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LIPIDS, EMULSIONS, AND EMULSIFYING AGENTS

Mayonnaise Protocol Copyright © 1978 D. B. Fankhauser

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I. OBJECTIVES:

- To study some properties of common lipids.
- To investigate the lecithin in egg yolk as an example of an emulsifying agent useful for making the emulsion known as mayonnaise.

II. BACKGROUND:

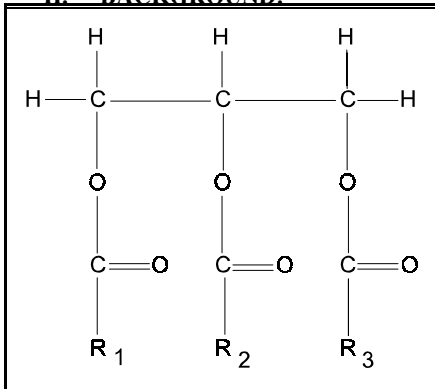


Figure 1. Triglyceride

Lipids (**lipo** = fat) are a group of organic compounds which are grouped together because they are hydrophobic (**hydro** = water, **phobia** = fear), that is, they do not mix with water. Most lipids with which we are familiar are oils or fats – **triglycerides** (**tri** = three) – with the general chemical formula illustrated in **Figure 1**, where R_1 , R_2 , and R_3 are any hydrocarbon chains (**radical**). The length of these hydrocarbons and the number of double bonds present determine if the lipid will be an oil, fat, or wax.

An **emulsifying agent** is something which is soluble in both oil and water, thus enabling the two to mix. Lecithin (**lecithos** = egg yolk), a **phospholipid** (**phos** = light;

III. SAFETY CONSIDERATIONS:

A. Your cooperation is requested in keeping the oil in the designated space in the lab room and in using only designated glassware to measure it – if spilled on the floor, it is **VERY** slippery and dangerous.

B. Do not insert the scraper into the blender while the blender motor is running. The blender could propel a scraper out at high speed possibly injuring you (and/or painting the ceiling with mayonnaise).

IV. MATERIALS NEEDED:

bring a clean container to take your mayonnaise home

blender
rubber scraper
measuring cup or beaker
egg

oil (safflower, corn, soy, olive, peanut)
lemon juice and/or vinegar
dry mustard
(opt. other spices such as red pepper)
opt. veggies, blue cheese and/or garlic

phoro = bear, carry – these refer to phosphorus, some forms of which “glow in the dark”) present in egg yolk, is an example of an emulsifying agent and is reputed to be useful in removing cholesterol from one’s arteries. Another rich source of lecithin is soybeans.

Phospholipids have the same basic structure as triglycerides. The difference, however, is that phospholipids have one of the carbons of the glycerol (**glycer** = sweet; **-ol** = alcohol ending) joined to a phosphate (**-ate** = to treat, to make, to form, characterized by having) group which, in turn, is joined to some other hydrophilic (**philia** = brotherly love) organic molecule (the glycerol is joined to only two hydrocarbon “tails”). Thus, having a hydrophilic “head” and two hydrophobic “tails” makes phospholipids, such as the lecithin in egg yolk, good emulsifying agents, thereby enabling us to enjoy the emulsion known as mayonnaise. **Figure 2** shows the full structure of lecithin with all the hydrocarbon “tails” illustrated rather than using the abbreviation “R.”

Mayonnaise, which is thought to have originated in the Mediterranean port city of Mahon, Minorca (hence the name), is primarily a mixture of oil with lemon juice or vinegar, **emulsified** by the lecithin in the egg. Other ingredients are added for flavor.

Other examples of biological emulsions include such things as blood and milk in mammals as well as various milky plant saps and soap.

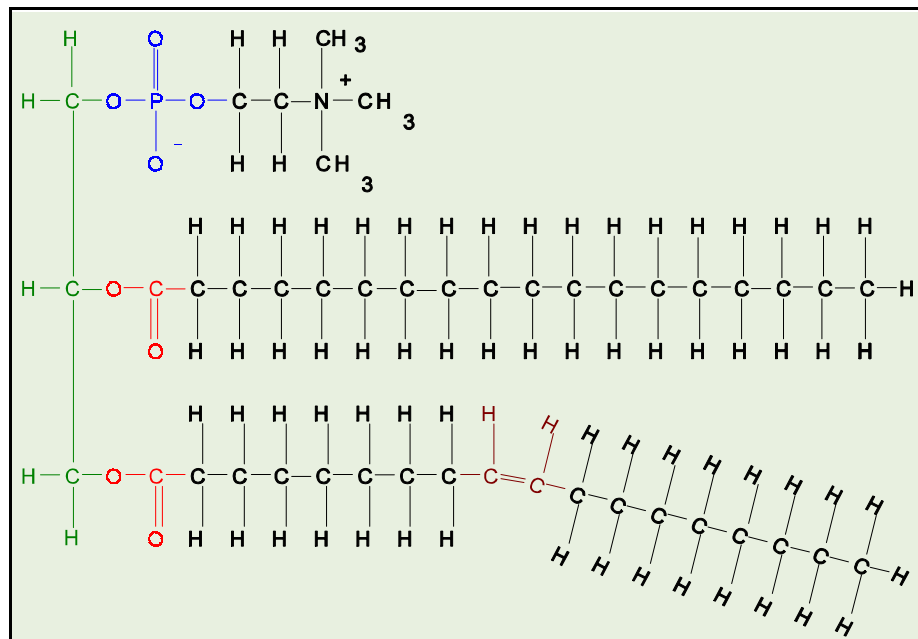


Figure 2. Lecithin

V. PROCEDURE:

This recipe makes about 1½ C of mayonnaise, and you should bring a clean container in which to take it home.

- Each person** should place in a blender (take turns using the blender):

1 egg
2 T lemon juice or vinegar (or a mixture of them)
1 t dry mustard
optional ingredients such as red or black pepper, salt, or whatever tastes good to you

- Mix on high speed to blend.
- TURN OFF BLENDER, then, if necessary, scrape down sides with rubber scraper. **CAUTION: DO NOT INSERT SCRAPER WITH BLENDER MOTOR RUNNING!!!**

4. With the blender motor running (high), slowly and carefully drizzle in 1 C of salad oil (safflower is highest in vitamin E, or use corn, olive, peanut, soy, etc.) through the hole in the lid – put the lid on but remove the center first. Occasionally turn off the blender to scrape the sides. You may need to occasionally stop and “burp” the blender if an air bubble gets trapped under the mayonnaise as it thickens.

5. Transfer the finished mayonnaise to a clean container with a lid and store it in the refrigerator (it will keep about a week or so). If you are not the last person in your group to use the blender, you can just scrape your mayonnaise out with a spatula. After the last person, the blender will need to be cleaned with soapy water.

6. After everyone is done, all utensils should be **thoroughly** cleaned with hot soapy water. Oil is difficult to remove from labware, yet it is very important to do so. Be careful around sharp blender blades. All spilled oil on the floor, countertops, etc. should be thoroughly cleaned up – spilled oil on the floor can be very slippery and dangerous. Carefully clean all spills off your lab bench so it’s clean for the next class coming in.

7. If blue cheese, garlic, and veggies are available, donate *some* of your mayo to help make blue cheese and/or garlic dip and then try some with the veggies.

8. Optional at home: Grated blue cheese, onion, and/or various other herbs or spices may be stirred into mayonnaise to give it a variety of flavors. Try your mayo on a sandwich or whatever and record how it tasted or any other observations.

VI. DATA:

TAKE NOTES on everything you did! What kind of oil did you use? Did you use vinegar or lemon juice? What other ingredients did you add? Did you try any "variations" from the original recipe? What

did your mayonnaise look like when it was done? How did it taste? Record all observations and notes. Draw any equipment, etc. (blender, blender lid, spatula) as needed.

VII. CONCLUSIONS:

Include the following:

1. How did your mayonnaise turn out? Do you have any suggestions for ingredients that you would like to try next time you make mayonnaise?

2. When cleaning up after the mayonnaise, compare the ease of cleaning the blender jar

with the emulsion in it versus cleaning the measuring cup used to measure the oil. Which was easier to clean? Why?

3. Devise/Suggest an experiment either to test the ability of various emulsifying agents to emulsify a given lipid or of various lipids to be emulsified by a given emulsifying agent.