Team 1 Report
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Purpose:

This image was created for the Team 1 assignment. The goal of the experiment was to capture the effect mixing a fatty solution, or milk, with a surfactant. This reaction would be tracked using food dye. Although the reaction created wildly vibrant displays of chemistry the post-reaction state showed the clear barriers between the resulting colors. These barriers were exploited using a slim, metal rod to stir the solution creating additional fluid phenomenon. Complementing the soap, various other additives were used in an attempt to enhance the reaction including glycerin, acetone, olive oil, and bleach. Each of the additives did have their own effect on the reaction but the final image was created using only the basics; milk, coloring, and soap.

Analysis:

The composition of milk is mostly water but contains vitamins, minerals, proteins, and small particles of fat suspended in solution. Whole milk will simply have less water and more compounds than skim milk which is intentionally watered down. The important components of milk that pertain to this experiment are the fats and proteins which are extremely sensitive to changes in the surrounding solution, or milk. The addition of dish soap alters the chemical bonds that hold the proteins in suspension causing them to rapidly, and semi-chaotically, spread throughout. The food coloring is along for the ride; as the proteins move the coloring droplets are drug along allowing the path of the proteins to be visible.

After the initial drop of soap is added it forms a micelle, or a cluster of soap molecules. This cluster has a special structure which allows it to "grab" fat molecules. Figure 1 shows a typical micelle.

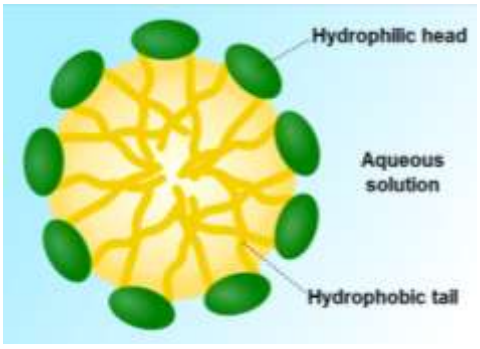

Figure 1: Simple diagram of a micelle.

The tails of the soap molecule are hydrophobic, forcing them inward and away from water, and lipophilic, which causes the tails to secure a fat molecule. The result is a fat molecule surrounded by soap molecules. As time passes, the micelle will distribute itself around the milk until both the soap and fat are evenly distributed. Once distributed, the motion in the milk will stop leaving a display of randomized wonder.

Another cause for the explosion of color is the change in surface tension. Since milk is primarily water, its surface will behave as such. This can be seen when the food coloring is first added and the droplets sit near the surface with minimal spreading. Dish soap is a surfactant

which will change the surface properties of the milk, or water. In this case the soap reduces the surface tension by dissolving fat molecules allowing the rapid mixing as described above.

This reaction took place inside a clear Pyrex circular dish, 9 inches across. The milk was filled to a depth at or just below one inch. Drops of food coloring were added in various places and followed by a small droplet of soap over each coloring drop, Figure 2. The reaction was immediate.

Figure 2: Preparing a sample of milk, coloring, and soap.

In the above figure, it can be seen that the Pyrex dish contains milk with a collection of food coloring droplets in the center of the dish into which the soap is being added. Once the surfactant was evenly mixed within the milk and the reaction stilled, a skinny rod was used to stir the solution creating a wonderful swirling effect. Without the rod, the color barriers would not be broken, but stirring allowed to the colors to flow together creating the psychedelic final image.

Visualization Technique:

The final product was created using standard food coloring to track the movements of the milk/soap reactions. The dye also was used to show the path of the rod as it passed between color layers. In order to ensure the maximum amount of reactions, whole milk, which has more fat and protein, was used. The temperature of the milk was close to room temperature by the time of the experiment although a thermal dependence is not suspected.

Lighting for the image came from background, standard room lighting. The light fixture shown in Figure 2 was very bright but gave a yellow hue to the image which was not desired.

Photographic Technique:

The camera used was a Canon EOS Rebel T2i, a digital SLR camera. The following table describes the settings used.

Shutter Speed	1/100 seconds
Aperture	5
F-Stop	f/5.6
ISO	800
Focal Length	68 mm
Flash	None
Final Image Size	5184 x 3456 pixels
Distance from Object	Approx. 33 cm

Table 1: Camera settings used for final image.

The final imaged was slightly tweaked using Photoshop where the brightness and the contrast were enhanced. A better lighting system for the original image might help reduce the need for post-capture processing.

Opinion of Image:

The artistic side of the final image in wonderful. It has great color and a very psychedelic feel. The lighting could have been better which would have reduced the need to use Photoshop and which would have kept the final image crisper. I also believe the image would have benefitted from fluid flow that was more complex. From this point, I would increase the lighting and use a time lapse to enhance the physics of the flow.

Sources:

References from technical journals on this topic were extremely difficult to find so I had to settle with internet sources.

http://www.stevespanglerscience.com/experiment/00000066

http://www.nipissingu.ca/education/jeffs/4284Winter/PDFS/MagicMilk.pdf

http://en.wikipedia.org/wiki/Surfactant