Effects of Various Additives on the Stability of Egg Foams

Objective

To investigate the effects of various additives on the stability of egg foams

Principles

Foams are dispersions of gas throughout a liquid phase without dissolving. However, air bubbles have a tendency to coalesce and pop. Yet, egg white (which is basically a colloidal solution of proteins) can expand 6 to 8 times its volume and form stable foams when whipped. Egg foams can be incorporated into a variety of dishes and are used in many recipes.

Physical whipping denatures the proteins in the egg white and simultaneously introduces air bubbles. The denatured proteins unfold, exposing their hydrophobic (water-fearing) and hydrophilic (water-loving) amino acids to the water-rich fluid around them. The unfolded proteins congregate on the surface of each bubble, with their hydrophilic amino acids remaining in the egg white liquid, while the hydrophobic parts of the protein protrude into the air bubble (refer to Figure 1). Meanwhile, the proteins bond with each other side-to-side around the surface of the bubble to form a reinforced protein network. This strong and stable network of protein keeps the air trapped and dispersed throughout the fluid egg white, forming the foam.

However, foam formation will be hindered if there are substances (e.g. fat and oil) competing with proteins for water. Also, if there are extensive sulphur bonds (S-S) formed among the sulphur-containing amino acids in the protein network, these sulphur bonds can be so strong that they squeeze water from between protein networks surrounding bubble walls and make the foam collapse. Thus, additives that help prevent the formation of these sulphur bonds (e.g. acidic ingredients such as vinegar and lemon juice) will help stabilise the foam.

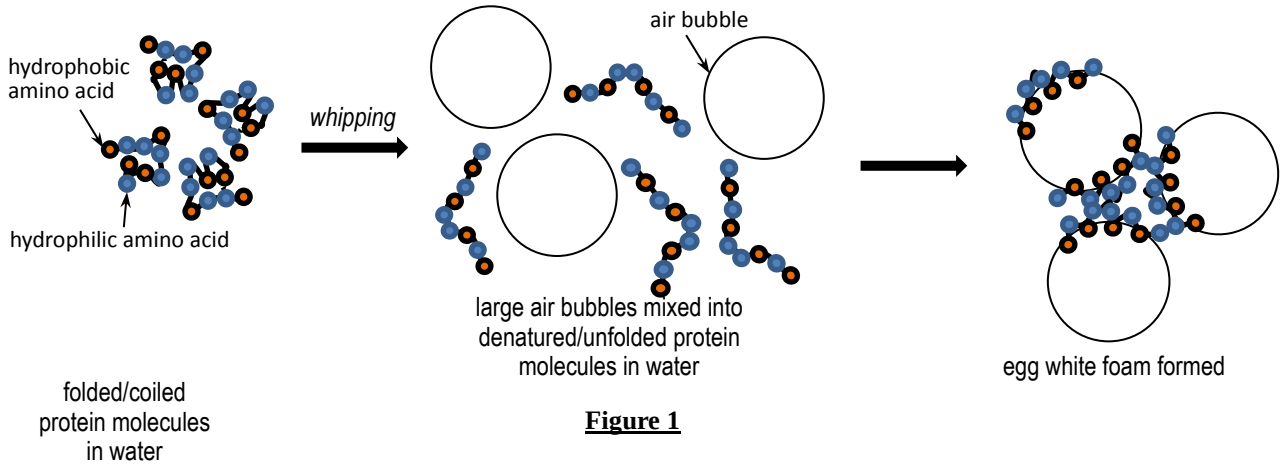

Figure 1

Part I – Experimental Work

Apparatus and Materials

Apparatus		Materials	
15 ml test-tube	× 4	label	× 8 pieces
test-tube rack	× 1	egg white	× 4
funnel (large enough to hold the foam developed from 1 egg white)	× 4	egg yolk	¼ tsp
large bowl / mixing bowl	× 4	cream of tartar	¼ tsp
small bowls	× 2	castor sugar	25 g
fork	× 1	food wrap	
10 ml measuring cylinder	× 1		
measuring spoons	× 1 set		
stop watch / timer	× 1		
rubber scraper	× 1		
electronic scale	× 1		
hand-held electric beater	× 1		

Procedure

1. Label the large bowls and funnels.
2. Separate egg white from the yolks. Place 1 egg white in each big bowl and put all the yolks in a small bowl.
3. Prepare samples A to D by placing the contents as shown below in the respective labelled big bowl.

Sample A	Sample B	Sample C	Sample D
1 egg white	1 egg white	1 egg white	1 egg white
--	¼ tsp cream of tartar	¼ tsp egg yolk	*25 g castor sugar (*added *after* whipping for 1 min)

4. Whip each of samples A to C on medium-low speed with the hand-held electric beater for 3 minutes. Clean and dry the beaters and the rubber scrapper thoroughly before using them for whipping the next sample.
5. Prepare sample D, whip 1 egg white in a mixing bowl on medium-low speed for 1 minute. Gradually add in 25 g castor sugar and continue to whip on medium-low speed for 2 minutes.
6. Place a funnel on top of each test-tube. Scrape the egg foams formed in each sample into the respective labelled funnel. Level the foam in each funnel with a scrapper. Cover the top of the funnel with food wrap and leave the samples to stand aside for 20 minutes. Record the appearance and texture of the foams.
7. After allowing the samples to stand aside for 20 minutes, measure the volume of the fluid collected in the test-tube in each sample.

Results

Sample	A	B	C	D
Appearance and texture of the foam				
Volume of fluid collected in test-tube after 20 minutes				

Part II - Report Writing

Discussion

1. Based on the appearance and texture of the foams and the volume of fluid collected in the test-tube in samples A, B, C and D, describe the effects of cream of tartar, egg yolk and sugar on the stability of the foam.

2. Explain how these additives stabilise or weaken the egg foams formed.

3. Why should fine sugar be used and added gradually into the egg foam in preparing sample D?

4. Suggest a dish which illustrates the application of egg white as a foaming agent. State the precautions required in preparing this dish to ensure foaming is successful.

5. Suggest another commonly used additive that would affect the stability of egg foams. Briefly describe an investigation for finding out its effect on foam stability.

Conclusion