
Photographic Sciences
MILK
A visual viscosity evaluation of
various milk samples via splash analysis
Nutrition Facts
Serv Size 1 cup (240 mL)
Photography and Article
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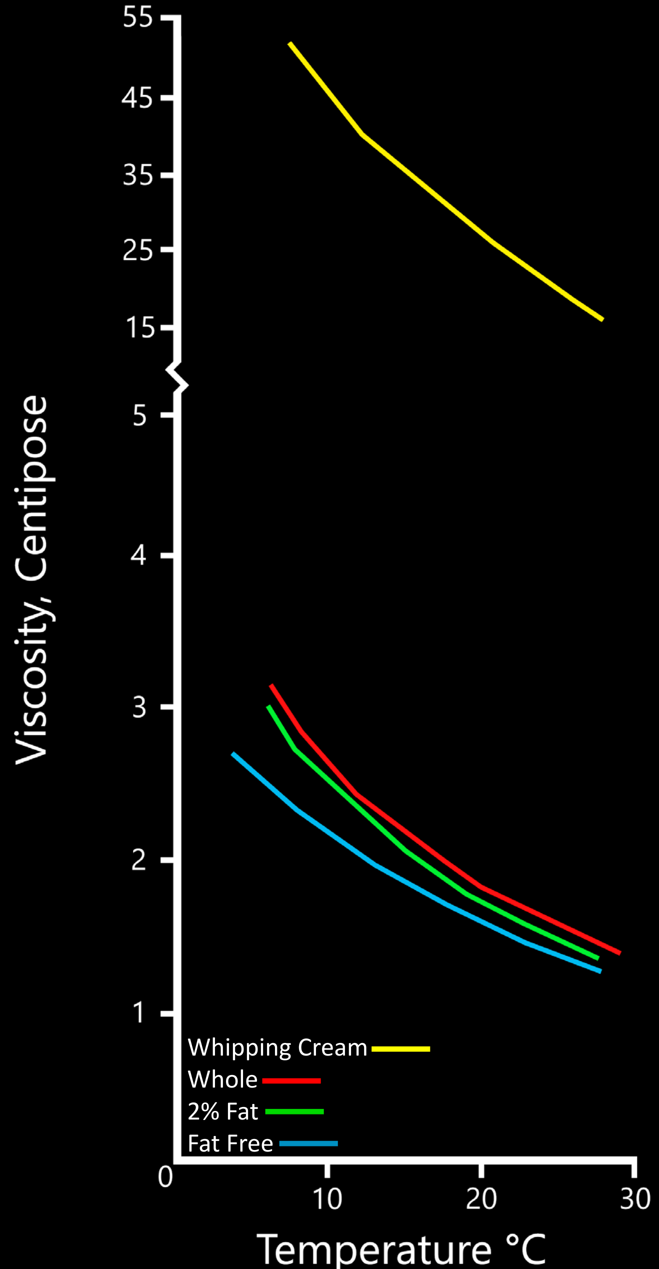
vis·cos·i·ty

Viscosity is the measurement of a fluid's resistance to flow. This is determined by the internal friction of the fluid. The unit generally used for the measurement of viscosity is the Pascal (Pa. s). The poise is often used for the measurement of dynamic viscosity which is a measure of stress the substance is exposed to whilst moving. Substances with a high viscosity will exhibit a greater "thickness" and generally move or drip much more slowly. Honey is a common substance with a higher viscosity.

Temperature is a powerful factor when calculating a fluid's visocity. As in the case with heavy whipping cream, a change of 10°C is enough to double it's viscosity. It is with this in mind, that I had to ensure the drip tests were done at the same temperature. 16 °C was the temperature chosen simply because this is the temperature the samples were chilled to by the refridgerator.

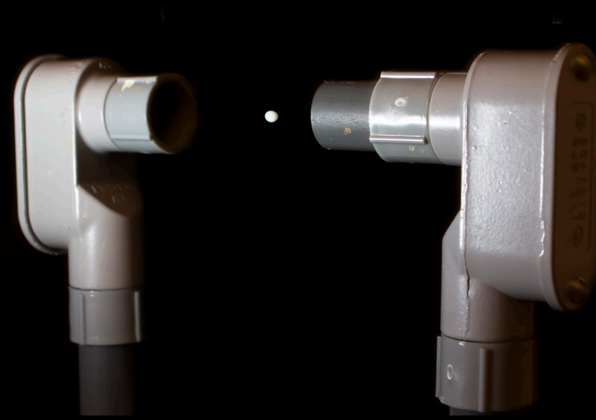


Journal of Dairy Science[1]

Imaging Setup

The following setup of equipment was utilized to create the images used throughout this document. A Cognysis Inc. Stopshot provided drip control, the highspeed laser triggering system to fire a Canon 600EX-RT flash set to a power of 1/136, and a timer to synchronize the two. The timer could adjust time by intervals of 100µs.Images were taken on a Canon 5D MkII, with a 100mm Macro Lens. Droplets were dispensed from the system's nozzle 30cm above the surface. In other scenarios, two droplets were dispensed during each imaging trial. Droplets would pass through the infrared "gate" situated below the nozzle, which then triggers the timer. After the set time has lapsed, the system would issue a pulse to the connected flash unit. The camera sits on a tripod, with the shutter open on the bulb setting.

Use of a low flash output is critical when doing high speed imaging. A higher flash output would result in the flash unit's bulb emitting light for a longer period of time. Despite the length of time increasing by magnitudes of microseconds, it is enough to introduce motion blur and ruin a potential image.



A ramekin was used as the vessel to contain the surface fluid for the droplets to collide with. The ramekin was filled with 300ml of milk, with a depth of roughly 31mm, and diameter of 108mm. Surface temperatures of the different milk types were measured using a infrared thermometer. The milk was chilled to roughly 16°C before the imaging took place, in order to reduce temperature skewing the final results.

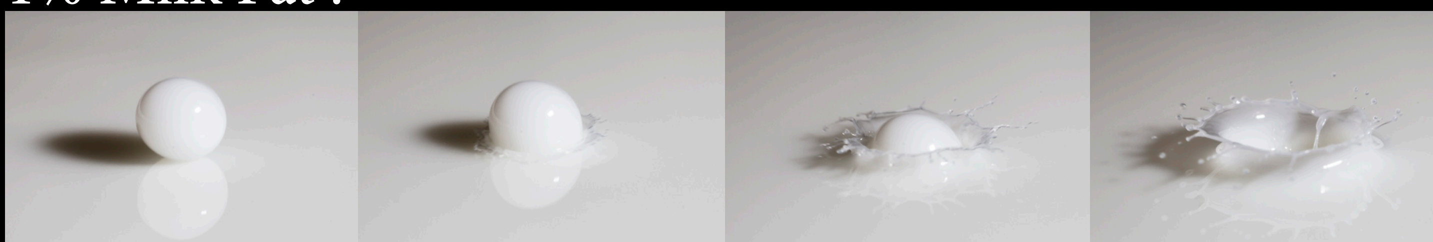
Splash Test

Droplet Nozzle 30cm above surface

Fat-Free Milk :

26.5ms after passing gate | 27.0ms | 27.5ms | 28.0ms

1% Milk Fat :

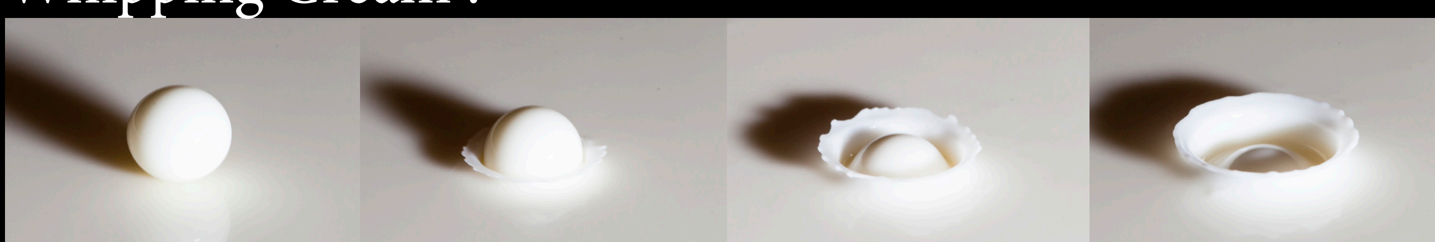


26.0ms after passing gate | 26.5ms | 27.0ms | 27.5ms

Whole Milk :

26.0ms after passing gate | 26.5ms | 27.0ms | 27.5ms

Whipping Cream :



26.0ms after passing gate | 26.5ms | 27.0ms | 27.5ms

Splash Analysis

Fat free, 2%, and Whole milk have for the mostpart similar structures and patterns when their droplet makes contact with the surface. One difference would be in the opacity of the splash itself. Fat free's thinner structures appear almost entirely transparent. This lends it a very watery appearance, which is to be expected considering it has the lowest viscosity of the four milk types.

2% Milk performed similarly to fat free. The splashes were slightly more opaque than that of fat free yet this is hardly an objective observation. Both have smaller droplets that go outward away from the crown of the splash. This effect is seen less in more viscous fluids, like in whole milk and whipping cream.

Whole milk at first appears similar to Fat free and 2% in form, yet the opacity becomes significantly more obvious. The splash itself has fewer droplets that spread out away from the crown, and has a much more rounded look to it later on in the splash. The higher viscosity prevents the crown from dispersing the smaller droplets, as seen in fat free and 2%. Whole milk however still has a relatively low viscosity. It still has a small amount of splashing, despite a more cohesive form.

Heavy whipping cream has virtually no smaller droplets that form from the crown. The opacity is not significantly different from whole milk. What appears to be consistent is that the higher the viscosity of a fluid, the smaller the splash that results. Greater internal friction would prohibit a greater spread of fluid during a splash.

Collision Analysis

These images involve the collisions of two seperate milk droplets. The lower droplet forms as a response to the original, and collides with a second droplet dispensed from the nozzle. The differences in fluid viscosity have slight effects on the structures and shapes of the collision splash. The first two images were made with 2% fat droplets colliding. The later image features whole milk droplets colliding. Greater viscosity increases internal friction, which may result in a lower rate of speed for the droplet that forms after the initial splash. As a result, the shape of the collision varies depending on the velocities of the two droplets

1. http://www.journalofdairyscience.org/article/S0022-0302%2884%2981417-4/pdf