

COURSE

# Coffee Fundamentals

10 Chapters

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COFFEE FUNDAMENTALS

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## A Seed, Not a Bean

Coffee is a drink made from the roasted seeds of plants in the genus *Coffea*. The fruit is called a **cherry** and the seed inside is called a **bean**, but Wikipedia's Coffea article points out that coffee is neither a true cherry (it is not from the genus *Prunus*) nor a true bean (it is not from the legume family). The article describes the fruit as an epigynous berry or an indehiscent drupe, which is botanists' way of saying a fleshy fruit that does not split open by itself.

| EVERYDAY WORD | WHAT IT REALLY IS | DETAIL |
|---|---|---|
| Cherry | The fruit of the coffee plant | About 1.5 cm long, ripening from green to yellow to crimson (black if left to dry) |
| Bean | The seed inside the fruit | Usually two seeds per fruit, lying with their flat faces together |
| Peaberry | A fruit with only one seed | About 5 to 10 percent of fruits |

In the tropics the plant is a shrub or small tree that typically reaches 3 to 3.5 m. Most cultivated species grow best at high elevations but cannot tolerate freezing temperatures.

## Two Species Do Most of the Work

The genus is large: Wikipedia says "over 120 species" in its introduction and lists 133 species and one hybrid following Plants of the World Online as of January 2026. Only two matter for the cup you buy.

| TRAIT | ARABICA (*C. ARABICA*) | ROBUSTA (*C. CANEPHORA*) |
|---|---|---|
| Reputation | Sweeter taste, generally more highly regarded | More bitter, less flavour, fuller body (Coffee article) |
| Caffeine | Lower | About 40 to 50 percent more than arabica |

| TRAIT | ARABICA (*C. ARABICA*) | ROBUSTA (*C. CANEPHORA*) |
|---|---|---|
| Origin | Ethiopian highlands and the Boma Plateau of Sudan | Tropical Africa (check) |
| Share of world output | Roughly 55 to 64 percent, depending on source and year | The rest |

**THE SOURCES DISAGREE ON THE SHARE**

The Coffea article says arabica is "around 55%" of production, while the Coffee article says "about three-quarters". A web search of secondary sources quoting International Coffee Organization reports gave 55.9 percent (December 2023 report), about 58 percent for coffee year 2024, and about 61 percent in a 2026 report; export-only figures can reach 64 percent. I could not open the ICO reports themselves, so treat "roughly 55 to 64 percent" as a range, not an exact number (check).

Arabica is thought to be a natural hybrid of *C. canephora* and *C. eugenioides*. Carl Linnaeus described the genus and its type species, *C. arabica*, in 1753.

## The Journey in Six Steps

Every cup follows the same route. The remaining chapters of the course take each stop in turn.

| STEP | WHAT HAPPENS | KEY FACT FROM THE SOURCES |
|---|---|---|
| 1. Pick | Ripe cherries are harvested | Selective hand-picking at peak ripeness, or strip-picking everything at once |
| 2. Process | Fruit is removed from the seed and the seed dried | The dry method is simpler and less labour-intensive; the wet method uses batch fermentation and more water and often gives a milder coffee |
| 3. Roast | Green seeds are heated until they turn brown and aromatic | Roasting proper begins when the bean's internal temperature reaches about 200 °C |
| 4. Grind | Roasted beans are broken into particles | A burr grinder is generally considered better than a blade grinder for most methods |
| 5. Brew | Hot water pulls flavour out of the grounds | Optimal extraction is said to occur between 91 and 96 °C |

| STEP | WHAT HAPPENS | KEY FACT FROM THE SOURCES |
|---|---|---|
| 6. Drink | You taste the result of every earlier choice | Roasting does not change the total caffeine in a bean |

**DARK ROAST, SAME CAFFEINE**

The Coffee article notes that light and dark roasts differ in caffeine by only about 0.1 percent. Darker beans expand during roasting, so a scoop of dark roast holds less coffee by weight and therefore a little less caffeine. This is why serious brewers weigh coffee rather than measure it by volume, which is where the next section starts.

## Weigh It: Your First Brewing Numbers

Brewing is mostly a ratio of coffee to water. A common starting point for filter coffee is about 1 part coffee to 15 or 16 parts water by weight, and for espresso about 1 part coffee to 2 parts liquid. These ratios come from my own knowledge, not from the pages I read, so treat them as starting points to adjust to taste (check). The script below turns a coffee dose into a water amount, and also does the peaberry arithmetic from the table above. I ran it to get the output shown.

```
def water_for(dose_g, ratio):
    return dose_g * ratio

for name, dose, ratio in [("Filter (1:16)", 20, 16), ("Filter (1:15)", 20, 15), ("Espres
    print(f"{name}: {dose} g coffee -> {water_for(dose, ratio):.0f} g water")

# Peaberry share: 5-10% of fruits hold one seed
fruits = 1000
for pct in (5, 10):
    one = fruits * pct // 100
    seeds = one * 1 + (fruits - one) * 2
    print(f"{pct}% peaberry: {fruits} fruits -> {seeds} seeds")
```

```
# Output
Filter (1:16): 20 g coffee -> 320 g water
Filter (1:15): 20 g coffee -> 300 g water
Espresso (1:2): 18 g coffee -> 36 g water
```

```
5% peaberry: 1000 fruits -> 1950 seeds
10% peaberry: 1000 fruits -> 1900 seeds
```

**WHAT THE NUMBERS SHOW**

Moving from 1:16 to 1:15 saves 20 g of water on a 20 g dose, a small shift you can taste. And because peaberries are only 5 to 10 percent of fruits, 1,000 cherries yield about 1,900 to 1,950 seeds, close to the 2,000 you would expect if every fruit held two.

## A Short, Honest History

The popular story of Kaldi, the goatherd who noticed his goats becoming lively after eating the plant, is set in the 9th century. The Coffee article says the story does not appear before 1671 and calls it likely apocryphal; the name Kaldi itself appears to be a 20th-century invention. The same article says there is no confirmed historical or archaeological evidence of coffee being drunk before the 15th century, and that by the late 15th century coffee drinking was well established among Sufi communities in Yemen.

## Who Grows It

For 2023 the FAO statistics quoted on Wikipedia give world green coffee production of 11.06 million tonnes, led by Brazil (3.41 million tonnes, 31 percent), then Vietnam (1.96), Indonesia (0.76), Colombia (0.68) and Ethiopia (0.56).

## Not Yet Verified, and Sources

- **Sources.** Wikipedia articles Coffea and Coffee, plus one web search about arabica's share of production. The Coffee article is about 251,000 characters long and I read only the first 100,000, so the economics, consumption and specialty-coffee sections were not read.
- **Conflict.** Arabica's share of production differs between the two articles and between secondary sources (see the box above).
- **Not in the pages read.** The brew ratios (1:15, 1:16 and 1:2), robusta's exact origin and the claim that dark roast leaves a scoop with less caffeine by weight beyond what the article states are from my own knowledge or inference (all marked check).

- **Not tested.** I did not brew with these ratios; the script only does arithmetic.

## Exercises

**EXERCISE 1**

Explain in two or three sentences why "coffee bean" and "coffee cherry" are both slightly misleading names. Then say what a peaberry is and roughly what fraction of fruits are peaberries.

→ Solution

**EXERCISE 2**

Using the script, work out the water needed for a 25 g dose at 1:16 and a 15 g dose at 1:15. Change the script so it also prints the total brew weight (coffee plus water) for each line, and run it.

→ Solution

**EXERCISE 3**

Fill in a table with the two main species and the three differences you would tell a friend about (taste, caffeine, rough share of world production). Then list the six steps from cherry to cup in order and say which step you think affects flavour most, giving a reason.

→ Solution

**QUICK REFERENCE**

- **Bean:** the seed of the coffee cherry; usually two per fruit
- **Peaberry:** a single-seed fruit, about 5 to 10 percent
- **Arabica:** sweeter, less caffeine; **robusta:** bitter, fuller body, 40 to 50 percent more caffeine
- **Six steps:** pick, process, roast, grind, brew, drink
- **Brew water:** 91 to 96 °C; roasting begins about 200 °C
- **Starting ratios:** filter about 1:15 to 1:16, espresso about 1:2 (check)

**COMING NEXT**

Coffee Fundamentals 2 follows the plant to the farm: where coffee grows and why altitude matters.

# Coffee Fundamentals

Course 1 · Chapter 2 · Where It Grows: Climate, Altitude and the Growing Year

## What the Plant Wants

Chapter 1 followed coffee from fruit to cup. This chapter goes back to the plant. Wikipedia's Coffea arabica article gives the conditions in which arabica does best, and they explain why coffee comes from a limited set of places.

| CONDITION | ARABICA DOES BEST WITH | NOTE |
|---|---|---|
| Altitude | Usually cultivated at 1,200 to 1,500 m | Some plantations run from sea level up to 2,800 m |
| Temperature | Average of 15 to 24 °C | It tolerates low temperatures but not frost |
| Rainfall | 1.2 to 1.8 m a year | Evenly distributed through the year |

Chapter 1 noted that most cultivated species grow best at high elevations but cannot tolerate freezing temperatures. The tropics give year-round warmth, and altitude brings the average temperature down into arabica's range. The articles I read do not explain how altitude changes the flavour of the cup; that is commonly claimed, but I have not verified it (check).

> **RANGE, NOT A RULE**
>
> The altitude figure is where arabica is *usually* grown, and the article also says some plantations go from sea level to 2,800 m. Treat 1,200 to 1,500 m as typical, not as a requirement. The articles I read give no altitude range for robusta (check).

## Metres and Feet

Altitudes are quoted in both units, so it helps to convert quickly. The script below converts the figures above, and also does the harvest-timing arithmetic from the next section. I ran it to get the output shown.

```
# Altitude conversion and harvest timing
MONTHS = ["Jan","Feb","Mar","Apr","May","Jun","Jul","Aug","Sep","Oct","Nov","Dec"]
```

```
def m_to_ft(m):
    return m * 3.28084

for m in (1200, 1500, 2800):
    print(f"{m} m = {m_to_ft(m):,.0f} ft")

def harvest_month(flower_month, lag=8):
    return MONTHS[(MONTHS.index(flower_month) + lag) % 12]

for f in ("Feb", "Aug"):
    print(f"Flowering in {f} -> cherries ripe about {harvest_month(f)}")

print(f"Year of first useful crop if planted in 2026: {2026 + 5}")
```

```
# Output
1200 m = 3,937 ft
1500 m = 4,921 ft
2800 m = 9,186 ft
Flowering in Feb -> cherries ripe about Oct
Flowering in Aug -> cherries ripe about Apr
Year of first useful crop if planted in 2026: 2031
```

**ROUNDED IN THE SOURCE**

The article writes 3,900, 4,900 and 9,200 ft. The script gives 3,937, 4,921 and 9,186 ft, which round to the same figures at that precision. The flowering examples are only arithmetic on the "about eight months" rule, not real farm calendars.

## The Growing Year

Coffee is slow. The Coffee production article says a plant usually begins flowering three to four years after planting, and the first useful harvest is possible around five years after planting. The Coffea arabica article says the plant takes about seven years to mature fully. Cherries ripen about eight months after flowering, changing from green to red, and should be harvested at that point.

| STAGE | TIME |
| --- | --- |
| Planting to first flowers | 3 to 4 years |

| STAGE | TIME |
| --- | --- |
| Planting to first useful harvest | Around 5 years |
| Planting to full maturity (arabica) | About 7 years |
| Flowering to ripe cherry | About 8 months |

Most producing countries have one major harvest a year. Colombia is the article's example of a country with two flowerings, so it has a main harvest from October to December and a secondary crop, called *mitaca*, from April to June.

## Who Grows Which

The Coffee production article says about 70 countries grow coffee.

| SPECIES | LEADING GROWERS, IN THE ARTICLE'S ORDER |
| --- | --- |
| Arabica | Brazil, then Colombia, Ethiopia and Honduras |
| Robusta | Vietnam, then Brazil, Indonesia, India and Uganda |

Brazil, India, Indonesia, Uganda and Vietnam grow both species. Broadly, Latin America produces most of the world's arabica, Asia produces most of its robusta, and Africa grows both in roughly equal measure.

## A Fragile Crop

Nearly all coffee cultivated over the past few centuries descends from a handful of wild plants from Yemen, according to the Coffea arabica article, and plantation coffee holds less than 1 percent of the diversity found in the wilds of Yemen alone. That narrow base helps explain why disease is a worry. The main disease the article cites is coffee leaf rust, caused by the fungus *Hemileia vastatrix*. It causes rapid loss of leaves, which hinders photosynthesis, and the article gives losses of up to 2 billion US dollars annually and a 16 percent production drop in Central America from 2012 to 2013.

**WHY THIS MATTERS IN THE CUP**

Where a coffee grows, which species it is and when it was picked are the first things printed on a good bag. Later chapters on buying and tasting come back to these labels.

## Not Yet Verified, and Sources

- **Sources.** Wikipedia articles Coffea arabica and Coffee production, plus the Coffea and Coffee articles from chapter 1.
- **Truncated.** The Coffee production article is about 115,000 characters and I read the first 100,000, so its later part was not read. It may contain the coffee belt, climate and shade-versus-sun material that I could not find in the portion read. The Coffea arabica article was read to about 100,000 of 107,000 characters; the unread tail was external links and reference material.
- **Not in the pages read.** Altitude and flavour, altitude limits for robusta, and the latitude band of the growing regions (all marked check or left out).
- **Possible variation.** Different parts of Wikipedia give different maturity times (about five years to first useful crop versus about seven to full maturity), which are different milestones rather than a conflict.
- **Not tested.** The script is arithmetic only.

## Exercises

**EXERCISE 1**

State the three growing conditions arabica does best with (altitude, temperature, rainfall) with their numbers. Then say why saying "arabica must be grown at 1,200 to 1,500 m" would be too strong.

→ Solution

**EXERCISE 2**

Change the script to convert 1,800 m to feet, and to find the harvest month for a plant that flowers in November, using the same eight-month lag. Run it and check the answers by hand.

→ Solution

**EXERCISE 3**

A farmer plants new coffee in March 2027. Using the article's timings, estimate the year of first flowers (give a range) and the year of the first useful harvest. Then explain why a farm might be slow to replace

its plants when a disease arrives.

→ Solution

### QUICK REFERENCE

- **Arabica:** usually 1,200 to 1,500 m; 15 to 24 °C average; 1.2 to 1.8 m of rain; no frost
- **First flowers:** 3 to 4 years after planting; first useful harvest about 5 years
- **Flower to ripe cherry:** about 8 months
- **Growers:** about 70 countries; arabica led by Brazil, robusta by Vietnam
- **Main disease:** coffee leaf rust (*Hemileia vastatrix*)

### COMING NEXT

Coffee Fundamentals 3 looks at what happens to the cherry once it is picked: processing.

## The Layers Around the Seed

A picked coffee cherry is a wet, sugary fruit with a seed inside. **Processing** is everything done between picking and the dry green coffee that gets shipped to a roaster. Wikipedia's Coffee processing article labels the layers of the fruit, from the outside in:

| LAYER | OTHER NAME | FATE IN PROCESSING |
|---|---|---|
| 1. Outer skin | Exocarp | Removed or dried and stripped off |
| 2. Pulp | Mesocarp | Removed or dried and stripped off |
| 3. Mucilage | Pectin layer | Washed or fermented off, or left on to dry |
| 4. Parchment | Hull, endocarp | Removed by hulling |
| 5. Silver skin | Testa | Mostly lost later, in roasting (check); can be polished off |
| 6. The bean | Endosperm | What the roaster wants |

The methods differ in how much of the fruit is dried together with the seed.

## Dry (Natural) Process

The simplest method: the whole fruit is cleaned and then dried in the sun, on patios or raised trestle beds, and turned by hand or rake. According to the article, drying can take about four weeks to reach a maximum moisture content of 12.5 percent, depending on the weather. The dried fruit is stored in bulk, then hulled, sorted, graded and bagged.

The article says drying "governs the final quality of the green bean more than any other stage". Over-drying makes beans brittle; under-drying invites fungal and bacterial spoilage. It also states that around 90 percent of Brazilian arabica uses this method.

## Wet (Washed) Process

Cherries are cleaned and graded (the article lists winnowing, screens, flotation and hydraulic separation), then pulped. The remaining mucilage is removed either by ferment-and-wash or by mechanical demucilaging. Published fermentation times run from about 12 to 36 hours, with millers judging the end point by touch. The beans are then washed in clean water and dried.

Washed coffee leaves the mill at about 53 percent moisture and must be dried to 10 to 12 percent (wet basis). The article warns that sun drying above about 40 °C (parchment) or 45 °C (cherry) damages quality.

On flavour, the article cites the International Trade Centre: washed coffee is the most common of the three main methods and often the highest quality. Fermenting underwater is said to emphasise acidity and aroma and suppress astringency, and mechanically demucilaged beans have sharper acidity while fermented beans are juicier and finer. These are the article's reported claims, not my own tasting (check).

## Honey (Pulped Natural) Process

The skin is removed but the mucilage is left on the parchment and the beans dry with it in place, with no washing step. How much mucilage stays gives the colour names:

| NAME | MUCILAGE LEFT | DRYING TIME |
|---|---|---|
| Yellow honey | Partly removed | About 8 to 10 days |
| Red honey | Roughly half to three-quarters kept | About 12 to 15 days |
| Black honey | All kept | Around 30 days, with frequent turning |

The article describes the cup as mellow and sweet, with mild acidity and fruit or honey notes, and says the method uses considerably less water than wet processing. "Honey" refers to the sticky mucilage, not to anything added.

## Wet-Hulled (Semi-Washed)

In the Indonesian method called *giling basah*, the parchment is removed while the bean is still wet. Beans are hulled at 40 to 45 percent moisture, sun-dried for 3 to 5 days to 14 to 17 percent, and dried further by exporters to about 13 percent. The article describes low acidity, heavy body

and spicy, earthy and fruity notes, and warns that wet storage can allow mould: a 2005 study found ochratoxin A in 5 of 42 samples, below the EU limit.

## Comparing the Methods

| METHOD | WHAT IS DRIED | REPORTED FLAVOUR | MOISTURE TARGET |
|---|---|---|---|
| Dry (natural) | Whole fruit | Not described in the part I read (check) | 12.5% maximum |
| Washed | Seed in parchment, mucilage removed | Often highest quality; acidity and aroma | 10 to 12% |
| Honey | Seed in parchment with mucilage | Mellow, sweet, mild acidity | Not stated in the part I read (check) |
| Wet-hulled | Seed after early hulling | Low acidity, heavy body, earthy | About 13% at export |

## After Drying: Hulling, Sorting, Grading

Hulling removes the remaining parchment or dried fruit covering; below 12 percent moisture, chipping and breakage rise sharply. Polishing, which removes silver skin by friction, is optional: the ITC does not recommend it for arabica, and unpolished coffee weighs 0.5 to 0.7 percent more. The beans are then cleaned by air and sorted by size, density and colour. The article says peaberries (chapter 1) are roughly a tenth of a typical crop, which is slightly above the 5 to 10 percent given there for fruits (check).

Most green coffee falls between screens 12 and 19, where screen 16 is 6.30 mm and screen 18 is 7.10 mm. Defects are classed as primary (a significant effect on the cup) or secondary (minor). Under Specialty Coffee Association standards a 350 g sample is graded, and any category-one defect excludes specialty grade.

## Water Leaves, the Seed Stays

Drying removes water and nothing else, so the amount of dry matter stays the same. If moisture is quoted on a wet basis (water as a share of total weight), the new weight is dry mass divided by (1 minus the new moisture). The script below applies this to the figures above and was run to

get the output shown. It treats everything as if only water is lost, so it ignores the weight of fruit or parchment that is stripped off, and the wet-hulled line is therefore only a rough illustration (check).

```
def final_mass(start_kg, start_moist, end_moist):
    dry = start_kg * (1 - start_moist)
    return dry / (1 - end_moist)

for label, start, end in [("Washed", 0.53, 0.11), ("Washed", 0.53, 0.12), ("Wet-hulled",
    m = final_mass(100, start, end)
    print(f"{label}: 100 kg at {start:.1%} -> {m:.1f} kg at {end:.0%} (water removed {10

for name, days in [("Yellow honey", (8, 10)), ("Red honey", (12, 15)), ("Black honey", (
    print(f"{name}: about {days[0]}-{days[1]} days drying" if days[0] != days[1] else f"
```

```
# Output
Washed: 100 kg at 53.0% -> 52.8 kg at 11% (water removed 47.2 kg)
Washed: 100 kg at 53.0% -> 53.4 kg at 12% (water removed 46.6 kg)
Wet-hulled: 100 kg at 42.5% -> 66.1 kg at 13% (water removed 33.9 kg)
Yellow honey: about 8-10 days drying
Red honey: about 12-15 days drying
Black honey: about 30 days drying
```

**READING THE OUTPUT**

Drying washed coffee from 53 percent moisture to about 11 percent removes almost half the starting weight. The difference between targeting 11 and 12 percent is only about 0.6 kg per 100 kg, which is why the target matters more for storage safety than for weight.

## Not Yet Verified, and Sources

- **Sources.** Wikipedia article Coffee processing, plus the Coffee and Coffea articles from earlier chapters. The processing article is about 115,000 characters; I read the first 100,000, and the unread tail appeared to be navigation text.
- **Not in the part read.** The flavour of the dry method, the moisture target for honey process, and what becomes of the silver skin (all marked check).

- **My inference.** The mass calculation assumes only water is lost, which is a simplification.
- **Secondary claims.** Flavour descriptions are the article's reports of other sources, not tested by me.

## Exercises

**EXERCISE 1**

Write the six layers of the fruit in order from outside to inside. Then say which layers are still on the seed when it is drying in (a) the dry method and (b) the black honey method.

→ Solution

**EXERCISE 2**

Use the script to find how much 250 kg of washed coffee at 53 percent moisture weighs after drying to 10.5 percent. Then work out the weight at 12.5 percent and say what the difference tells you.

→ Solution

**EXERCISE 3**

Make a table comparing the four methods on three points: how long the seed spends drying with fruit material on it, how much water the method needs, and the reported flavour. Mark any cell the chapter does not support with "(check)".

→ Solution

**QUICK REFERENCE**

- **Layers:** skin, pulp, mucilage, parchment, silver skin, bean
- **Dry:** whole fruit sun-dried, up to about four weeks, 12.5% maximum moisture
- **Washed:** pulp and mucilage removed, 12 to 36 h fermentation reported, dried to 10 to 12%
- **Honey:** mucilage left on; yellow 8 to 10 days, red 12 to 15, black about 30
- **Wet-hulled:** hulled at 40 to 45% moisture, dried to about 13%

- **Hulling, sorting, grading** come after drying

**COMING NEXT**

Coffee Fundamentals 4 takes the dry green seed to the roaster.

## Why Roast?

The dry green seed from chapter 3 has little of the smell or taste we call coffee. Roasting supplies it. Wikipedia's Coffee roasting article says that sugars caramelise, that Maillard and other reactions produce the roast flavour, and that chlorogenic acids break down, which it calls a key goal of roasting. The beans lose about 15 to 18 percent of their mass, mainly water, and their volume roughly doubles as vaporised water raises the pressure inside.

## The Stages

The article describes a sequence you can hear. Early roasting absorbs heat (it is endothermic), but at around 175 °C it turns exothermic and the beans begin heating themselves, so a roaster has to manage the heat carefully rather than just keep adding it.

| STAGE | APPROXIMATE BEAN TEMPERATURE | WHAT HAPPENS |
|---|---|---|
| Drying | About 165 °C (image caption) | Water is driven off; the green seeds turn yellowish (check) |
| First crack | About 196 °C | After several minutes the beans "pop or crack" |
| Second crack | About 224 to 225 °C | A few more minutes later; oils start to surface on darker roasts |

**TWO FIGURES FOR ONE EVENT**

The article's text gives about 224 °C for second crack and its table gives 225 °C, and it does not reconcile them. I treat the difference as rounding. Chapter 1 quoted the Coffee article saying roasting begins when the bean's internal temperature reaches about 200 °C; the roasting article puts first crack at about 196 °C. These describe different moments (start of roasting versus first crack), and I have not found a source that lines them up (check).

The article gives no total roast time, saying only that first crack comes "after several minutes" and second crack "a few more minutes" later. Real roasting profiles are not covered by the page I read (check).

## Roast Levels

Roast names are traditional and not standardised across roasters; the article lists these names against bean temperature.

| LEVEL | BEAN TEMPERATURE |
|---|---|
| Cinnamon | 196 °C |
| New England | 205 °C |
| American | 210 °C |
| City | 219 °C |
| Full City | 225 °C |
| Vienna | 230 °C |
| French | 240 °C |
| Italian | 245 °C |

The article notes that its Roasts section is flagged as needing more citations, so treat these numbers as typical, not exact (check). Light roasts keep higher acidity; acidity is muted at medium-dark levels and nearly eliminated at the Italian roast. Lipids liquefy and can surface as oil, more so on darker roasts.

## Code: Naming a Roast and Tracking Weight Loss

The script below looks up the highest level whose temperature has been reached, and works out roasted weight from the 15 to 18 percent loss. I ran it to get the output shown.

```
LEVELS = [("Cinnamon", 196), ("New England", 205), ("American", 210), ("City", 219),
          ("Full City", 225), ("Vienna", 230), ("French", 240), ("Italian", 245)]

def roast_level(temp_c):
```

```
    name = "Before first crack"
    for label, t in LEVELS:
        if temp_c >= t:
            name = label
    return name

for t in (190, 200, 212, 226, 244, 250):
    print(f"{t} C -> {roast_level(t)}")

for loss in (0.15, 0.18):
    print(f"1000 g green -> {1000 * (1 - loss):.0f} g roasted ({loss:.0%} loss)")

print(f"250 g roasted needs about {250 / 0.85:.0f} to {250 / 0.82:.0f} g green")
```

```
# Output
190 C -> Before first crack
200 C -> Cinnamon
212 C -> American
226 C -> Full City
244 C -> French
250 C -> Italian
1000 g green -> 850 g roasted (15% loss)
1000 g green -> 820 g roasted (18% loss)
250 g roasted needs about 294 to 305 g green
```

**WHAT THE OUTPUT SHOWS**

The lookup is a step function: a bean at 212 °C is "American" because it has passed 210 but not 219. And to end up with 250 g of roasted coffee you must start with roughly 294 to 305 g of green, since 15 to 18 percent is lost. The exact loss depends on the roast and the batch, which the article does not detail (check).

## Caffeine, Density and Scoops

Caffeine is stable up to 200 °C and decomposes around 285 °C, which roasting rarely reaches, so roasting changes caffeine content little. This matches chapter 1. By volume, though, a lighter roast holds more caffeine than a darker one because darker beans are less dense. Measuring by weight removes the difference, which is why chapter 1 recommended it.

## After the Roaster: Degassing and Freshness

Roasted coffee gives off carbon dioxide. Coffee that will be vacuum-packed has to degas for several days first; valved bags or pressurised canisters allow faster packaging. The article gives an optimal shelf life for roasted coffee of about two weeks and for ground coffee about 15 minutes. It also says whole roasted beans can stay fresh up to a month if kept cool, but that claim is marked "citation needed" on the page, so I treat it as unconfirmed (check). Green coffee can be stored about 12 to 18 months in a climate-controlled setting before quality loss is noticeable.

**HOME ROASTING**

The article says home roasting means roasting small batches for personal use, was more common than buying roasted coffee after 1900, faded as commercial roasters grew, and has revived recently. Its stated motives are some economic advantage but mainly finer control over quality and flavour. I have not covered home-roasting equipment here (check).

## Not Yet Verified, and Sources

- **Sources.** Wikipedia article Coffee roasting, plus the Coffee article quoted in chapter 1.
- **Conflicts.** Second crack is given as both 224 and 225 °C on the same page; the "roasting begins about 200 °C" statement in the Coffee article does not match the roasting article's first crack at about 196 °C, though they may describe different moments. Not resolved.
- **Weak support.** The roast-level table sits in a section flagged for missing citations, and the one-month freshness claim is marked "citation needed".
- **Not in the page read.** Total roast time, roast colours, the change of colour during drying, and degassing duration beyond "several days" (all marked check).
- **Not tested.** The script is arithmetic and a lookup only; I did not roast anything.

## Exercises

**EXERCISE 1**

Put these in order of increasing temperature and say what happens at each: first crack, drying, second

crack, the point at which the process becomes exothermic.

→ Solution

**EXERCISE 2**

Use the script to name the roast level at 207, 222 and 235 °C. Then add a line that works out how much green coffee you need for 400 g of roasted coffee at the 15 percent and 18 percent loss figures.

→ Solution

**EXERCISE 3**

A friend says a dark roast has "much less caffeine". Using the chapter, explain when that is roughly true and when it is not, and what you would do to compare fairly.

→ Solution

**QUICK REFERENCE**

- **Mass loss:** about 15 to 18 percent; volume roughly doubles
- **Exothermic from:** about 175 °C; first crack about 196 °C; second crack about 224 to 225 °C
- **Levels:** Cinnamon 196, New England 205, American 210, City 219, Full City 225, Vienna 230, French 240, Italian 245 °C
- **Caffeine:** barely changed by roasting; less per scoop in darker roasts
- **Freshness:** roasted about two weeks optimal; ground about 15 minutes

**COMING NEXT**

Coffee Fundamentals 5 turns to grinding.

# Coffee Fundamentals

Course 1 · Chapter 5 · Grinding: Size, Uniformity and Machines

## Why Grind at All?

Whole roasted beans barely give anything to water. Grinding breaks them into particles so the water can reach the flavour inside. Wikipedia's Coffee preparation article says brewing methods that keep grounds in contact with hot water for longer need a coarser grind than faster methods. Wikipedia's Burr mill article adds that a finer grind gives more surface contact with water and more complete extraction of caffeine and flavour.

## Too Fine, Too Coarse

| PROBLEM | WHAT THE ARTICLE SAYS |
|---|---|
| Too fine | A bitter, harsh, "over-extracted" taste; also slows filtration or screening |
| Too coarse | Weak coffee unless more coffee is used |
| Uneven | A uniform grind is "highly desirable" |

The same article notes that with an adjustable brew time, a finer grind lets you use a shorter brew for similar flavour with less coffee. This is a trade-off, not a free gain (check).

## Matching Grind to Method

The Burr mill article groups grinds into qualitative categories only. It gives no millimetre or micrometre figures, so the numbers in the table below are the article's words, not measurements.

| METHOD | GRIND |
|---|---|
| Turkish coffee, espresso | Finest |
| Pour-over, drip | Medium-fine to medium |
| French press, cold brew | Coarse to extra coarse |

Coffee preparation notes that Arabic and Greek (Turkish) coffee need near-powder fineness, finer than most home burr grinders can reach; traditional Greek hand grinders can, and a mortar and pestle can do it by pounding.

## Four Ways to Break a Bean

| TYPE | HOW IT WORKS | STRENGTHS AND WEAKNESSES (FROM THE ARTICLES) |
|---|---|---|
| Burr | Two revolving abrasive elements (wheels or cones) crush the beans; the gap sets the size | Fairly uniform particles, less frictional heat, avoids excess fines; two types, conical and flat wheel |
| Blade (chopper) | Blades spin at 20,000 to 30,000 rpm | Cheaper, but non-uniform and particles keep shrinking while it runs; makes "coffee dust"; best for drip, not recommended for pump espresso machines |
| Pounding | Mortar and pestle | Reaches near-powder fineness |
| Roller | Corrugated rollers | Even sizes and little heat, but only commercial and industrial |

**HEAT AND FLAVOUR**

The Burr mill article says oils and aromas can dissipate if beans become too hot during grinding, though most grinders do not reach a risky temperature, and that low rotational speed helps preserve flavour. It does not compare flat and conical burrs for coffee, so I make no claim about which is better (check).

## Electric and Manual

Cheap electric burr grinders use a small motor with reduction gears, which the article says are noisier and usually shorter-lived; heavy-duty commercial machines use direct drive with a large motor and belt. Settings are either numbered steps (repeatable) or stepless. Commercial machines may have a doser, or be doserless and drop grounds straight into a container such as a portafilter. Manual grinders are turned by hand, have largely been replaced by electric ones, and remain popular for cost, size and looks; fast, precise manual grinders gained popularity in the 2020s for single servings. Very fine Turkish-style powder cannot be reached in inexpensive electric or simple manual grinders without straining them.

The Burr mill article gives some history: in 1799 an English blacksmith from Birmingham named Richard Dearmann made the first coffee grinder, and in 1818 Increase Wilson patented the first wall coffee grinder in the US. I have not checked these against other sources (check).

## Freshness

Ground coffee deteriorates faster than whole roasted beans because more surface is exposed. That is why many drinkers grind just before brewing, and why chapter 4 gave ground coffee a much shorter optimal life (about 15 minutes) than roasted beans (about two weeks).

## Code: Why Finer Means More Surface

For a sphere, surface area divided by volume equals 6 divided by the diameter, so halving the diameter doubles the surface per unit of coffee. Real grounds are irregular, so this is only an illustration, and the diameters are made up for the demonstration, not measured grind sizes. The script also repeats the water-to-coffee ratio range of 15 to 18 to 1 by mass given in the Coffee preparation introduction. I ran it to get the output shown.

```
GRIND_FOR = {
    "Turkish": "finest", "espresso": "finest",
    "pour-over": "medium-fine to medium", "drip": "medium-fine to medium",
    "French press": "coarse to extra coarse", "cold brew": "coarse to extra coarse",
}

for method, grind in GRIND_FOR.items():
    print(f"{method}: {grind}")

# Surface area per unit volume of a sphere is 6 / diameter
for d_mm in (1.0, 0.5, 0.25):
    print(f"particle {d_mm} mm -> surface/volume {6 / d_mm:.0f} per mm")

for ratio in (15, 18):
    print(f"20 g coffee at {ratio}:1 -> {20 * ratio} g water")
```

```
# Output
Turkish: finest
espresso: finest
```

```
pour-over: medium-fine to medium
drip: medium-fine to medium
French press: coarse to extra coarse
cold brew: coarse to extra coarse
particle 1.0 mm -> surface/volume 6 per mm
particle 0.5 mm -> surface/volume 12 per mm
particle 0.25 mm -> surface/volume 24 per mm
20 g coffee at 15:1 -> 300 g water
20 g coffee at 18:1 -> 360 g water
```

**WHAT THE OUTPUT SHOWS**

Each halving of particle size doubles the surface the water can reach, which is the intuition behind "finer grinds extract more quickly". The 15:1 line matches the 1:15 filter figure from chapter 1, which I had marked "check"; the source's 15 to 18 to 1 range supports it, though its 1:16 and espresso 1:2 figures are still not confirmed here (check).

## Not Yet Verified, and Sources

- **Sources.** Wikipedia articles Burr mill (read in full as returned) and Coffee preparation. The Coffee preparation article is about 110,000 characters; I read the first 100,000, which included the whole grinding section.
- **Not in the pages read.** Any measured particle size for any grind; the difference between flat and conical burrs for coffee; the effect of burr material (all marked check or left out).
- **Weak support.** The Burr mill article cites some community references that the page does not verify, and the history dates are single-source.
- **Illustration only.** The surface-to-volume figures assume spherical particles and invented diameters.

## Exercises

**EXERCISE 1**

Explain in your own words why a blade grinder gives uneven results and a burr grinder does not. Then say which type you would avoid for a pump espresso machine and why.

→ Solution

**EXERCISE 2**

Extend the script to print the surface-to-volume figure for a 0.125 mm particle, and the water needed for a 25 g dose at both ends of the 15 to 18 to 1 range. Run it and say how many times more surface the 0.125 mm particle has than the 1.0 mm one.

→ Solution

**EXERCISE 3**

A brew tastes bitter and harsh, and the filter is slow to drain. Using the chapter, say what is probably wrong with the grind, what you would change, and what you would expect to happen to the taste. Note which part of your answer is the article's claim and which is your inference.

→ Solution

### QUICK REFERENCE

- **Longer contact, coarser grind;** shorter contact, finer grind
- **Too fine:** bitter, harsh, slow to filter; **too coarse:** weak
- **Burr:** uniform, less heat; **blade:** 20,000 to 30,000 rpm, uneven, dust
- **Finest:** Turkish, espresso; **medium:** pour-over, drip; **coarse:** French press, cold brew
- **Ratio range given:** 15 to 18 parts water to 1 part coffee, by mass

**COMING NEXT**

Coffee Fundamentals 6 looks at the principles of brewing: ratio, temperature and extraction.

# Coffee Fundamentals

Course 1 · Chapter 6 · Brewing Principles: Ratio, Temperature, Time and Extraction

## Four Variables

Wikipedia's Coffee preparation article says that "key variables in coffee preparation include grind size, water temperature, brew time, and the ratio of coffee to water", which together control extraction and flavour. It also names the water itself as a factor. Chapter 5 covered grind size; this chapter covers the rest.

| VARIABLE | WHAT THE ARTICLE GIVES |
|---|---|
| Grind size | Chapter 5: finer for faster methods, coarser for longer ones |
| Water temperature | Close to boiling; espresso 91 to 95 °C |
| Brew time | Method-dependent, from seconds to many hours |
| Ratio | 15 to 18 parts water to 1 part coffee by mass |

## Water

The article says proper brewing uses water of "balanced mineral composition", and notes that the Specialty Coffee Association (written SCAA in the article) defines a precise composition of water for barista championships. It does not give that composition (check). On temperature, it says aromatic oils are released at 96 °C, just below boiling, and bitter acids are released once the water reaches boiling point. Chapter 1 quoted 91 to 96 °C as the optimal range from the Coffee article; the figures agree in spirit, but the two articles state the range differently.

## Ratio

The introduction gives a preferred ratio of 15 to 18 to 1 water to coffee by mass. The article also gives standard brew strengths by volume: 55 g/L (the American standard) up to 63 g/L (the Norwegian standard), which it says yields about 14 to 16 g of coffee for a 240 ml cup. Espresso is an exception: 7 g of grounds for a 25 ml shot (280 g/L), and a typical presentation ratio of 1 to

2 (ground coffee to water). That finally supports the 1:2 espresso figure that chapter 1 marked "check".

> **NUMBERS THAT DO NOT QUITE AGREE**
>
> 55 g/L over 240 ml works out to 13.2 g, not the "14 to 16 g" the article states, while 63 g/L gives 15.1 g. The stated range is therefore a little high at the lower end. The mismatch may come from rounding or from a cup being slightly larger than 240 ml; I could not tell which (check).

## Time

| METHOD | TIME GIVEN |
|---|---|
| French press | Typically 4 to 7 minutes of steeping |
| Cold brew | 8 to 24 hours (one gallery caption says 12) |
| Cold drip | About 2 hours |
| Turkish coffee | Brought to the boil, sometimes two or three brief boils; no time given |
| Espresso | No brew time given in the part I read (check) |

## Extraction

**Extraction** means dissolving flavour out of the grounds. The article says the ideal yield is widely agreed to be 20 ± 2 percent (18 to 22 percent), meaning about a fifth of the dry coffee ends up in the cup. It gives ideal *strength* targets as well: American 1.25 percent (1.15 to 1.35), Norwegian 1.40 percent (1.30 to 1.50) and European 1.20 to 1.45 percent, though some of these are tagged "citation needed" on the page (check).

| PROBLEM | CAUSE GIVEN | RESULT |
|---|---|---|
| Over-extraction | Grounds too fine (too much surface) | Bitter, harsh taste |
| Under-extraction | Grounds too coarse | Weak coffee unless more is used |

## Four Basic Methods

| TYPE | HOW IT WORKS | EXAMPLES IN THE ARTICLE |
|---|---|---|
| Decoction | Grounds and water are boiled together | Turkish or Arabic coffee in a cezve, cowboy coffee, kopi tubruk |
| Infusion | Grounds steep in water, then are separated | French press, AeroPress-style immersion, coffee bags |
| Gravity | Water flows down through the grounds | Drip brewers, Indian filter coffee, percolators, Neapolitan flip pot |
| Pressure | Water is forced through the grounds | Espresso, the moka pot (about 1 bar of steam pressure) |

Espresso uses water at 91 to 95 °C at 8 to 18 bar, forced through a lightly packed puck of finely ground coffee to make a 30 to 60 ml drink. Chapters 7 and 8 take these families in turn.

## Code: Doses, Ratios and Yield

The script below turns the article's strengths and ratios into doses, and applies a yield formula. The formula (yield equals strength percent times drink weight divided by dose) is from my own knowledge, not from the pages I read, and the example input numbers are invented, so treat that line as a worked illustration (check). I ran the script to get the output shown.

```
def dose_for(volume_ml, grams_per_litre):
    return volume_ml / 1000 * grams_per_litre

for name, gpl in [("American standard", 55), ("Norwegian standard", 63)]:
    print(f"{name}: {gpl} g/L -> {dose_for(240, gpl):.1f} g for 240 ml")

print(f"Espresso: 7 g in 25 ml = {7 / 25 * 1000:.0f} g/L")

for ratio in (15, 16, 18):
    print(f"{ratio}:1 -> {1000 / ratio:.1f} g coffee per litre of water")

def extraction_yield(tds_percent, beverage_g, dose_g):
    return tds_percent * beverage_g / dose_g

print(f"Example yield: {extraction_yield(1.3, 300, 20):.1f}% (target 18-22%)")
```

```
# Output
American standard: 55 g/L -> 13.2 g for 240 ml
```

```
Norwegian standard: 63 g/L -> 15.1 g for 240 ml
Espresso: 7 g in 25 ml = 280 g/L
15:1 -> 66.7 g coffee per litre of water
16:1 -> 62.5 g coffee per litre of water
18:1 -> 55.6 g coffee per litre of water
Example yield: 19.5% (target 18-22%)
```

**WHAT THE OUTPUT SHOWS**

The 15 to 18 to 1 ratio range corresponds to roughly 56 to 67 g of coffee per litre of water, a little different from the 55 to 63 g/L standards, so the two ways of stating a recipe overlap but are not identical. The espresso line reproduces the article's 280 g/L. The example yield lands inside the 18 to 22 percent target.

## Not Yet Verified, and Sources

- **Sources.** Wikipedia article Coffee preparation, read as returned (about 100,000 of 110,000 characters; the unread tail was references and navigation), plus the earlier chapters' articles. A second article I tried to fetch did not exist (404).
- **Conflict.** The article's "14 to 16 g for 240 ml" does not match its own 55 to 63 g/L figures (see the box above). Not resolved.
- **Weak support.** Some strength targets are tagged "citation needed" on the page.
- **Not in the page read.** The SCA water composition; a brew time for espresso; how to measure strength at home.
- **My own knowledge.** The extraction-yield formula and the example input numbers (check).

## Exercises

**EXERCISE 1**

List the four variables of brewing. For each, say what goes wrong at one extreme, using only what the chapter supports and marking anything else "(check)".

→ Solution

**EXERCISE 2**

Use the script to find the dose for a 500 ml pot at the American and Norwegian strengths, and the coffee needed for 750 g of water at 16 to 1. Then work out the yield for a 28 g dose that makes 420 g of drink at 1.45 percent strength.

→ Solution

**EXERCISE 3**

Sort these into the four basic method families and give a typical brew time or pressure for each where the chapter has one: French press, moka pot, Turkish coffee, drip brewer, espresso, cold brew.

→ Solution

### QUICK REFERENCE

- **Variables:** grind size, water temperature, brew time, ratio (plus water quality)
- **Ratio:** 15 to 18 parts water to 1 part coffee; 55 to 63 g/L
- **Espresso:** 7 g in 25 ml (280 g/L), about 1:2, 91 to 95 °C, 8 to 18 bar
- **Ideal yield:** 20 ± 2 percent
- **Families:** decoction, infusion, gravity, pressure

**COMING NEXT**

Coffee Fundamentals 7 looks at filter and immersion methods in practice.

# Coffee Fundamentals

Course 1 · Chapter 7 · Filter and Immersion: Press, Drip and Cold Methods

## Two Ideas, Three Drinks

Chapter 6 split brewing into four families. Here are three of them in practice: **immersion** (the grounds sit in the water), **filter** or gravity (water runs through the grounds and a filter) and **cold** brewing (immersion with cool water over many hours). The facts come from Wikipedia's articles on the French press, drip coffee and cold brew coffee.

| METHOD | FAMILY | CONTACT | GRIND |
|---|---|---|---|
| French press | Infusion | Steeped, about four minutes by some accounts | Coarse |
| Drip / pour-over | Gravity | Water passes through | Medium-fine to medium (chapter 5) |
| Cold brew | Infusion, cold | 12 to 24 hours | Coarse |

## The French Press

Coarse grounds steep in hot water, then a mesh plunger pushes them to the bottom. The article says some writers give the optimal time as around four minutes, which sits inside the 4 to 7 minutes chapter 6 took from another article. It describes the right grind as "about the consistency of cooking salt": finer grounds reduce permeability, can seep past the filter, and tend to over-extract and turn bitter. A starting recipe given is about 30 g of grounds to 500 ml of water at 93 to 96 °C, adjusted to taste.

The article lists strengths and weaknesses in scattered sentences. It is simple, compact and portable, and can deliver an excellent taste. Fine grounds can pass the filter and end up in the cup, and coffee left sitting on the used grounds may become astringent and bitter, though some drinkers like that. It cites a 2012 study of cafestol extraction in different brews but does not explain the result, so I make no claim about oils or cholesterol effects (check).

### A short history

| YEAR | EVENT (FROM THE ARTICLE) |
|---|---|
| 1812 | Benjamin Thompson invents a drip-press brewing device, an early ancestor |
| 1852 | Mayer and Delforge patent a forerunner in France that did not seal around the filter |
| 1924 | A patent by Marcel-Pierre Paquet dit Jolbert is published (5 August) |
| 1928-1929 | Moneta and Calimani add a spring to seal the filter and patent it in the US in 1929 |
| 1958 | Faliero Bondanini patents his version, made under the Melior brand |

## Drip and Pour-Over

Hot water is poured onto the grounds, seeps through and carries flavour with it, while the grounds stay in the filter and the brew collects below. Pour-over is the usual term for manually brewed drip coffee. In automatic machines the article says water is heated in a metal tube, rises up a hose by thermosiphon action and is sprayed onto the grounds.

| YEAR | EVENT (FROM THE ARTICLE) |
|---|---|
| 1908 | Melitta Bentz invents commercial paper coffee filters in Germany |
| 1941 | The Chemex is listed among filter systems |
| 1944 | Willy Brand develops an automatic drip brewer with circular paper filters in Switzerland |
| 1954 | The Wigomat, one of the first electric drip brewers, is patented in Germany |
| 1970s | Drip makers largely replace percolators, which tend to over-extract |
| 2004 | The Hario system is listed |

### Paper or metal?

| FILTER | EFFECT AND TRADE-OFF (FROM THE ARTICLE) |
|---|---|
| Paper | Clear, light-bodied coffee; traps oils and essences; thrown away with the grounds |
| Permanent (metal, mesh, ceramic) | Does not normally remove the oils; cuts cost and waste but needs cleaning |

**Technique: bloom and pour**

The article describes blooming: pour a small amount of hot water over the grounds and wait for about 30 to 45 seconds before continuing, which releases carbon dioxide and can improve the taste. Pour slowly in a circle; it says rapid pouring gives a "more watery consistency" and slow pouring can give a "richer taste". It gives no water temperature, total pour-over time or coffee-to-water ratio for drip coffee, so use the chapter 6 figures as a start (check).

## Cold Brew

Coarse-ground beans are soaked in water for 12 to 24 hours; the water is usually room temperature, though chilled water can be used. The grounds are removed with a paper filter, a fine metal sieve or felt. The result is a concentrate, diluted with water or milk and served hot, chilled or over ice. Chapter 6 gave 8 to 24 hours from another article; this one says 12 to 24, and I did not resolve the difference (check).

On chemistry, the article says brewing at a lower temperature for 24 hours gives higher caffeine content than a hot brew of equal volume, compared against 6 minutes at 98 °C (the quote was cut short in my extract, so I have not verified the full claim). It says cold and hot brews have similar acidity but cold brew has lower titratable acid concentration, and attributes the different flavour to never meeting heated water. It does not give ratios, shelf life or a comparison with iced coffee (check). A slow-drip variant, sometimes called Kyoto-style, drips water through grounds at room temperature over many hours.

## Code: Ratios, Temperatures and Time

The script below checks the press recipe against the 15 to 18 to 1 ratio from chapter 6, converts temperatures, and compares cold and hot contact times. I ran it to get the output shown.

```
def ratio(water_ml, coffee_g):
    return water_ml / coffee_g

print(f"French press: 30 g in 500 ml = {ratio(500, 30):.1f}:1")
print(f"A 1 litre press at that ratio needs {1000 / ratio(500, 30):.0f} g of coffee")

def c_to_f(c):
    return c * 9 / 5 + 32
```

```
for c in (93, 96, 98):
    print(f"{c} C = {c_to_f(c):.0f} F")

for lo, hi in ((12, 24),):
    print(f"Cold brew steeping: {lo} to {hi} hours = {lo * 60} to {hi * 60} minutes")
    print(f"Compared with a 6 minute hot brew: {lo * 60 / 6:.0f} to {hi * 60 / 6:.0f} ti
```

```
# Output
French press: 30 g in 500 ml = 16.7:1
A 1 litre press at that ratio needs 60 g of coffee
93 C = 199 F
96 C = 205 F
98 C = 208 F
Cold brew steeping: 12 to 24 hours = 720 to 1440 minutes
Compared with a 6 minute hot brew: 120 to 240 times longer
```

**WHAT THE OUTPUT SHOWS**

The press recipe works out to 16.7 to 1, inside the 15 to 18 to 1 range from chapter 6, and 93 to 96 °C matches the 199 to 205 °F the article states. Cold brew takes roughly 120 to 240 times as long as the 6-minute hot brew it was compared with, which is why it uses a different temperature and a coarse grind. The ratio here treats 1 ml of water as 1 g.

## Not Yet Verified, and Sources

- **Sources.** Wikipedia articles French press, Drip coffee and Cold brew coffee. The extracts I read appeared complete, though I saw them through a summarising tool, not the full page text.
- **Conflict.** Cold brew time is 12 to 24 hours here and 8 to 24 hours in the Coffee preparation article from chapter 6. Not resolved.
- **Not in the pages read.** Drip water temperature, pour-over time and ratio, cold brew ratio and shelf life, the cafestol result, and a full account of the caffeine comparison (all marked check).
- **Weak support.** The drip coffee article's automatic-machine section is marked on the page as needing expansion.

- **Not tested.** I made no coffee; the script is arithmetic only.

## Exercises

**EXERCISE 1**

A friend's press coffee tastes bitter and gritty. Using the chapter, give two likely causes and a fix for each.

→ Solution

**EXERCISE 2**

Use the script to work out the coffee for a 750 ml press at the article's 30 g per 500 ml, and the ratio you get. Then add a line converting 94 °C to Fahrenheit and decide whether it falls inside the article's range.

→ Solution

**EXERCISE 3**

Compare paper and permanent filters on body, oils and upkeep. Then write a one-paragraph plan for a pour-over using the bloom step, saying which numbers come from this chapter and which you are guessing and must mark "(check)".

→ Solution

**QUICK REFERENCE**

- **Press:** coarse like cooking salt; about 30 g per 500 ml; 93 to 96 °C; about four minutes
- **Drip:** paper gives clear, light body; bloom 30 to 45 seconds
- **Cold brew:** coarse; 12 to 24 hours; a concentrate you dilute
- **Dates:** paper filter 1908, Chemex 1941, press patents 1852, 1924, 1929, 1958

**COMING NEXT**

Coffee Fundamentals 8 covers espresso and the drinks made from it.

# Coffee Fundamentals

Course 1 · Chapter 8 · Espresso and Milk: The Machine and the Menu

## What Espresso Is

Wikipedia's Espresso article defines it as a concentrated coffee made by forcing hot water under high pressure through finely ground coffee, served in about 25 to 30 ml portions. It has a dark body topped with a lighter foam called **crema**, a dense foam of emulsified oils that the article says forms when high-pressure water dissolves more carbon dioxide left from roasting. Chapter 6 gave the family (pressure), the temperature and the pressure range; this chapter fills in the details.

## A Reference Shot

The article quotes a standard from the Italian Espresso National Institute (INEI). Here it is beside what the article calls typical.

| QUANTITY | INEI STANDARD | TYPICAL (ARTICLE) |
|---|---|---|
| Dose | 7 ± 0.5 g of ground coffee | Single, double and triple baskets use roughly 7, 14 and 21 g |
| Water pressure | 9 ± 1 bar at entry | Pump machines about 9 bar since the Faema E61 |
| Water temperature | 88 ± 2 °C leaving the unit; 67 ± 3 °C in the cup | Chapter 6: 91 to 95 °C |
| Time | 25 ± 5 seconds | Usually 25 to 30 seconds |
| Volume in cup | 25 ± 2.5 ml including crema | 25 to 30 ml |

**TEMPERATURES FROM DIFFERENT PLACES**

The INEI figure of 88 ± 2 °C is for water leaving the unit; chapter 6 quoted 91 to 95 °C from the Coffee preparation article. I did not find a source that reconciles them (check). The espresso machine article gives no brew temperature at all. Also, chapter 6 gave espresso pressure as 8 to 18 bar; the espresso

article's own standard is 9 ± 1 bar, and the machine article gives 8 to 10 bar for spring piston machines. These describe different machines and standards, not an error, but the ranges differ.

### Shot variants

| NAME | VOLUME | NOTE |
|---|---|---|
| Ristretto | About 20 ml | Shorter than a standard shot |
| Espresso | 25 to 30 ml | The standard |
| Lungo | About 60 ml | Pulled with twice the water |

## The Machine

The espresso machine article describes a portafilter (group handle) that holds a tamped puck of grounds in a basket and attaches to the grouphead, sealing against a gasket. It is usually brass for heat retention. A bottomless portafilter lets a barista check for "channeling", water carving a path through the puck. It also describes boiler layouts:

| TYPE | HOW IT WORKS (FROM THE ARTICLE) |
|---|---|
| Single boiler (SB) | Brews only, no steam |
| Single boiler, dual use | One chamber for brewing and steaming, one operation at a time, with a warm-up period |
| Heat exchanger (HX) | One boiler at steaming temperature; brew water cooled by a flush of 4 to 6 seconds before the first pull |
| Dual boiler (DB) | Separate brew and steam heating |

Auxiliary steam wands heat and froth milk, and can make microfoam for latte art. Operation is manual, semi-automatic or fully automatic (superautomatic). The article marks several of its machine sections as needing more citations (check).

### How it developed

| YEAR | EVENT (FROM THE ARTICLES) |
|---|---|
| 1884 | Angelo Moriondo of Turin patents a steam-driven machine that brews in bulk (the machine article gives 16 May) |

| YEAR | EVENT (FROM THE ARTICLES) |
|---|---|
| 1901-1902 | Luigi Bezzera of Milan applies for (Dec 1901) and is granted (Jun 1902) patents for individual servings |
| 1903-1905 | Desiderio Pavoni buys the patents and begins selling machines, generally considered the first commercial espresso machines |
| 1935 | Francesco Illy patents the compressed-air Illetta |
| 1938-1948 | Achille Gaggia patents a hand-pulled piston design (1938); the piston machine goes on sale in 1947 to 1948 and is marketed as "crema caffe" |
| 1961 | Ernesto Valente invents the Faema E61 with an electric pump to 9 bar |
| 1970 | The La Marzocco GS is the first dual boiler (machine article) |

The machine article dates Gaggia's piston machine to 1945, while the espresso article has the patent in 1938 and sales in 1947 to 1948; these may be different milestones, but I did not resolve which is which (check).

## Milk Drinks

The Espresso article lists drink volumes; the Cappuccino article adds composition.

| DRINK | VOLUME (ESPRESSO ARTICLE) | WHAT IT IS |
|---|---|---|
| Macchiato | 30 to 40 ml | Espresso with milk foam |
| Americano | 150 to 180 ml | Espresso topped with hot water, a 1:5 ratio |
| Long black | 150 to 180 ml | Espresso poured over hot water |
| Cappuccino | 150 to 180 ml | A large amount of milk and foam |
| Caffè latte | 250 to 280 ml | At least 210 g of milk at 58 to 70 °C |
| Latte macchiato | 250 ml | Milk and foam first, then espresso |

The Cappuccino article gives the traditional ratio as equal thirds of espresso, steamed milk and milk foam, with the Italian standard being 25 ml of espresso and the rest of the cup split evenly between milk and foam. Milk is steamed to about 55 to 65 °C, and World Barista Championship rules want foam at least 1 cm deep. The traditional cup is small with a handle, 180 ml at most; chains in the US often serve 360 ml or more. The same article says a latte has the same espresso

with more milk and microfoam (200 to 300 ml), a flat white is a cappuccino with textured milk and little or no foam on top in a small cup, and a macchiato is a much shorter drink with only a little milk.

> **THE NAME**
>
> Cappuccino refers to the colour of Capuchin friars' robes. The popular story that it was named after Marco d'Aviano is called "popular but unverified" in the article, and the Italian word is first documented in the 19th century.

## Code: Shot Arithmetic

The script below works with the INEI numbers: the ratio of drink volume to dose, basket scaling, and a 150 ml cappuccino split. I ran it to get the output shown.

```
BASKET_DOSE_G = {"single": 7, "double": 14, "triple": 21}

def shot_ratio(dose_g, yield_ml):
    return yield_ml / dose_g

print("Standard shot (7 g -> 25 ml):", f"1:{shot_ratio(7, 25):.1f}")
for name, dose in BASKET_DOSE_G.items():
    print(f"{name} basket: {dose} g -> about {dose * 25 / 7:.0f} ml at the same ratio")

for name, ml in [("ristretto", 20), ("espresso", 25), ("lungo", 60)]:
    print(f"{name}: {ml} ml from 7 g = 1:{shot_ratio(7, ml):.1f}")

total = 150
espresso = 25
rest = total - espresso
print(f"Cappuccino {total} ml: {espresso} ml espresso + {rest/2:.1f} ml milk + {rest/2:.
print(f"Americano at 1:5 from a 25 ml shot: {25 * 5} ml of drink total")

def c_to_f(c):
    return c * 9 / 5 + 32
print(f"Milk 55-65 C = {c_to_f(55):.0f}-{c_to_f(65):.0f} F")
```

```
# Output
Standard shot (7 g -> 25 ml): 1:3.6
```

```
single basket: 7 g -> about 25 ml at the same ratio
double basket: 14 g -> about 50 ml at the same ratio
triple basket: 21 g -> about 75 ml at the same ratio
ristretto: 20 ml from 7 g = 1:2.9
espresso: 25 ml from 7 g = 1:3.6
lungo: 60 ml from 7 g = 1:8.6
Cappuccino 150 ml: 25 ml espresso + 62.5 ml milk + 62.5 ml foam
Americano at 1:5 from a 25 ml shot: 125 ml of drink total
Milk 55-65 C = 131-149 F
```

**READING THE OUTPUT**

By volume a standard shot is about 1:3.6, not the 1:2 of chapter 6. That figure was by weight, and a shot with crema takes up more volume than it weighs, so the two are not directly comparable (my explanation, not the article's; check). The Americano line gives 125 ml, below the article's 150 to 180 ml, so the article's drink size and its 1:5 ratio do not obviously fit a single 25 ml shot; perhaps a double shot is meant, which I could not confirm (check).

## Not Yet Verified, and Sources

- **Sources.** Wikipedia articles Espresso, Espresso machine and Cappuccino. The Espresso article is about 126,000 characters and I read the first 100,000; the unread tail looked like navigation and templates. The Cappuccino article was read to about 100,000 of 106,000 characters. I saw them through a summarising tool.
- **Conflicts.** Espresso temperature (88 versus 91 to 95 °C), pressure ranges, Gaggia's dates, latte volume (250 to 280 ml versus 200 to 300 ml across articles), the "caffè crema" volume inside the Espresso article, and the Americano ratio. Not resolved.
- **Weak support.** Several machine-article sections are marked as needing more citations.
- **Not in the pages read.** A numeric brew temperature in the machine article, tamping pressure, and the flat white's exact size (all marked check).
- **Not tested.** I made no drinks; the script is arithmetic only.

## Exercises

**EXERCISE 1**

Describe the INEI reference shot in one sentence (dose, pressure, time, volume). Then name two reasons the chapter gives for treating its numbers cautiously.

→ Solution

**EXERCISE 2**

Use the script to work out the volume and dose ratio for a ristretto from a double basket (14 g) giving 40 ml, and the milk and foam amounts for a 180 ml cappuccino with a 25 ml shot. Run it and compare with the traditional equal-thirds rule.

→ Solution

**EXERCISE 3**

Make a table of the drinks in the chapter ordered by size, with one distinguishing feature each. Then pick one pair that the articles describe differently (for example latte and cappuccino) and explain the difference.

→ Solution

**QUICK REFERENCE**

- **INEI shot:** 7 g, 9 bar, 25 seconds, 25 ml, 88 °C at the unit
- **Variants:** ristretto about 20 ml, lungo about 60 ml
- **Machine milestones:** 1884 Moriondo, 1901 Bezzera, 1903 Pavoni, 1961 Faema E61
- **Cappuccino:** thirds of espresso, milk and foam; milk 55 to 65 °C
- **Latte:** more milk and microfoam; 200 to 300 ml

**COMING NEXT**

Coffee Fundamentals 9 moves from making coffee to tasting it.

## Tasting on Purpose

Drinking a coffee and *tasting* it are different. The industry's method is called **cupping**, and Wikipedia's articles on Coffee cupping, Coffee taster and Specialty coffee describe what it looks for. The chapter covers only what those pages say; they leave out several details that cupping guides usually give, and I list those below instead of filling them in from memory.

## The Method

1. Dry grounds are sampled first: tasters run a finger through the grounds and smell them. The article describes trays of green, whole roasted and ground coffee.
2. Hot water is used, which the article says is "typically just below boiling temperature". This is the only temperature it gives.
3. The coffee is tasted from a cupping spoon. The taster deeply sniffs it, then slurps it so that it is "aerated and spread across the tongue".
4. Each spoonful is about 4 to 5 ml.

The traditional cup is an 8 oz glass, "such as a whiskey glass", so colour and foam can be seen. Ideally the coffee is roasted and ground immediately before tasting. The Coffee taster article says cupping became standard industry practice in the late 19th century, linked to Hills Brothers Coffee of San Francisco.

> **WHAT THE PAGES DO NOT SAY**
>
> The articles I read give no coffee-to-water ratio for cupping, no steeping times, no crust-breaking step, no scoring form details and no recommended roast level. A formal cupping protocol covers all of these, but I have not verified any of the numbers, so I give none (check).

## What Tasters Judge

| ATTRIBUTE | WHAT THE ARTICLES SAY |
|---|---|
| Body | The drink's physical properties, from thin to full, like skim versus whole milk |
| Sweetness | Named as a judged attribute |
| Acidity | A desirable sharp taste, distinct from sourness |
| Flavour | The overall taste and aroma impression |
| Aftertaste | What stays after swallowing |

The Coffee taster article groups vocabulary into three sets.

| GROUP | TERMS LISTED |
|---|---|
| Aroma | Animal-like, ashy, burnt or smoky, chemical or medicinal, chocolate-like, caramel, cereal, malty or toast-like, earthy, floral, fruity or citrussy, grassy, green or herbal, nutty, rancid or rotten, rubber-like, spicy, tobacco, winey, woody |
| Basic tastes | Acidity, bitterness, sweetness, saltiness, sourness |
| Mouthfeel | Body, astringency |

That article does not describe a flavour wheel; it only links to a guide to one. Nor does it describe how tasters are trained or certified, naming only the title Q Graders for professionals. Cupping can also be done informally by anyone, and tasters may try to identify the coffee's origin.

## Specialty Coffee and the 100-Point Scale

The Specialty coffee article says the term was first used in 1974 by Erna Knutsen for beans of the "best flavor" grown in special micro-climates. The widely accepted definition today is coffee that scores 80 or above on the 100-point Specialty Coffee Association (SCA) cupping form. It lists three bands:

| SCORE | GRADE |
|---|---|
| 90 to 100 | Outstanding |
| 85 to 89.99 | Excellent |
| 80 to 84.99 | Very Good |

The article adds that specialty coffee has 0 to 5 defects per 350 g of milled beans and is hand-picked from mature beans by selective picking. That connects to chapter 3, which said a 350 g sample is graded and that any category-one defect excludes specialty grade; the two statements fit together but are not the same wording (check). The article says flavour is shaped by climate, altitude, rainfall and grower skill, and that specialty coffee varies from harvest to harvest, unlike commercial blends, which aim for consistency. It also mentions the "Third Wave of Coffee", relating to farmers and brewers and a demand for exceptional quality, without explaining it further.

## Code: Scores and Sips

The script below turns a score into the article's grade, converts the 8 oz cup, and shows how little of a cup one slurp is. I ran it to get the output shown.

```
def grade(score):
    if score >= 90: return "Outstanding"
    if score >= 85: return "Excellent"
    if score >= 80: return "Very Good"
    return "Below specialty (under 80)"

for s in (92.5, 86, 80.25, 79.75):
    print(f"{s} -> {grade(s)}")

OZ_TO_ML = 29.5735
cup_ml = 8 * OZ_TO_ML
print(f"8 oz cup = {cup_ml:.0f} ml")
for sip in (4, 5):
    print(f"A {sip} ml slurp is {sip / cup_ml:.1%} of the cup")

print(f"350 g sample: 5 defects = {5 / 350 * 1000:.1f} per kg at the upper limit")
```

```
# Output
92.5 -> Outstanding
86 -> Excellent
80.25 -> Very Good
79.75 -> Below specialty (under 80)
8 oz cup = 237 ml
A 4 ml slurp is 1.7% of the cup
```

```
A 5 ml slurp is 2.1% of the cup
350 g sample: 5 defects = 14.3 per kg at the upper limit
```

**READING THE OUTPUT**

A single slurp is only about 2 percent of an 8 oz cup, which is why a cupper can taste many cups in a row. The 79.75 case shows the 80-point line is a hard edge: the article's bands start at 80, and I assumed that scores between 79.99 and 80 round the way the code does (check). The defects-per-kilogram line is only a unit conversion of the 350 g figure.

## Not Yet Verified, and Sources

- **Sources.** Wikipedia articles Coffee cupping, Coffee taster and Specialty coffee. The extracts looked complete and the missing items were absent from the articles, not cut off, but I saw them through a summarising tool.
- **Not in the pages read.** Cupping ratio, steeping times, crust-breaking, score sheet categories, roast level for cupping, flavour wheel contents and tasting training (all deliberately omitted or marked check).
- **Possible overlap.** The defect statements here and in chapter 3 are consistent but worded differently; I did not reconcile the exact categories.
- **Not tested.** I did no tasting; the script is arithmetic and a lookup only.

## Exercises

**EXERCISE 1**

Describe the slurping method in your own words and give two reasons the articles or chapter suggest for it. Say which part is the article's claim and which is your inference.

→ Solution

**EXERCISE 2**

Use the script to grade scores of 89.99, 90, 84.99 and 85, and add a line giving the volume in ml of a 6 oz cup and what fraction a 5 ml slurp is. Run it and say which grade 84.99 lands in.

→ Solution

**EXERCISE 3**

Taste two different coffees side by side (or one coffee made two ways). For each, write a short note covering body, sweetness, acidity, flavour and aftertaste in your own words, using at least two terms from the aroma list. Then say what you think caused any differences, marking guesses "(check)".

→ Solution

### QUICK REFERENCE

- **Cupping:** sniff, then slurp about 4 to 5 ml from a spoon; hot water just below boiling
- **Judged:** body, sweetness, acidity, flavour, aftertaste
- **Specialty:** 80 or more on the SCA 100-point scale; 0 to 5 defects per 350 g
- **Bands:** 80 Very Good, 85 Excellent, 90 Outstanding
- **First use of "specialty":** 1974, Erna Knutsen

**COMING NEXT**

Coffee Fundamentals 10 covers buying, storing and troubleshooting.

# Coffee Fundamentals

Course 1 · Chapter 10 · Buying, Storing and Troubleshooting

## Storing Coffee

Storage advice in the sources is thin. Wikipedia's Coffee roasting article, covered in Coffee Fundamentals 4, gives an optimal shelf life of about two weeks for roasted coffee and about 15 minutes for ground coffee. It also says green coffee can be stored about 12 to 18 months in a climate-controlled setting before quality loss is noticeable, and that whole roasted beans can stay fresh up to a month if kept cool (marked "citation needed" on the page). Roasted coffee gives off carbon dioxide, so bags with a one-way valve let gas out. The Coffee article has a photo caption for a bag with a ziplock and one-way valve "to prevent mold". Coffee Fundamentals 5 explained why ground coffee goes stale faster: more surface is exposed.

**WHAT I COULD NOT VERIFY**

The pages I read do not say whether to keep coffee in a fridge or freezer, which container is best, or how light affects it. Many guides give firm advice on these; I have not checked any of it, so I give none here (check).

## Buying

What the course has already shown gives a short buying checklist. Each point links to a chapter, and the numbers are from that chapter's sources.

| LOOK FOR | WHY (CHAPTER) |
|---|---|
| Species | Arabica is sweeter, robusta more bitter with 40 to 50 percent more caffeine (Coffee Fundamentals 1) |
| Origin and harvest | Where and when it grew shapes the cup; specialty coffee varies from harvest to harvest (Coffee Fundamentals 2 and 9) |
| Processing method | Dry, washed, honey or wet-hulled change the cup (Coffee Fundamentals 3) |
| Roast level | Lighter keeps more acidity; darker is less dense (Coffee Fundamentals 4) |

| LOOK FOR | WHY (CHAPTER) |
|---|---|
| **Whole beans** | Ground coffee loses freshness fast, so grind at home (Coffee Fundamentals 5) |
| **Roast date, not just best-before** | Optimal shelf life is about two weeks after roasting (Coffee Fundamentals 4; check whether the bag prints one) |

The Coffee article says specialty coffee has driven demand for traceable coffee, such as single-origin or single-farm lots. Some roasters trade directly with producers, or "fairly trade" without certification, usually only for high-quality coffee, and some coffee is sold through competitions and online auctions, which can make final prices more transparent.

## Ethical Labels

Wikipedia's Fair trade coffee article defines the coffee as certified to fair-trade standards, aiming for greater equity in international trade and prohibiting child or forced labour. The Coffee article says fair trade labelling, which guarantees growers a negotiated price before harvest, began in the late 1980s with the Max Havelaar Foundation in the Netherlands. Fairtrade International sets standards and its subsidiary FLO-CERT certifies; the article names competing labels as Bird-Friendly Coffee, Rainforest Alliance and UTZ Certified.

> **OUT-OF-DATE PRICES, MIXED EVIDENCE**
>
> The minimum prices on the page (for example 1.40 per pound for arabica) come from 2011 to 2013 sources and are likely outdated, so I do not quote them as current. The evidence on impact is mixed: one study found certification has generally had little effect on wages, farmers often cannot sell all their output as fair trade, and critics call it ethical consumerism. A 2005 Belgian study cited in the Coffee article found most respondents unwilling to pay the 27 percent premium. The labels are a starting point, not a verdict (check).

## Decaf

Wikipedia's Decaffeination article says caffeine is removed from the *green* beans, before roasting. The legal standard varies:

| PLACE | STANDARD |
|---|---|
| United States (FDA) | At least 97 percent of the caffeine removed |

| PLACE | STANDARD |
|---|---|
| European Union | Green beans 99.9 percent caffeine-free by mass |
| Canada | Less than 0.1 percent caffeine (decaf instant coffee less than 0.3 percent) |

A 2006 study found decaf drinks typically retain 1 to 2 percent of the original caffeine, sometimes as much as 20 percent. The main methods are an organic solvent (direct or indirect), water (the Swiss Water method, 8 to 10 hours, using green coffee extract and activated carbon), triglyceride soaking in coffee oils, and supercritical carbon dioxide (about 300 atmospheres and 65 °C). The methods aim to leave flavour precursors as close to their original state as possible. So decaf is not caffeine-free, though much lower.

## How Much Caffeine?

The Coffee article gives 40 mg per 100 ml for typical brewed coffee and 212 mg per 100 ml for restaurant espresso, notes that 3 to 4 cups a day (300 to 400 mg of caffeine) do not pose health risks for adults, and mentions possible risks including increased bone fracture risk in women and risk to pregnancy. It also quotes the American Heart Association (2026) saying up to five cups a day, about 400 mg, may benefit cardiovascular health in some people. This is general information, not medical advice; ask a doctor about your own situation.

## Code: Caffeine and Decaf Arithmetic

The script turns those figures into amounts. I ran it to get the output shown.

```
def caffeine_mg(volume_ml, mg_per_100ml):
    return volume_ml / 100 * mg_per_100ml

print(f"240 ml brewed at 40 mg/100 ml: {caffeine_mg(240, 40):.0f} mg")
print(f"30 ml espresso at 212 mg/100 ml: {caffeine_mg(30, 212):.0f} mg")
print(f"Brewed volume holding 400 mg: {400 / 40 * 100:.0f} ml")
print(f"3-4 cups of 240 ml brewed: {3 * caffeine_mg(240, 40):.0f}-{4 * caffeine_mg(240, 4

for removed in (0.97, 0.999):
    print(f"{removed:.1%} removed from 100 mg leaves {100 * (1 - removed):.1f} mg")
```

```
print(f"Fair trade share 2004: {24222 / 7050000:.2%}, 2005: {33991 / 6685000:.2%}")
```

```
# Output
240 ml brewed at 40 mg/100 ml: 96 mg
30 ml espresso at 212 mg/100 ml: 64 mg
Brewed volume holding 400 mg: 1000 ml
3-4 cups of 240 ml brewed: 288-384 mg
97.0% removed from 100 mg leaves 3.0 mg
99.9% removed from 100 mg leaves 0.1 mg
Fair trade share 2004: 0.34%, 2005: 0.51%
```

**WHAT THE OUTPUT SHOWS**

Per drink, a 30 ml espresso (64 mg) holds less caffeine than a 240 ml cup of filter coffee (96 mg), even though espresso is much stronger per millilitre. The 3 to 4 cups give 288 to 384 mg, consistent with the article's 300 to 400 mg. The fair trade shares match the 0.34 and 0.51 percent the article gives. The article also gives a 1979 espresso figure of 100 mg per 45 to 60 ml, which is a different measurement from 212 mg per 100 ml (about 64 mg for 30 ml versus about 100 mg per 45 to 60 ml); these are not reconciled (check).

## Troubleshooting the Whole Course

| SYMPTOM | LIKELY CAUSE (FROM THE COURSE) | WHERE TO LOOK |
|---|---|---|
| Bitter, harsh | Grind too fine, water too hot, or left on grounds | Coffee Fundamentals 5, 6 and 7 |
| Weak, thin | Grind too coarse or too little coffee | Coffee Fundamentals 5 and 6 |
| Gritty cup from a press | Grounds too fine for the filter | Coffee Fundamentals 7 |
| Flat, stale | Ground long ago or roasted weeks ago | Coffee Fundamentals 4 and 5 |
| Different every day | Measuring by scoop, not weight; uneven grind | Coffee Fundamentals 1 and 5 |

| SYMPTOM | LIKELY CAUSE (FROM THE COURSE) | WHERE TO LOOK |
|---|---|---|
| Slow-draining filter | Grind too fine | Coffee Fundamentals 5 |
| Espresso too fast or too slow | Dose, grind, or pressure off the reference shot (the sources give targets, not fixes) | Coffee Fundamentals 8 (check) |

## What You Can Do Now

You can say where coffee comes from and why, how processing and roasting change the seed, why grind size and ratio matter, and how the main brewing families differ. You know the language professionals use to taste it and some of the questions to ask when buying. The course relied on a handful of reference pages, so treat the figures as a starting point and trust your own tasting.

## Not Yet Verified, and Sources

- **Sources.** Wikipedia articles Coffee (second part, characters 100,000 to 200,000 of about 251,000), Decaffeination and Fair trade coffee, plus earlier chapters' articles. The last quarter of the Coffee article was still not read. Sources were seen through a summarising tool.
- **Not in the pages read.** Storage advice for fridge, freezer, containers and light, and how to read bag labels such as roast dates (all marked check).
- **Out of date.** The fair trade minimum prices are from 2011 to 2013 and are not quoted as current.
- **Not reconciled.** The espresso caffeine figures in the Coffee article (212 mg per 100 ml versus 100 mg per 45 to 60 ml).
- **Health.** The caffeine and health statements are the article's summary, not medical advice.

## Exercises

**EXERCISE 1**

Write a five-point plan for buying and keeping coffee, using only the chapter's sources. Mark any point that goes beyond them with "(check)".

→ Solution

**EXERCISE 2**

Use the script to find the caffeine in a 350 ml brewed coffee and in two 30 ml espressos, and the caffeine left in 250 mg of beans' worth at the FDA 97 percent and EU 99.9 percent standards. Run it and compare.

→ Solution

**EXERCISE 3**

A cup tastes bitter, thin and stale all at once. Using the troubleshooting table, list the three most likely causes, one change for each, and the order in which you would try them. Explain your order.

→ Solution

### QUICK REFERENCE

- **Freshness:** roasted about two weeks, ground about 15 minutes, green 12 to 18 months
- **Decaf:** US 97 percent removed; EU 99.9 percent; made on green beans
- **Caffeine:** brewed about 40 mg per 100 ml; 3 to 4 cups a day reported as no risk for adults
- **Labels:** Fairtrade, Bird-Friendly, Rainforest Alliance, UTZ; mixed evidence
- **Troubleshooting:** weigh, grind fresh, adjust one thing at a time

**COURSE COMPLETE**

This is the last chapter of Coffee Fundamentals. Revisit chapters 5 to 7 whenever a brew goes wrong.