

BAFFLING BEATERS

Background

Egg White Foam

Egg white foam is a type of foam (a colloid in which a gas is dispersed or spread throughout a liquid) used in meringues, soufflés, and angel food cake to make them light and porous (airy). To prepare an egg white foam, egg whites are initially beaten (with a wire whisk or electric mixer) until they become frothy. Then an acid (such as cream of tartar) is added. Depending on the application, the beating of the egg white continues until soft (when the peaks stand straight and bend slightly at the tips) or stiff peaks (when the peaks stand straight without bending) are formed. Salt and sugar may also be added.

How It Works:

Egg whites are made up of water, protein, and small amounts of minerals and sugars. When the egg whites are beaten, air is added and the egg white protein, albumen, is denatured. Denaturation is the change of a protein's shape under stress (in this case, beating). The denatured protein coats the air bubbles and holds in the water, causing them to become stiff and stable. When an acid such as cream of tartar is added, the foam becomes even more stable and less likely to lose water (a process known as syneresis).

Several factors affect the formation and stability of egg white foams, including:

- **Fat:** The addition of even a small amount of fat will interfere with the formation of a foam. Fat is present in the egg yolk, so it is very important that all of the egg yolk is separated from the egg white.
- **Salt:** Salt is added to egg white foams for flavor.
- **pH:** Addition of an acid (such as cream of tartar) will decrease the pH of the egg white foam to near the isoelectric point of the proteins. At this point, the proteins are least stable and more sensitive to denaturation. Adding an acid also increases the beating time.
- **Temperature:** An egg white foam is formed and reaches greater volume more quickly when egg whites are at room temperature.
- **Sugar:** Sugar is added during foam preparation because it creates a smooth, stable foam – one that will not collapse and drain quickly.



References

Food Mysteries Case 4: Protein Puzzlers. 1992. Originally developed by 4-H Youth Development, Michigan State University Extension, East Lansing.

Himich Freeland-Graves, J and Peckham, GC. 1996. *Foundations of Food Preparation*. 6th ed. Englewood Cliffs: Prentice Hall. 750 pgs.

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Administrator's Guide

Adapted with permission from Food Mysteries Case 4: Protein Puzzlers (1992), originally developed by 4-H Youth Development, Michigan State University Extension, East Lansing.

PLEASE NOTE: *The foams prepared in this demonstration are 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: 90 minutes *In order to demonstrate the syneresis to the class, part of this experiment must be prepared 1 hour before the demonstration.*

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 their molecules. These interactions are determined by the structure of the molecule, including the constituent atoms and the distances and angles between them.

Reference:

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Objectives:

- To introduce food science to students
- To introduce foams and investigate what affects their formation and stability



Materials:

- 4 egg whites from equal-size eggs at room temperature
- 1/2 teaspoon cream of tartar
- 2 mixing bowls of the same size
- Electric mixer
- 2 clear glasses (10 oz. or larger) of the same size
- Measuring cup
- Marker
- Measuring spoons

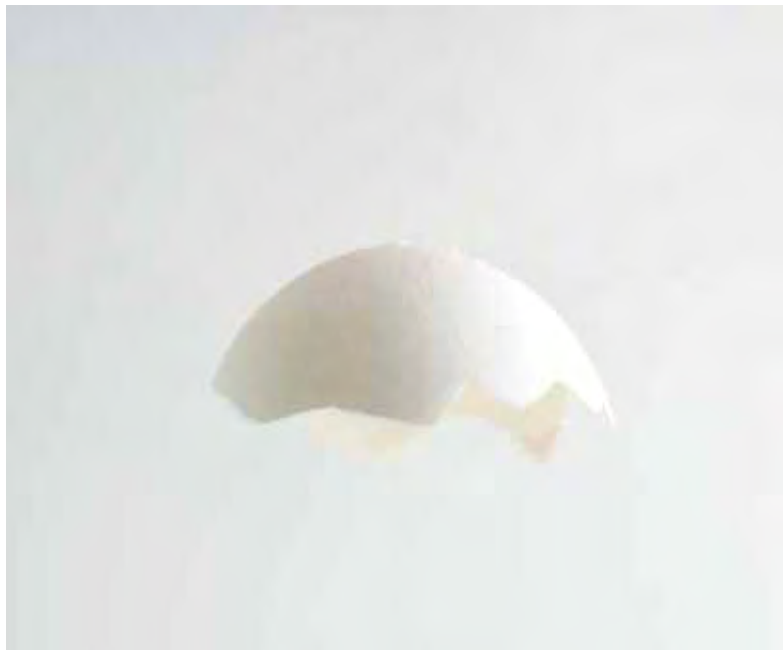
Set-up Procedure:

1. 1 HOUR before the demonstration

- i. Beat one egg white with an electric mixer until stiff peaks form when the beaters are lifted out of the egg white. Pour the beaten egg white into a clear glass. Label the glass "without cream of tartar."
- ii. Beat a second egg white with an electric mixer until foamy; then add 1/8 teaspoon cream of tartar. Start beating again at the same speed until stiff peaks form. Pour the beaten egg white into a clear glass labeled "with cream of tartar."
- iii. Let the egg whites stand for one hour.

Experimental Procedure:

1. You will need to record the exact time you begin to beat each egg white. Have students record the time on the chart provided in their handout.
2. In a mixing bowl, beat one egg white with the electric mixer until stiff peaks form when the beaters are lifted out of the egg white. Have students record the minutes and seconds this took. Keep this egg white for comparison.
3. As you begin to beat the second egg white, have students record the time. Beat the second egg white in the remaining bowl until it is foamy. Add the cream of tartar and immediately start beating again at the same speed until stiff peaks form. Have students record the total beating time.
4. Pour off the accumulated liquid and measure the liquid in the measuring cup. Record the amount.
5. Ask the students to answer the following questions based on their observations:
 - i. Did it take longer to beat to stiff peaks the egg white with cream of tartar or the egg white without cream of tartar?
 - ii. Which egg white lost LESS liquid after one hour?
 - iii. What can you conclude about how cream of tartar affects egg whites when beaten?
 - iv. Why would you want egg whites to be stable after beating?



Extension: This experiment can also be done by preparing a third batch with 2 tablespoons of sugar added with the cream of tartar and/or by preparing another batch using powdered egg whites. The powdered egg whites will not foam because the drying process denatures the proteins in a different way than beating.

Note: Check the ingredient statement; some powdered egg white products (sometimes called meringue powder) contain gums and stabilizers so that the dried egg whites will foam.



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Student Handout

Adapted with permission from *Food Mysteries Case 4: Protein Puzzlers* (1992), originally developed by 4-H Youth Development, Michigan State University Extension, East Lansing.

Background: Egg whites are made up of water, protein, and small amounts of minerals and sugars. When egg whites are beaten, air is added. The air bubbles are then surrounded by the egg white protein (albumen), causing the egg white foam to become stiff and stable. When an acid, such as cream of tartar, is added to an egg white foam, the foam becomes even more stable.

This experiment will help you understand this baffling mystery!

Objectives:

To study foams and investigate what affects their formation and stability

Conclusion Questions:

1. Did it take longer to beat to stiff peaks the egg white with cream of tartar or the egg white without cream of tartar?

2. Which egg white lost LESS liquid after one hour?

3. What can you conclude about how cream of tartar affects egg whites when beaten?

4. Why would you want egg whites to be stable after beating?

Data Sheet:

| | <i>Egg White without Cream of Tartar</i> | <i>Egg White with Cream of Tartar</i> |
|-------------------------------------|--|---------------------------------------|
| <i>Starting Time</i> | | |
| <i>Total Amount of Beating Time</i> | | |
| <i>Amount of Accumulated Liquid</i> | | |