

# Water Reduces Ground Coffee's Charge

Adding water to coffee beans before grinding can reduce the buildup of static charge—and make a stronger espresso.

By **Rachel Berkowitz**

Chris Hendon and his colleagues at the University of Oregon love free espresso, which Hendon serves up at coffee hour. They also all study granular systems that, like freshly ground beans, are electrified. Now Hendon and some of those colleagues have uncovered how electrical charge accumulates in coffee grounds and how that charge impacts the properties of the resulting beverage [1]. The team's findings suggest that adding a few drops of water to whole beans before grinding could improve the quality of the espresso brewed.

Scientists know that granular materials can accumulate electrical charge (electrons) when granules fracture or rub against each other. Charged granules can also exchange electrons when they collide. In nature, the dazzling lightning storms that occur during large volcanic eruptions are perhaps the most dramatic examples of this electrification. Similar

processes also occur when a coffee grinder pulverizes beans and can cause the coffee grounds to clump and stick to surfaces. What scientists don't know though is how to predict the magnitude and polarity of the electric charge that builds up during coffee grinding.

Inspired by the goal of brewing the perfect espresso, Hendon and his colleagues started by measuring the charge that collected on 1 gram of coffee beans as the beans passed through a grinder and exited its chute. To do that they placed a metal cup under the chute and measured the net charge on the collected mass with an electrometer. In a separate experiment, the researchers replaced the metal cup with two electrodes angled such that the electrodes guided positive, neutral, and negative grounds into separate containers. They repeated the experiments for 30 commercially available coffee-bean types and for 12 home-roasted beans.

The researchers observed two main trends in the data. First, the charge per unit mass of grounds was higher for more finely ground coffee. Because of that, finer particles tended to stick to each other more, forming larger aggregates. Second, grounds made from more lightly roasted beans tended to be positively charged, while those made from darker roasts tended to be negatively charged. This trend was particularly strong for the home-roasted beans.

Roasting is a key factor in determining how much moisture coffee beans contain—unprocessed beans are 45%–55% water, while darkly roasted ones are around 8%–12% water, implying a link between water content and charge. To tease out this link, the researchers added droplets of water to roasted beans before grinding them. The team found that beans with more added



Adding a drop of water to coffee beans before grinding them can reduce in magnitude the static charging that occurs when the beans collide and fracture.

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water were more positively charged. They also found that the size distribution of the grounds decreased, indicating an absence of aggregates.

The experiments all show that internal moisture content is a good predictor of both the magnitude and polarity of the electrical charge of the ground beans and of their “clumpiness.” This finding could allow people to achieve a stronger brew, Hendon says. A compacted pile of unclumped coffee grounds contains less void space, slowing down the rate at which water percolates through the system. That slowdown increases the amount of coffee the water can extract. The team found that this additional extraction increased the concentration of the final espresso by up to 15% compared to that made using completely dry grounds. In the US, that increase could save a quarter of a million dollars in material costs, as baristas could use less coffee to achieve the same results, Hendon says.

“We were surprised by just how much finely ground coffee charges,” says team member Joshua Méndez Harper, a volcanologist now at Portland State University, Oregon. He notes that one grinder the team tried out was able to achieve the same magnitude of charging as that of ice particles in thunderclouds or ash particles in volcanic lightning. The effect

was especially pronounced in twice-ground beans, which the team says indicates that fracturing, not collisions, was the main cause of charging.

Scott Waitukaitis, an experimental physicist who studies soft and complex materials at the Institute of Science and Technology Austria says that while the new “bold and creative” study yielded robust results, the outcome is not a surprise. Water has been shown to be important in the electrification of systems ranging from thunderclouds to polymers, he says.

As well as coffee making, Alexa Van Eaton, a volcanologist at the US Geological Survey’s Cascades Volcano Observatory, Washington, says that the results could be relevant to lightning generation in a plume of ash. The coffee study reveals quantitative effects at the particle scale that are broadly applicable. “It’s also fun.”

Rachel Berkowitz is a Corresponding Editor for *Physics Magazine* based in Vancouver, Canada.

#### REFERENCES

1. J. Méndez Harper *et al.*, “Moisture-controlled triboelectrification during coffee grinding,” *Matter* (2023).