

# I SECOND THAT EMULSION

## Background

This material was developed by Jeremy Peacock and Amy Rowley as part of The Science Behind our Food NSF Grade K-12 program at The University of Georgia in collaboration with the College of Agricultural and Environmental Sciences and the Department of Food Science and Technology. This material is based upon work supported by the National Science Foundation under Grant Award No. DGE0229577. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

### *Emulsions*

Oil and water don't mix! You've heard it a thousand times. You've probably seen it for yourself. But the truth is that we are surrounded by foods that are made by mixing oil and water. Salad dressing, butter, ice cream, and milk are all oil-water mixtures that don't separate under normal conditions. So how can we explain this? All of these foods are emulsions. An emulsion is a colloid (a mixture of very tiny particles that are dispersed in another substance but do not settle out of that substance), in which liquids that do not normally mix are spread throughout each other. Emulsifying is done by slowly adding one ingredient to another while simultaneously mixing. This disperses and suspends tiny droplets of one liquid (known as the dispersed phase) through another (known as the continuous phase). To prevent the mixture from separating, an ingredient, known as an emulsifier, which is attracted to both oil and water, is added, thus allowing the two to mix.



### *Mayonnaise*

Mayonnaise is an example of an oil-in-vinegar emulsion. Mayonnaise, like all emulsions, contains an emulsifier... in this case, the incredible, edible egg. Egg yolk contains the phospholipid lecithin. Each lecithin molecule contains a polar end that is attracted to water and a non-polar end that is attracted to oil. The result is that the lecithin dissolves half of itself in water and the other half in oil. Thus, droplets of oil can be dissolved in vinegar, creating mayonnaise.

Mayonnaise was invented in 1756 by the French chef of the Duc de Richelieu. After the Duc beat the British at Port Mahon, his chef created a victory feast that was to include a sauce made of cream and eggs. Realizing that there was no cream in the kitchen, the chef substituted olive oil for the cream and a new culinary creation was born. The chef named the new sauce "Mahonnaise" in honor of the Duc's victory.



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## Administrator's Guide

**PLEASE NOTE:** *The mayonnaise prepared in this demonstration is made with raw eggs and should not be consumed. Raw eggs may contain Salmonella, a bacterium which can cause foodborne illness.*

**Grade levels:** 3-12

**Estimated Preparation Time:** 15 minutes

**Estimated Demonstration Time:** 30 minutes

**Standard Addressed:** Content Standard B

(Structure and Property of Matter)

- Bonds between atoms are created when electrons are paired up by being transferred or shared. A substance composed of a single kind of atom is called an element. The atoms may be bonded together into molecules or crystalline solids. A compound is formed when two or more kinds of atoms bind together chemically.
- The physical properties of compounds reflect the nature of the interactions among its molecules. These interactions are determined by the structure of the molecule, including the constituent atoms and the distances and angles between them.

### Reference:

The following demonstration is adapted from:

Peacock, J and Rowley, A. I Second That Emulsion. The Science Behind Our Food: A hands-on resource for science teachers. The University of Georgia College of Agricultural & Environmental Sciences.

<http://www.uga.edu/discover/sbof>

### Objectives:

- To introduce food science to students
- To introduce the importance of ingredient functionality and the function of an emulsifier

### Materials:

- 2 mixing bowls
- 2 wire wisks
- 1 measuring cup
- Measuring spoons
- 1 egg yolk
- 6 teaspoon vinegar
- 2 cup vegetable oil

### Set-up Instructions:

1. Assemble the ingredients and photocopy the student handout.
2. Pre-measure the oil in two 1-cup portions.

### Demonstration Instructions:

1. Prepare the emulsion with and without the emulsifier (egg yolk):
  - i. No emulsifier:
    1. Add 1 tsp. vinegar to a mixing bowl.
    2. Add oil, 1 tbsp. at a time, while continuously beating the mixture, until 1/3 cup has been added.
    3. Add 1 tsp. of vinegar and continue to beat mixture.
    4. Repeat steps 2 and 3 until all liquids have been added.
  - ii. Emulsifier:
    1. Add egg yolk and 1 tsp. vinegar to a mixing bowl.
    2. Beat vigorously until slightly thick.
    3. Add oil, 1 tbsp. at a time, while continuously beating the mixture, until 1/3 cup has been added.
    4. Add 1 tsp. of vinegar and continue to beat mixture.
    5. Repeat steps 2 and 3 until all liquids have been added.

**NOTE:** The emulsion will not form unless the oil is added VERY slowly. You will know you have formed an emulsion when the mixture turns white and thick.

2. Ask students what they think about the egg could have caused the oil and vinegar to mix.
3. Discuss that eggs contain lecithin which is an emulsifier (see background).

**Extension:** This demonstration can also be done using pasteurized egg yolks. If pasteurized egg yolks are used, the mayonnaise will be safe to consume. Pasteurized egg yolks have been rapidly heated and held at a minimum required temperature for a specified time. This process destroys *Salmonella*, but it does not cook the egg yolks or affect their color, flavor, nutritional value, or use. Lecithin is not affected by the heat treatment and remains an effective emulsifier. Be sure to buy only pasteurized egg products that bear the USDA inspection mark.

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## Student Handout

**Background:** Oil and water don't mix! You've heard it a thousand times. You've probably seen it for yourself. But the truth is that we are surrounded by foods that are made by mixing oil and water. Salad dressing, butter, ice cream, and milk are all oil-water mixtures that don't separate under normal conditions. So how can we explain this? All of these foods are emulsions. An emulsion is a colloid (a mixture of very tiny particles that are dispersed in another substance but do not settle out of that substance) in which liquids that do not normally mix are spread throughout each other. Emulsifying is done by slowly adding one ingredient to another while simultaneously mixing. This disperses and suspends tiny droplets of one liquid through another. To prevent the mixture from separating, an ingredient which is attracted to both oil and water, known as an emulsifier, is added, thus allowing the two to mix.

### Conclusion Questions:

1. Observe the appearance, texture, and aroma of the mixtures.

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2. Why do you think they are different?

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3. What common food emulsion was prepared?

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### Objective:

- To prepare an emulsion of oil in water
- To learn about emulsions and the functions of an emulsifier

