

Espresso, Filter Coffee, Cold Brew, French Press or Moka: Which Has the Most Caffeine Content?

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Coffee is a highly complex matrix, influenced by a wide range of variables across origin, processing, and roasting. For this reason, defining universal rules or general statements remains inherently challenging. In this study **Accademia Del Caffè** Espresso teamed up with **CDR CoffeeLab®** to look closer at the caffeine content of several coffee beverages brewed with different extraction methods. There is substantial research on caffeine and its safe consumption levels. On average, the recommended maximum intake is 400 mg of caffeine per day, although this threshold can vary depending on individual sensitivity and physiological factors.

The aim of this study is to quantify the caffeine content in the most common coffee beverages, taking into account its strong dependence on both the characteristics of the raw material and the preparation method used. The study was designed to evaluate caffeine variability by combining different roasting levels and brewing techniques starting from a single origin coffee.

Study Overview

- **Origin:** Brazil, Cerrado Mineiro (Arabica, Yellow Catuai, Natural, 950 amsl)
- **Roasting:** Light | Medium | Dark
- **Brewing methods:** Espresso (extraction with 9 bar), Filter Coffee (V60), French Press, Moka, Cold Brew (Toddy® Home Unit, full immersion and gravitation)

Does roasted coffee contains more caffeine than green coffee?

From the results obtained, caffeine content in roasted coffee appears to be higher than that found in green coffee beans. However, this increase is only apparent, as the caffeine content itself does not change during the roasting process. During roasting, moisture loss leads to a concentration effect, increasing the amount of caffeine per unit weight. To verify this hypothesis, caffeine concentration was first measured in green coffee. The same coffee was then roasted using three different profiles, and the theoretical caffeine content in the roasted samples was calculated based exclusively on weight loss. Experimental measurements of caffeine in roasted coffee were subsequently carried out. The agreement between measured and calculated values confirms the hypothesis: the darker the roast, the greater the moisture loss and,

consequently, the higher the caffeine concentration per unit weight.

	End temperature (°C)	Roast time (h)	Green weight (g)	Roasted weight (g)	Roast color ground	Weight loss (%)	Caffeine: theoretical value (%)	Caffeine: experimental value (%)
Green								1.3
Light roast	209.6	09:02	3000	2585	104.9	-13.80	1.4	1.4
Medium roast	215.4	10:11	3000	2548	85.9	-15.00	1.4	1.4
Dark roast	235.1	11:05	3000	2444	54.0	-18.50	1.5	1.5

Table 1: Information about roasting process.

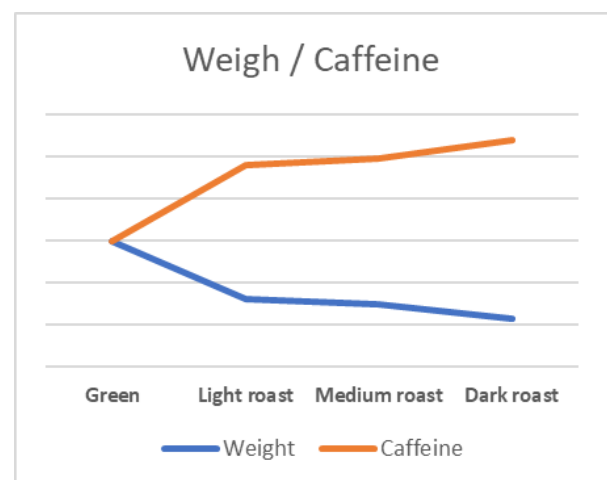
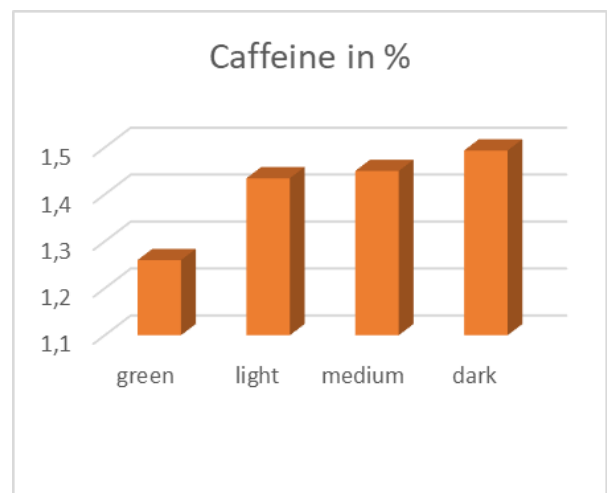


Figure 1: Changes in caffeine concentration as the roast level varies.

How much caffeine is actually in a cup of coffee?

Brewing Method	Cup	Brew ratio
Espresso	30 ml	1:2
Filter coffee (V60)	150 ml	1:17
French press	150 ml	1:17
Moka	50 ml	1:8
Cold Brew ready to drink	150 ml	1:14
Cold Brew concentrate	30 ml	1:4

Table 2: Brew ratios and coffee volumes used for each brewing method. These volumes were used to calculate the caffeine content per cup.

Knowing the exact amount of caffeine, you consume when drinking a cup of coffee isn't that simple: the concentration in a cup depends on numerous variables, with the variety and origin of the coffee being particularly crucial. Within the two main coffee species, **Coffea Arabica** and **Coffea Canephora (Robusta)**, there are numerous different varieties and cultivars that contain varying amounts of caffeine. Even when using the same raw material, the caffeine content in the final beverage can vary significantly depending on the extraction method chosen, the brew ratio, and the roast level of the beans.

In this study, 18 coffee samples were analyzed to **determine caffeine content**; all were prepared using the same green coffee bean but with 3 different roast levels and 6 different extraction methods. Figure 2 shows the caffeine content measured in the various beverages, with different roasts (the coffee volumes associated with these beverages are listed in Table 2).

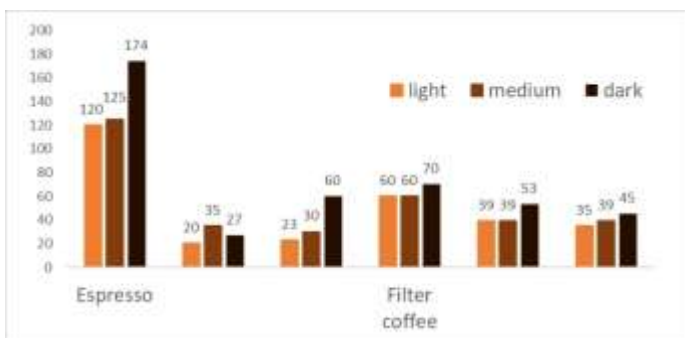


Figure 2: Caffeine content (mg) measured in different beverages.

Espresso is a method of brewing coffee that concentrates not only the aromas and sensory characteristics but also the caffeine. In the case of espresso (30 mL, prepared with a brew ratio of 1:2), caffeine levels exceeding

120 mg per serving were detected, reaching values up to six times higher than those in a cup (150 mL) of filter coffee.

Results similar to those of filter coffee were obtained with the French Press, while the values were higher with the moka pot.

Special attention should be given to the results obtained with cold brew coffee. This cold-extracted beverage can be prepared in various ways: by percolation/dripping or by infusion, using cold or room-temperature water, with varying infusion times (from 6 to 12 hours or more), and with different brew ratios. In this study, we used the Toddy® Home Cold Brew System with a 12-hour infusion time and two different brew ratios: a more concentrated one, with a ratio of 250 g of coffee to 1 liter of water, and a more diluted one (ready-to-drink: 60 g of coffee to 1 liter of water). The caffeine content in ready-to-drink cold brew is comparable to that of filter coffee, as the brew ratio and beverage volume are similar. Caffeine extraction in cold brew occurs due to the prolonged contact time between the coffee and water at a temperature of 20–25°C, and the concentration of this substance in the final beverage is higher than that found in filter coffee, where the extraction temperature is higher but the contact time is shorter.

For ready-to-drink cold brew, we considered a 150-ml serving, while for concentrated cold brew, we used a 30-ml serving that can then be further diluted with ice, milk, or plain cold water. For this reason, the calculated caffeine values are similar to those of ready-to-drink cold brew.

Does a Darker Roast Really Contain More Caffeine?

With a darker roast, the caffeine content of the beans increases slightly on a weight-for-weight basis due to moisture loss. However, the differences in caffeine content measured between light- and dark-roasted coffee are not sufficient to explain the variations observed in the final beverages.

Furthermore, in the case of filter coffee, there is no evidence of an increasing trend in caffeine content in beverages prepared using the same extraction method but with different roast levels, from light to dark.

Dark-roasted coffee contains more caffeine available for extraction, but this does not necessarily mean that the extraction method used will be able to extract all the caffeine present in the ground beans. The contact time between the water and the coffee, as well as the water temperature during preparation, certainly influence the amount of caffeine in the cup. Another key factor to consider is the dynamics of water extraction: the ease with

which water passes through the ground coffee determines the level of extraction and, consequently, the caffeine concentration in the final beverage. This explains why we observe an anomalous trend in caffeine concentration in the case of filter coffee. This extraction method is less efficient than the others examined, which accounts for the variable trend in caffeine concentrations found in the different brews. When calculating extraction percentages (mg of caffeine in the beverage/mg of caffeine in the coffee beans), the moka pot proves to be the method that most effectively extracts the caffeine from the coffee beans. Thanks to water temperatures exceeding 90°C and the extraction time, this method is particularly efficient at extracting caffeine. Despite this, due to the much lower brew ratio compared to espresso, the cups of moka coffee had a lower caffeine concentration than espresso.

Figure 3 shows how caffeine concentrations in the beverage and TDS (Total Dissolved Solids) are linked, highlighting the importance of extraction in caffeine concentration. Obviously, the values do not match exactly because TDS also includes other substances that are not proportional to caffeine.

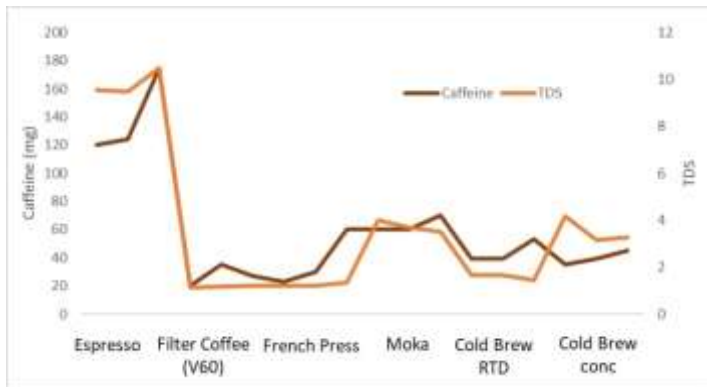


Figure 3: Variation in caffeine content (in mg) and TDS in different beverages.

Conclusions

The results of the analyses, performed by **CDR CoffeeLab®**, confirm that **caffeine** content in coffee beverages is not determined by a single factor, but by the interaction between raw material, roasting, and extraction method. Roasting does not increase the total caffeine content in coffee beans; the observed increase is due only to **moisture loss**, which concentrates caffeine per unit weight. However, roast level alone does not explain the differences found in the final beverages. The **brewing method is the main factor influencing caffeine content in the cup**. Espresso shows the highest caffeine levels per serving, while filter coffee and French press result in lower concentrations due to different extraction dynamics. Cold brew highlights the importance of **contact time and brew ratio** in caffeine extraction. In general, a higher caffeine intake is often associated with dark roast coffee. However, this is not due to a higher intrinsic caffeine content, but rather to **more efficient extraction**, as darker roasted coffee tends to facilitate the release of caffeine during brewing. Overall, caffeine content is primarily governed by **extraction conditions**, including temperature, time, pressure, and water flow through the coffee bed.