The coagulation of egg white changes its composition

(Item No.: P7185100)

Curricular Relevance

Area of Expertise: Chemie

Education Level: Klasse 7-10

Topic: Organische Chemie

Subtopic: Lebensmittelchemie

Experiment: Gerinnung von Eiklar verändert seine Zusammensetzung

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Intermediate	10 Minutes	20 Minutes	2 Students

Additional Requirements:

Experiment Variations:

Keywords:

food chemistry, proteins, composition of eggs

Task and equipment

Information for teachers

Additional Information

Milk going sour is a well known phenomenon. The contents of a hen's egg solidify when it is boiled.

Notes on contents and learning objectives

- When egg white is heated, the protein contained in it coagulates.
- Protein flocculates out on the addition of alcohol, solutions of heavy metals or small quantities of acids.
- When protein flocculates out, it loses its natural composition. The protein is denatured.

Notes on the method

The experience of the students can be used as an entry to this problem. Boiling eggs or the flocculation of milk offer opportunities for a discussion on this subject.
Alongside the knowledge gained from the experiment, reference should be made to the danger from Salmonella when eggs are used to prepare foods without sufficient heat treatment. The basics of hygiene in the kitchen could be worked out here.
The poisonous effect of heavy metals on the human organism can also be explained with the help of this experiment.

Fundamentals and remarks

The coagulation of proteins is connected to a change in the structure of the protein molecule. The native conformation (tertiary structure) is lost, one says that the protein has been denatured.
Denaturization can be reversible or irreversible. The coagulation of proteins in foods can also be demonstrated by heating butter or leaf fat. Coagulated protein hinders light transmittance. When milk is acidified, casein flocculates out. Casein is present in milk as calcium caseinate. Acids precipitate out casein and calcium ions.

Hints on going deeper

- The production of foods using egg white. Sauce bernaise and sauce hollandaise are made from fresh eggs.
- The production of sour milk products.
- The production of pickled cabbage by lactic acid fermentation (preserving).

Notes on set-up and procedure

Preparation:
The egg white solution is prepared as follows:
Carefully separate the white of a hen's egg from the yolk. Stir the egg white in 100 ml of a 1 % common salt solution.
Subsequently filter the solution through glass wool.
The egg white solution can be used for further experiments.

Notes on the students experiment:
Should the temperature of the water bath drop to below 70 °C, it must be heated up again, for the protein in the test tube to coagulate.
The protein precipitation can also be carried out using other heavy metal salts solutions, such as lead acetate, zinc sulphate or nickel nitrate. Please note that solutions of many heavy metal salts are poisonous.

Hazard and Precautionary statements

Ethanol:

H225:	Highly flammable liquid and vapour.
P210:	Keep away from heat/sparks/open flames/hot surfaces – No smoking.
Acetic acid:	
H226:	Flammable liquid and vapour.
H314:	Causes severe skin burns and eye damage
P280:	Wear protective gloves/protective clothing/eye protection/face protection.
P305 + P351 + P338:	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do – continue rinsing.
Fehling's solution I:	
H410:	Very toxic to aquatic life with long lasting effects.
P273:	Avoid release to the environment.

Hazards

- Ethyl alcohol is highly inflammable. Extinguish all flames before handling it.
- Acetic acid is caustic.
- Do not allow chemicals to contact any part of the body.
- Wear protective glasses and gloves.

Waste disposal

The solutions in test tubes 1, 2 and 4 can be poured down the drain.
Pour the solution in test tube 3 in the container for heavy metal residues.

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Task and equipment

Task

Why does egg white coagulate when heated or treated with reagents?

Demonstrate that protein is precipitated on heating egg white, or treating it with reagents.

Equipment

Position No.	Material	Order No.	Quantity
1	Support base, variable	02001-00	1
2	Support rod, stainless steel, l=370 mm, d=10 mm	02059-00	1
3	Ring with boss head, i. d. = 10 cm	37701-01	1
4	Wire gauze with ceramic, 160 x 160 mm	33287-01	1
5	Glass beaker DURAN®, short, 400 ml	36014-00	1
6	Test tube rack for 12 tubes, holes d= 22 mm, wood	37686-10	1
7	Test tube, 180x18 mm,100pcs	37658-10	(4)
8	Test tube holder, up to d 22mm	38823-00	1
9	Test tube brush w. wool tip,d25mm	38762-00	1
10	Pipette with rubber bulb	64701-00	4
11	Labor pencil, waterproof	38711-00	1
12	Protecting glasses, clear glass	39316-00	1
13	Rubber gloves, size S (7)	39325-00	1
	Butane burner f.cartridge 270+470	47536-00	1
	Butane catridge CV 300 Plus, 240 g	47538-01	1
	Ethanol extra pure ab.95% 1000 ml	30008-70	1
	Fehling's solution I 1000 ml	30079-70	1
	Acetic acid 99...100%, pure 1 l	31301-70	1
	Boiling beads, 200 g	36937-20	1
Additional material			
	Egg		

Set-up and procedure

Set-up

Hazards

- Ethyl alcohol is highly inflammable. Extinguish all flames before handling it.
- Acetic acid is caustic.
- Do not allow chemicals to contact an part of the body.
- Wear protective glasses and gloves.

Setup

Number four test tubes from 1 to 4 and stand them next to each other in the test tube rack (Fig. 1).

Fig. 1

Assemble the stand as shown in figures 2 to 6. Fasten the support ring to the support rod and place the wire gauze on it. Adjust the height of the support ring so that the flame of the burner just reaches the wire gauze.

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 6

Half-fill the beaker with water and add a few boiling stones. Heat it to boiling, then put it aside. Extinguish the bunsen burner flame!

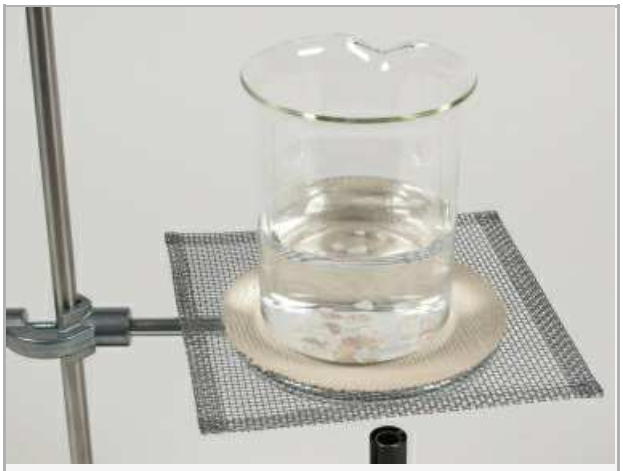

Fig. 7

Procedure

Pipette egg white solution into each of the test tubes to a height of 2 cm.

Place test tube 1 in the hot water bath prepared as above for about 5 minutes.

Add ethanol dropwise to test tube 2 until the height of the liquid is 4 cm.

Fig. 8

Pipette Fehlings solution I into test tube 3 to a liquid height of 4 cm, and mix this solution also.

Carefully add acetic acid dropwise to test tube 4 until a reaction is apparent.

Waste disposal

The solutions in test tubes 1, 2 and 4 can be poured down the drain.
Pour the solution in test tube 3 in the container for heavy metal residues.

Report: The coagulation of egg white changes its composition

Result - Table 1

Note your observations in the following table.

Test tube	Change in condition / reagents	Coagulation of egg white
1	Heat	1
2	Ethanol	1
3	Fehlings solution I	1
4	Acetic acid	1

Evaluation - Question 1

Draw conclusions from your observations.

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Evaluation - Question 2

Why must sauces which are prepared with new-laid eggs be heated in a water bath?

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Evaluation - Question 3

Why should fresh full-cream milk not be stored in copper vessels?

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Robert-Bosch-Breite 10
D - 37079 Göttingen

Tel: +49 551 604 - 0
Fax: +49 551 604 - 107

info@phywe.de
www.phywe.com

Evaluation - Question 4

Why must fresh milk be continually cooled?

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Evaluation - Question 5

Complete the following statements.

1. When proteins are strongly heated, they .....
2. Alcohol and acids cause proteins to .....
3. With heavy metals, proteins can be caused to .....

Evaluation - Question 6

Explain the statement "The milk has gone sour".

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D - 37079 Göttingen

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Evaluation - Question 7

Try to find an explanation for the change in colour of egg white after a hen's egg is boiled!

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