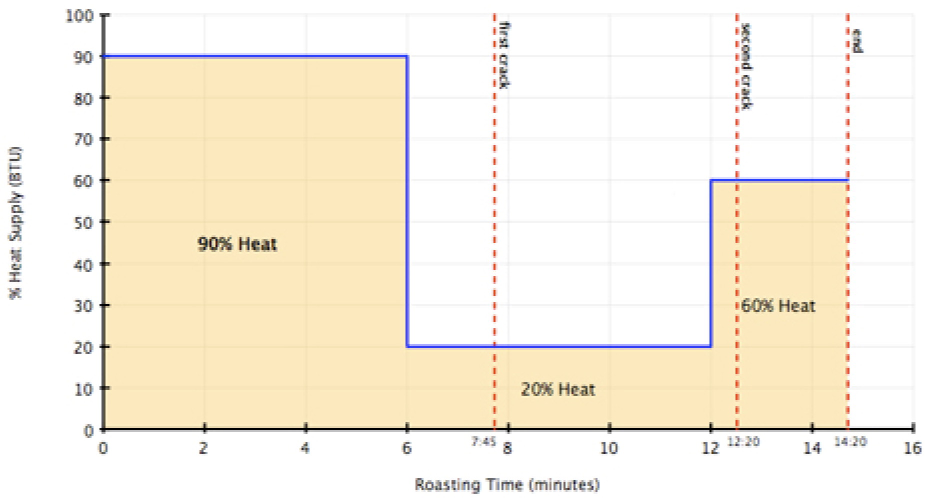
Stage Three - The third stage is terminating the roast. With bean temperature at 420 F or higher, it is now critical to stop the beans from cooking as quickly as possible. The traditional way is to release them into a perforated tray that is stirred while drawing the cool surrounding air through the beans with a fan below.'

'The choice for a roast color of your coffee beans is a choice for taste. For example, in coffees with a high degree of acidity, a darker roast will usually 'cover' the brighter, acidic notes and -in some cases- transform them into pleasant sweet flavour elements. However, a darker roast will also produce a number of 'roasting irritants' which can result in a bitter tasting cup of coffee. Some exotic coffee beans like Geisha, Pacamara and Maragogype deserve a very special profile. Due to the larger size of these beans and their lower density, we must be very careful and prevent at all times the overheating of the beans.

<u>The S-curve</u>

The S-curve can be very useful for roasting harder bean coffees. After loading the beans into the drum, the bean probe will display a drop in temperature, which will bottom out at the turning point. Hard beans will now be roasted with high initial heat. Until the start of the first crack, the heat inside the beans is endothermic; the beans are absorbing the supplied heat. Right before the start of the first crack, the heat inside the beans becomes exothermic and the beans start generating heat. At this point the operator has to reduce energy supply in order to gain control of the roast process. After about two minutes of controlling the roast with low energy supply (less BTU), the operator can again increase heat (endothermic heat; the beans are again absorbing heat) to prepare for the finish of the roast. The start of energy increase
can be seen at the point where the temperature curve is rising again.





In addition, it is essential to roast these exotic beans light enough to ensure that the true flavor of Mother Nature is preserved. In my opinion, it is madness to roast a precious coffee type like Geisha into the second crack.

Learning how to roast each green bean to perfection is the first step in creating that perfect cup of coffee. In all cases, a stringent cupping protocol should determine the optimal roasting profile of your coffee.

Once we have selected the roasting machine with the necessary gauges, the opportunity now arises to perform a variety of roasting profiles.'

viii. Evaluation

'The Statistics & Standards Committee of the Specialty Coffee Association of America recommends these standards for cupping coffee. These guidelines will ensure the ability to most accurately assess the quality of the coffee.

Necessary Equipment

Roasting Preparation Environment Cupping Preparation
Sample Roaster Well Lit Balance (Scale)
Agtron or other color
reading device
Clean, no interfering aromas Cupping glasses with lids
Grinder Cupping tables Cupping spoons
Quiet Hot water equipment
Comfortable temperature Forms and other paperwork
Limited distractions (no
phones, etc.)
Pencils and clipboards

Cupping Glasses | The type of glass recommended by the SCAA is a 5 or 6 ounce* Manhattan or "rocks" glass. Porcelain bouillon bowls of 175-225 ml are also permitted. The cups should be clean with no apparent fragrance and at room temperature. Lids can be of any material. Porcelain "bullion bowls" of 175-225 ml are also permitted. **All cups used should be of the same volume, dimensions, and material of manufacture.*

Determining Measurements

The optimum ratio is 8.25 grams of coffee per 150 ml of water, as this conforms to the mid-point of the optimum balance recipes for the Golden Cup.
Determine the volume of water in the selected cupping glass and adjust weight of coffee to this ratio within +/- .25 grams.

Cupping Preparation

Sample should be ground immediately prior to cupping, no more than 15 minutes before infusion with water. If this is not possible, samples should be covered and infused not more than 30 minutes after grinding.
Samples should be weighed out as WHOLE BEANS to the predetermined ratio (see above for ratio) for the appropriate cup fluid volume.
Grind particle size should be slightly coarser than typically used for paper filter drip brewing, with 70% to 75% of the particles passing through a U.S. Standard size 20 mesh sieve. At least 5 cups from each sample should be prepared to evaluate sample uniformity.
Each cup of sample should be ground by running a cleansing quantity of the sample through the grinder, and then grinding each cup's batch individually into the cupping glasses, ensuring that the whole and consistent quantity of sample gets deposited into each cup. A lid should be placed on each cup immediately after grinding.

Pouring

Water used for cupping should be clean and odor free, but not distilled or softened.
Ideal Total Dissolve Solids are 125-175 ppm, but should not be less than 100 ppm or more than 250 ppm.
The water should be freshly drawn and brought to approximately 200º F (93ºC) at the time it is poured onto the ground coffee. *Temperature needs to be adjusted to elevation
The hot water should be poured directly onto the measured grounds to the rim of the cup, making sure to wet all of the grounds. The grounds to steep undisturbed for a period of 3-5 minutes before evaluation.

Sample Evaluation

Sensory testing is done for three reasons:
- To determine the actual sensory differences between samples
- To describe the flavor of samples
- To determine preference of products

No one test can effectively address all of these, but they have common aspects. It is important for the evaluator to know the purpose of the test and how results will be used. The purpose of this cupping protocol is the determination of the cupper's perception of quality. The quality of specific flavor attributes is analyzed, and then drawing on the cupper's previous experience, samples are rated on a numeric scale. The scores between samples can then be compared. Coffees that receive higher scores should be noticeably better than coffees that receive lower scores.
The Cupping Form provides a means of recording important flavor attributes for coffee: *Fragrance/Aroma, Flavor, Aftertaste, Acidity, Body, Balance, Uniformity, Clean Cup, Sweetness, Defects,* and *Overall*.
The specific flavor attributes are positive scores of quality reflecting a judgment rating by the cupper; *Defects* are negative scores denoting unpleasant flavor sensations; the *Overall* score is based on the flavor experience of the individual cupper as a personal appraisal. These are rated on a 16-point scale representing levels of quality in quarter point increments between numeric values from 6 to 9. These levels are:

Quality Scale

6.00 - Good 7.00 - Very Good 8.00 - Excellent 9.00 – Outstanding

Theoretically the above scale ranges from a minimum value of 0 to a maximum value of 10 points. The lower end of the scale is below specialty grade.

Evaluation Procedure

Samples should first be visually inspected for roast color. This is marked on the sheet and may be used as a reference during the rating of specific flavor attributes. The sequence of rating each attribute is based on the flavor perception changes caused by decreasing temperature of the coffee as it cools:

Step #1 – Fragrance/Aroma

Within 15 minutes after samples have been ground, the dry fragrance of the samples should be evaluated by lifting the lid and sniffing the dry grounds.
After infusing with water, the crust is left unbroken for at least 3 minutes but not more than 5 minutes. Breaking of the crust is done by stirring 3 times, then allowing the foam to run down the back of the spoon while gently sniffing. The Fragrance/Aroma score is then marked on the basis of dry and wet evaluation.

Step #2 – Flavor, Aftertaste, Acidity, Body, and Balance

When the sample has cooled to 160º F (71º C), in about 8-10 minutes from infusion, evaluation of the liquor should begin. The liquor is aspirated into the mouth in such a way as to cover as much area as possible, especially the tongue and upper palate. Because the retro nasal vapors are at their maximum intensity at these elevated temperatures, Flavor and Aftertaste are rated at this point.
As the coffee continues to cool (160º F - 140º F), the Acidity, Body and Balance are rated next. Balance is the cupper's assessment of how well the Flavor, Aftertaste, Acidity, and Body fit together in a synergistic combination.
The cupper's preference for the different attributes is evaluated at several different temperatures (2 or 3 times) as the sample cools. To rate the sample on the 16-point scale, circle the appropriate tick-mark on the cupping form. If a change is made (if a sample gains or loses some of its perceived quality due to temperature changes), re-mark the horizontal scale and draw an arrow to indicate the direction of the final score.

Step #3 – Sweetness, Uniformity, and Cleanliness

As the brew approaches room temperature (below 100º F) Sweetness, Uniformity, and Clean Cup are evaluated. For these attributes, the cupper makes a judgment on each individual cup, awarding 2 points per cup per attribute (10 points maximum score).
Evaluation of the liquor should cease when the sample reaches 70º F (21º C) and the Overall score is determined by the cupper and given to the sample as "Cupper's Points"

based on ALL of the combined attributes.

Step #4 - Scoring

After evaluating the samples, all the scores are added as describe in the "Scoring" section below and the Final Score is written in the upper right hand box.

Individual Component Scores

The attribute score is recorded in the appropriate box on the cupping form. On some of the positive attributes, there are two tick-mark scales.
The *vertical* (up and down) scales are used to rank the *intensity* of the listed sensory component and are marked for the evaluator's record.
The *horizontal* (left to right) scales are used to rate the panelist's *perception of relative quality* of the particular component based upon their perception of the sample and experiential understanding of quality.
Each of these attributes is described more fully as follows:

Fragrance/Aroma | The aromatic aspects include Fragrance (defined as the smell of the ground coffee when still dry) and Aroma (the smell of the coffee when infused with hot water). One can evaluate this at three distinct steps in the cupping process: (1) sniffing the grounds placed into the cup before pouring water onto the coffee; (2) sniffing the aromas released while breaking the crust; and (3) sniffing the aromas released as the coffee steeps. Specific aromas can be noted under "qualities" and the intensity of the dry, break, and wet aroma aspects noted on the 5-point vertical scales. The score finally given should reflect the preference of all three aspects of a sample's Fragrance/Aroma.

Flavor | Flavor represents the coffee's principal character, the "mid-range" notes, in between the first impressions given by the coffee's first aroma and acidity to its final aftertaste. It is a combined impression of all the gustatory (taste bud) sensations and retro-nasal aromas that go from the mouth to nose. The score given for Flavor should account for the intensity, quality and complexity of its combined taste and aroma, experienced when the coffee is slurped into the mouth vigorously so as to involve the entire palate in the evaluation.

Aftertaste | Aftertaste is defined as the length of positive flavor (taste and aroma) qualities emanating from the back of the palate and remaining after the coffee is expectorated or swallowed. If the aftertaste were short or unpleasant, a lower score would be given.
Acidity | Acidity is often described as "brightness" when favorable or "sour" when unfavorable. At its best, acidity contributes to a coffee's liveliness, sweetness, and fresh- fruit character and is almost immediately experienced and evaluated when the coffee is first slurped into the mouth. Acidity that is overly intense or dominating may be unpleasant, however, and excessive acidity may not be appropriate to the flavor profile of the sample. The final score marked on the horizontal tick-mark scale should reflect the panelist's perceived quality for the Acidity relative to the expected flavor profile based on origin characteristics and/or other factors (degree of roast, intended use, etc.). Coffees expected to be high in Acidity, such as a Kenya coffee, or coffees expected to be low in Acidity, such as a Sumatra coffee, can receive equally high preference scores although their intensity rankings will be quite different.

Body | The quality of Body is based upon the tactile feeling of the liquid in the mouth, especially as perceived between the tongue and roof of the mouth. Most samples with heavy Body may also receive a high score in terms of quality due to the presence of brew colloids and sucrose. Some samples with lighter Body may also have a pleasant feeling in the mouth, however. Coffees expected to be high in Body, such as a Sumatra coffee, or coffees expected to be low in Body, such as a Mexican coffee, can receive equally high preference scores although their intensity rankings will be quite different.

Balance | How all the various aspects of Flavor, Aftertaste, Acidity and Body of the sample work together and complement or contrast to each other is Balance. If the sample is lacking in certain aroma or taste attributes or if some attributes are overpowering, the Balance score would be reduced.

Sweetness | Sweetness refers to a pleasing fullness of flavor as well as any obvious sweetness and its perception is the result of the presence of certain carbohydrates. The opposite of sweetness in this context is sour, astringency or “green” flavors. This quality may not be directly perceived as in sucrose-laden products such as soft drinks, but will affect other flavor attributes. 2 points are awarded for each cup displaying this attribute for a maximum score of 10 points.

Clean Cup | Clean Cup refers to a lack of interfering negative impressions from first ingestion to final aftertaste, a “transparency” of cup. In evaluating this attribute, notice the total flavor experience from the time of the initial ingestion to final swallowing or expectoration. Any non-coffee like tastes or aromas will disqualify an individual cup. 2 points are awarded for each cup displaying the attribute of Clean Cup.

Uniformity | Uniformity refers to consistency of flavor of the different cups of the sample tasted. If the cups taste different, the rating of this aspect would not be as high. 2 points are awarded for each cup displaying this attribute, with a maximum of 10 points if all 5 cups are the same.

Overall | The “overall” scoring aspect is meant to reflect the holistically integrated rating of the sample as perceived by the individual panelist. A sample with many highly pleasant aspects, but not quite “measuring up” would receive a lower rating. A coffee that met expectations as to its character and reflected particular origin flavor qualities would receive a high score. An exemplary example of preferred characteristics not fully reflected in the individual score of the individual attributes might receive an even higher score. This is the step where the panelists make their personal appraisal.

Defects | Defects are negative or poor flavors that detract from the quality of the coffee. These are classified in 2 ways. A taint is an off-flavor that is noticeable, but not overwhelming, usually found in the aromatic aspects. A “taint” is given a “2” in intensity. A fault is an off-flavor, usually found in the taste aspects, that is either overwhelming or renders the sample unpalatable and is given an intensity rating of “4”. The defect must first be classified (as a taint or a fault), then described (“sour,” “rubbery,” “ferment,” “phenolic” for example) and the description written down. The number of cups in which the defect was found is then noted, and the intensity of the defect is recorded as either a 2 or 4. The defect score is multiplied and subtracted from the total score according to directions on the cupping form.

Final Scoring

The Final Score is calculated by first summing the individual scores given for each of the primary attributes in the box marked “Total Score.” Defects are then subtracted from the “Total Score” to arrive at a “Final Score.” The following Scoring Key has proven to be a meaningful way to describe the range of coffee quality for the Final Score.

Total Score Quality Classification

90-100 Outstanding Specialty
85-89.99 Excellent Specialty
80-84.99 Very Good Premium
> 80.0 Below Specialty Quality Below Premium’
CUPPING_PROTOCOLS • VERSION: 20OCT2009A

B. Segmenting Sample Roasting into 6 phases

i. Heat Absorption

Once you charge a roaster at 400' with room temperature coffee, the drum/bean temperature will fall. The environmental temperature is what fall, while the bean's surface temperature is starting to increase. This fall will continue until the environmental and bean temperatures form a common temperature. The two temperature act as one reading, yet the "bean temperature" is still a majority environment with a close interaction with the surface of the beans. As the bean absorb the heat of the environment, the moisture in bean easily heats up causing the core of the bean to heat up while the surface is receiving direct contact with the heat sources. Once you start heating the core, then you are ready to uniformly increase the temperature.

ii. Turning Point

The turn point is the time and temperature at which your batch of coffee show the first increase in temperature. This shows us that the coffee is ready to increase in temperature.

iii. Building Momentum / Maillard Reaction

Now that the batch of coffee is increasing in temperature, you can gauge the rate of acceleration of the masses temperature by the application of gas. All three temperatures are increasing, air, bean and environment, causing radiant heat from bean to bean. As all of these sources heat increase, you have formed thermal energy that creates momentum. There comes a point where you will want to carefully change from "pushing" or "motivating" the batch of coffee towards acceleration and harness and guide the momentum through development.

iv. First Crack

As you are increasing in temperature, the cell structure of the bean is weakening. The cell walls are holding back moisture, forming a pressure on the wall, seeking a way out. If the temperature continues to rise, it'll find a way out. You will hear it. Known as first crack or pop, the moisture finds a way out intertwined with an aromatic release displaying a bouquet of nuanced scents. It will start with a subtle pop here and there, grow as more of the batch reaches the same point of development, it will reach a peak and slowly fade out. Some varietals and roasting styles might have an extended first crack. This is one of most critical times in the roasting process if not the whole industry chain. The Roaster has the difficult task of capturing the beauty and essence of not only the coffee bean, but it's varietal, terroir, labor, preparation and selection. If you force your way in, you run the risk of damaging the subtleties and nuance that individualizes the flavor profile possible to capture. If you are too timid, you might not fully develop the entire bouquet.

v. Final Development

The distance you put in between first crack and the end of the roast is your "focusing" time where you incorporate the captured nuance into the body and aftertaste. This is where you balance all that the coffee has to offer. Drop the batch too early, the sample will be unpalatable and underdeveloped. Roast it too dark and you alter the flavor.

C. The Environment Created

i. Warm up

In general, you want to allow your roaster to warm up for no less than 30 minutes. This time will allow your roaster to evenly and accurately be at the temperature that your gauge indicates. If your first roast acts "sluggish" or slow, try letting the roaster warm up for a longer period of time.

ii. Charging

Determining what temperature to charge the roaster with the batch of coffee depends on when you want your turn point to be, what size the batch is and how much gas is being used. If you want to turn around at 1:30, and it happens closer to two minutes, you could increase the air and environmental temperature, or increase the gas, or lower the batch size. With the use of high charging temperatures or gas pressures, you run the risk of affecting the flavor from the very beginning. If the drum is too hot you run the risk of scorching the surface of the bean. If the temperature is too low you might cause your coffee to "bake" or "drag" its way through the roast.

iii. When and How to Build Momentum

The coffee will tell you when it is ready for the next step. One way is to push your way to where you want to be right from the beginning. Starting with full gas, you will turn around and be on your way towards first. The trick here is being able to hold it back when you need to, by knowing when to apply less gas. The risk is forcing a turn around that doesn't allow the beans a chance to adjust to the environmental changes. The coffee is being catapulted towards first. You also have to know how to slow the roast down to reach first crack at the predetermined time for consistency. Another approach would have the "fall" happen in an environment that wasn't so aggressive. This allows the coffee to turn around and slowly increase in temperature by not having a lot of gas applied. Say you turn at 1:30, allowing 30 seconds to let the batch as a whole adjust to new acceleration from equilibrium before changing the applied gas pressure. At this point the coffee is ready to increase the acceleration. From here, you could add small increment of heat over the next few minutes allowing the batch to change to the new level of applied gas and adjust before moving to the next level of applied gas. Applying too little gas will extend the placement of first crack.

iv. Color Change

The color change I see is as follows:

Grey/green or Blue/green	- 0 - 1:30
Bright green	- 1 - 3
Yellow/green	- 3 - 5
Yellow	- 3:30 – 5:30
Orange/yellow	- 4 - 6
Orange	- 5:30 – 6:30
Light brown	- 6 – 7:30
Brown	- 7 - 8
(First Crack)	- 7 - 9
Brown	- 8 - 11
(Second Crack)	- 12
Dark brown	- 13
Black brown	- 14
Charcoal	- 15+

v. Delicacies of first crack

As you reach the point in the roast where the beans are in between the colors light brown and brown, you are in the midst of the maillard reaction causing the surface's color changes. The cell walls are weakening, yet still holding back trapped moisture seeking an outlet. This is the time to decide how you want to approach first crack. How much gas pressure do I need applied as the "clinched fist" of the coffee bean opens releasing the coffees aromatic bouquet amongst the release of trapped moisture? Too much heat or force as it opens could damage the subtleties, not enough might not release all that it offers, so finding the balance takes knowing how you got to that point and where that will lead. For some, the first audible sign of first crack is their indication of when to lower the gas, while others force their way right through first crack. Another approach would have you soften the approach towards first, not "pushing" so much as the beans open up to capture the nuance available. You can smell the coffee getting sweeter to know that you are approaching first crack. Small amounts of an intense aromatic release will sneak out before you hear any sound at all. These are signals of an upcoming first that you could anticipate and pre-softening the "push" without killing your momentum before the coffee is opening. As you reach the heart of first, one might reduce the amount of gas even more to allow the bouquet to "blossom".

vi. Finishing Development for Sample Level

Your first crack will slowly fade out while your momentum will continue to carry you through development. This is the part of the roast where the newly exposed interior of the bean has contact with the heat. Being too aggressive could cause the tender surface to tip or burn from within. Delicately encouraging the beans to a full representation of what the coffee can be is the goal. Appling too much heat might also jump quickly to more caramelization than desired. Getting too much caramelization can change the qualities of a coffee.

Anywhere from 2 to 4 minutes from first crack to the end of the roast is the amount of time needed to evenly finish a sample roast.

D. The Application of Heat discussion

   i. Forcing vs. Encouraging Development
   ii. Timing – Intuitive use of Senses

E. Theory and Purpose of Sample Level
   i. What is the Goal of Sample Roasting

The goal of sample roasting is to unlock and expose the qualities, good or bad, that the coffee has to offer without masking it's true flavor with the roasting process.

   ii. What are the Differences between Sample and Production Roasting

With sample roasting you mainly deal with coffee that is up for evaluation. This might be an arrival sample, spot offering or a quality control reevaluation. This is a roast to see what the coffee has to offer, nothing more. Production roasting takes a coffee you already own through a roast profile that maximizes what the coffee has to offer into a complete and desired flavor profile.

   iii. Lay Out Different Approaches to Sample Roasting
      a. full gas the whole roast
      b. full gas start back off at first
      c. lower gas start two step to first and down from first
      d. lower gas start three step to first and down from first
      e. lower gas start three step to first and roll on thru
      f. too low of gas slow roast

. Roasting Demonstration 2:00 – 6:00

A. Explanation of How to Operate the Sample Roaster Used
   i. Discussion of How to Apply Theory to Given Conditions
   ii. Explanation of Profilers and Purpose?????????
   iii. Discussion of Current Environmental Conditions of the Day
B. Instructor demonstrates six approaches - Eiii

Day 2 –

A. Cup Roast Demonstration for evaluation
B. Each student roasts two batches