

The concept of emulsion and salad dressings

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Abstract All substances are either pure substances or mixtures. In everyday life and cooking we mainly use mixtures such as emulsions. This article presents how the concept of emulsion can be taught to 7th grade students. The first step is to classify different substances and make different mixtures in a chemistry class. The next step is to apply what was learned by preparing different vinegar- and wine vinegar based salad dressings at a home economics class.

1. The aim of the workshop

The workshop is aimed at 7th grade students in basic education. The goal is for the students to learn the division of substances to pure substances and mixtures and further to classify mixtures to homogeneous and heterogeneous mixtures. In the inquiry-based work of the workshop the students practice making and identifying different mixtures in the context of chemistry and home economics.

2. Chemistry class: Pure substance and mixture

Emulsions are mixtures and in chemistry education they are part of a bigger entity of pure substance and mixture. One or two chemistry classes can be used for teaching this thematic entity.

2.1. Motivational introductory work

In the introductory work the students will classify substances they are already familiar with. Substances suitable for classifications include: a soft drink, a glass of water, iodised salt, sugar, natrium chloride, copper sulfate, an iron nail, a copper sheet, coal, a muesli bar, a rock and a test tube of air.

All the different grounds for classifications should be discussed with the students before they start. Different classification methods can include for example the form, size, alphabetical order, edible and poisonous, colour, packaging, shape, good and bad.

After the classification assignment it is worthwhile to discuss mixtures through introductory questions. These questions lead the students towards the key concepts of the matter at hand. The students' own questions can also act as introductory questions, or the teacher can prepare the questions to deal with only the substances that occur in the introductory assignment

Introductory questions:

- is all gold the same kind?
- what kind of a mixture is whipped cream?
- how does lemonade differ from juice?
- what is an impure substance?
- is air a pure substance?

2.2. Inquiry-based work: Different mixtures

Following the introductory questions the students will conduct in groups a two-part inquiry-based assignment, where they prepare two different mixtures (A and B) and answer questions about them.

Ingredients and the equipment:

- test tube, spoon, water, wheat flour, copper sulfate or sugar, cooking oil and egg yolk

Instructions:

- A. Take a half test tube of cold water. Add a spoon tip full of wheat flour in the tube. Shake the test tube vigorously. What happens?
- B. Repeat the experiment by using copper sulfate or sugar instead of wheat flour. How do the results differ?
- C. Measure 20 drops of cooking oil into a test tube. Add approximately 2 cm of water in the tube and shake vigorously. Observe together what kind of mixture was formed in the test tube. Add a few drops of egg yolk in the test tube and then shake the tube.

Findings:

- A. wheat flour + water → heterogeneous mixture (suspension)
Wheat flour does not dissolve in water; instead it sinks to the bottom of the test tube if the mixture is not continuously mixed.
- B. copper sulfate (or sugar) + water → homogeneous mixture (solution)
- C. cooking oil + water + egg yolk → heterogeneous mixture, that looks homogeneous (emulsion) to the naked eye
A heterogeneous mixture that can be classified as an emulsion forms in the test tube. Adding yolk and shaking the tube causes the oil and water to mix with each other as small drops. The yolk acts as an emulgator.

After the inquiry-based work the difference between a pure substance and a mixture should be reviewed. Differences between heterogeneous and homogeneous mixtures should also be discussed. It is worthwhile to display different heterogeneous and homogeneous mixtures and especially solutions.

3. Home economics class: French salad dressing and salad

The concepts of mixture and emulsion that were learned in the chemistry class are applied in the home economics class by preparing different salad dressings. 1–2 classes can be used for teaching the subject.

The equipment and ingredients:

- four identical glass jars with a lid or test tubes
- vegetable oil
- wine vinegar
- egg yolk
- mustard
- pepper powder

Instructions:

Prepare wine vinegar dressings according to the chart below.

oil-water emulsion	added substance	time passed until separation	time passed until complete separation
1 tbsp. wine vinegar 3 tbsp. vegetable oil			
1 tbsp. wine vinegar 3 tbsp. vegetable oil	1 tsp. egg yolk		
1 tbsp. wine vinegar 3 tbsp. vegetable oil	1 tsp. mustard		
1 tbsp. wine vinegar 3 tbsp. vegetable oil	1 tsp. pepper powder		

Mix each dressing by shaking vigorously for 30 seconds and observe the solidity of oil-water emulsions.

- What did you find?
- What is the reason for the possibly occurring differences?

4. Chemical background for emulsion and salad dressings

Emulsion is a colloidal solution that is formed from two liquids insoluble with each other. One liquid is divided in small drops to the other so that the mixture seems to have a homogeneous structure. Emulsions in foods are mixtures of fat and water. Generally, fat appears as drops in the water; this occurs in creams, for example. Butter is an example of an emulsion where water appears as drops in the fat.

There are both cold and warm emulsion sauces. Mayonnaise is an example of a cold sauce and Hollandaise sauce of a warm sauce. Fat and water mix evenly with each other in emulsion sauces.

When an emulsion sauce is prepared the fat disperses to water in a powdery form; this gives the dressing an even structure. It is very difficult to tell with a naked eye that the sauce is actually a heterogeneous and not a homogeneous mixture. The small fat drops formed in the water make the liquid more concentrated and thicken the dressing. It is important to mix the ingredients effectively for the emulsion to form. Otherwise the emulsion cannot form and the sauce curdles as the ingredients separate from each other.

Emulsion sauces can be either stable or unstable. For example, French salad dressing is unstable and mayonnaise is stable. In an unstable emulsion the fat and water slowly separate from each other. In order to achieve a stable emulsion, a substance that binds the small fat drops and water together, an emulgator, is needed. Egg is often used in preparing sauces as it contains lecithin. Proteins, starch, mustard, fine spices and flours can also act as an emulgator.