

Hold the (Broken) Mayo!

Although you were probably not aware of it, emulsions are very common around a household, as evidenced by several familiar foods and many cosmetics. Gourmet cooks and connoisseurs of fine sauces have long recognized the egg yolk as the mark of a classy sauce; one that is smooth and rich, with lots of oil or butter “held” into the water-based mixture. The secret of egg yolk is that it contains lecithin, a naturally-occurring emulsifying agent. Even so, the oil-holding capacity of a sauce is limited, and when too much oil is added (such as in mayonnaise), it “breaks” into two layers.

Some substances behave similarly to emulsifying agents, but their effect is temporary. For example, solid paprika and dry mustard help stabilize French dressing by collecting on the surfaces of the oil droplets. Honey and sugar syrup are used to thicken some salad dressings; shaking suspends the oil droplets and their coalescing again is retarded by the viscosity of the liquid.

Materials

- Vaseline® Intensive Care® (preferred) or other hand cream
- water
- 1/3 cup vegetable or mineral oil
- several small cups or plastic glasses
- teaspoon measure
- cup measure
- liquid dishwashing detergent
- clean towel or tissues
- (optional) beaten egg yolk or liquid soap
- (optional) additional vegetable or mineral oil
- (optional) 1 of the following emulsions:
 - second brand of hand cream
 - hair conditioner
 - mayonnaise
 - French dressing
 - hollandaise sauce

Safety

You may dispose of each mixture down the drain.

Exploration

- Step 1 Pour a little Vaseline Intensive Care (or other hand cream) into your palm and examine its appearance and feel. Wipe your hands with a clean towel or tissues. Does the hand cream label provide any clues as to whether it would be soluble in water and/or in oil?
- Step 2 Pour about 1 teaspoon Vaseline Intensive Care (or other hand cream) into a small cup or plastic glass. Add about 1/3 cup water and stir for several minutes. Use a dry finger to lightly touch the top of the liquid mixture. Record your observation(s) of sight and touch,

- including a comparison to those of Step 1. Explain what has happened to the components of the hand cream. What does this tell you about the ability of hand cream to hold water?
- Step 3 Pour about 2 teaspoons of liquid dishwashing detergent into a clean cup. Stir in about 1/2 teaspoon of the mixture from Step 2. Continue adding a little at a time until all the mixture has been stirred in. Compare your observations to those of Step 2 (neglect any suds). What can you say has happened to the components of the hand cream? What chemical term describes this functioning of a liquid detergent?
- Step 4 Pour about 1 teaspoon Vaseline Intensive Care (or other hand cream) into a small cup or plastic glass. Add about 1/3 cup vegetable or mineral oil and stir for several minutes. Use a dry finger to lightly touch the top of the liquid mixture. Record your observation(s) of sight and touch, including a comparison to those of Step 1. Explain what has happened to the components of the hand cream. What does this tell you about the ability of hand cream to hold oil?
- Step 5 Pour about 2 teaspoons liquid dishwashing detergent into a clean cup. Stir in about 1/2 teaspoon of the mixture from Step 4. Continue adding a little at a time until all the mixture has been stirred in. Compare your observations to those of Step 4 (neglect any suds). What can you say has happened to the components of the hand cream? What chemical term describes this functioning of a liquid detergent?
- Step 6 Does the sequence of adding a broken emulsion and the dishwashing detergent make a difference? Prepare a broken emulsion as in Step 2, then add small portions of liquid dishwashing detergent until two teaspoons have been added.
- Step 7 (optional) Repeat Steps 4 and 5, replacing the liquid dishwashing detergent with beaten egg yolk or liquid soap.

Challenge

Why is mayonnaise classified as an emulsion? What is the cure for a “broken” emulsion and how does it work?

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Concept

emulsions

Expected Student Response to Exploration

Step 1 Since hand creams typically contain oils and water, one might expect part of it to be soluble in oil and part in water.

Step 2 (a) The mixture may appear cloudy, and in some cases a thin layer of oil may be visible on the water. There is an “oily” feeling on your finger.

(b) The water-soluble components dissolved in water, leaving the oils undissolved (and floating on top since they are less dense).

(c) Hand cream can hold only so much water before it separates.

Step 3 (a) The oil layer is no longer detectable.

(b) The components mixed.

(c) Liquid detergent functions as an emulsifying agent.

Step 4 (a) Two layers are observable.

(b) The oil-soluble components dissolved in the oil and the water was left in the more dense layer.

(c) Hand cream can hold only so much oil before it separates.

Step 5 (a) The layers recombined.

(b) The emulsion was repaired by slowly stirring the separated mixture into the liquid detergent.

(c) Liquid detergent functions as an emulsifying agent.

Step 6 The sequence of adding emulsifying agent and broken emulsion does make a difference (especially for weaker emulsifying agents). Refer to the challenge answer for further explanation.

Expected Student Answer to Challenge

An emulsion is one type of colloid in which a liquid is dispersed in another immiscible liquid. Repairing a “broken” emulsion requires adding more emulsifying agent using a very specific procedure: the “broken” emulsion (mayonnaise) must be added and mixed in small portions to the emulsifying agent (beaten egg yolk). Adding a broken emulsion in small amounts to the concentrated emulsifying agent allows the micelles to be formed as necessary for the emulsion. (When the sequence of addition is reversed, the emulsifying agent is not in a high enough concentration to produce these micelles readily.)

Reference

Grosser, A.E.; *The Cookbook Decoder*; Beaufort Books: New York, 1981.

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