Denaturing Proteins Background & Instructions

Chapter 11, Food Science

**Background**

Proteins are large molecules made up of small amino acids. Common proteins used in cooking are albumen and casein; eggs are mostly albumen and milk is largely casein. Proteins are held in a natural shape due to the interaction of side groups on the amino acids from one part of the molecule to another area of the molecule. These interactions may be hydrogen bonds or disulfide bonds.

Denaturation is a process in which proteins lose their structure when attacked by forces like a strong acid, heat, or a solvent like alcohol. We can denature the proteins by disrupting the hydrogen bonds that are within the structure. When this happens, the overall shape of the protein changes and new properties can be observed. The shape of a protein is associated with food processing properties, such as solubility, gel formation, and enzyme activity.

Denaturation in the egg whites will change the albumin from clear to white. We will explore how the following denature egg albumin as well as milk casein.

- Heat – done by cooking
- Acids & bases – can form ions on some side groups of amino acids
- Organic compounds – form their own hydrogen bonds with the amino acids

**Part 1: Denaturing Proteins by Heat**

**Objective:**
The objective of this experiment is to determine whether proteins denature at the same temperature.

**Research Questions:**
- What happens when a protein denatures?
- Do all proteins denature at the same temperature?
- What temperature does albumen denature at?
- What temperature does casein denature at?
- Why might proteins denature at different temperatures?

**Materials:**
- small saucepan
- 3 eggs
- 2 mixing bowls
- candy thermometer
- 2 c 2% milk

**Experimental Procedure**

1. Crack an egg over the first bowl and separate the yolk and white. Use two bowls, keeping all the whites in one of the bowls. Make sure that your yolks do not contaminate the whites. Discard yolks.
2. Transfer the whites into a small saucepan. Place the candy thermometer into the saucepan.
3. Gently heat the whites. Record the temperature when their texture changes.
4. Clean the saucepan, thermometer, and bowls.
5. Add milk to the saucepan. Place the candy thermometer in the saucepan.
6. Gently heat the milk. Record what temperature the texture of the milk changes or a skin forms over the top.
Part 2: Denaturing Proteins by Other Methods

Objective:
The objective of this experiment is to experiment with different methods of denaturing the protein found in egg white (albumin) and milk (casein) using ionic compounds, acids, and bases.

Experimental Procedure
Follow the instructions assigned to your group. Allow other groups to observe results and complete the charts and questions found on the lab report.

Group 1:
Denaturation by Ionic Compound (NaCl – Table Salt)
1. Separate 1 egg white, placing the egg whites in a plastic cup. Discard the egg yolk. Note: The clarity of the egg white this is your baseline or control.
2. Add approximately 1 teaspoon (~15 grams) NaCl (Table Salt) to the cup containing an egg white and stir.
3. Keep adding the NaCl until you notice a change in the egg white.
4. Record your observation in the Egg Albumin Data Table.

Group 2:
Denaturation by Base (Sodium Bicarbonate-Baking Powder)
1. Separate 1 egg white, placing the egg whites in a plastic cup. Discard the egg yolk. Note: The clarity of the egg white this is your baseline or control.
2. Add approximately 1 teaspoon NaHCO3 (Sodium Bicarbonate – Baking Powder) to the cup containing an egg white and stir.
3. Keep adding the NaHCO3 a ½ teaspoon at a time until you notice a change in the egg white.
4. Record your observation in the Egg Albumin Data Table.

Group 3:
Denaturation by Acid (Lemon Juice)
1. Separate 1 egg white, placing the egg whites in a plastic cup. Discard the egg yolk. Note: The clarity of the egg white this is your baseline or control.
2. Add approximately 1 teaspoon (~5 ml) lemon juice to the cup containing an egg white and stir.
3. Record your observation in the Egg Albumin Data Table.

Group 4:
Control
1. Separate 1 egg white, placing the egg whites in a plastic cup. Discard the egg yolk. Note: The clarity of the egg white this is your baseline or control.

Group 5:
Procedure for Milk (Casein) Denaturation:
1. Place 3 Teaspoons (~15 ml) each of milk into two cups.
2. Place 1 Teaspoon (5ml) of Lemon Juice in one of the cups containing the milk and stir.
3. Record Observations on the Milk Table.

Adapted from:
http://www.education.com/science-fair/article/denaturing-proteins/
http://www.math.unl.edu/~jump/Center1/Labs/DenaturingProteins.pdf
Denaturing Proteins Lab Report
Chapter 11, Food Science

Part 1:
Summarize the experiment’s procedure in 2-3 sentences: (2 pt)

1. What temperature does albumen denature at? (1 pt)______________________________

2. What temperature does casein denature at? (1 pt)______________________________

Part 2:
Summarize the experiment’s procedure in 2-3 sentences: (2 pt)

Egg Albumin Data Table (2 pt)

<table>
<thead>
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<th>Group</th>
<th>Added</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NaCl – Ionic Compound</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>NaHCO₃ – Base</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Lemon Juice – Acid</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Nothing (Control)</td>
<td></td>
</tr>
</tbody>
</table>

Milk Casein Data Table (1 pt)

<table>
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<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Lemon Juice – Acid</td>
<td>CONTROL</td>
</tr>
</tbody>
</table>
Post Lab Questions:
Answer the following in complete sentences.

1. What happens when a protein denatures? (1 pt)

2. Explain why proteins might denature at different temperatures. (2 pt)

3. Which method appeared to have the most dramatic denaturing affect on egg albumin? Why do you think this method had a greater affect? (2 pt)

4. Of the methods you tested, which would be more likely to be used in the food industry? Explain your answer. (2 pt)

5. Investigate the protein, keratin. How does this relate to the human body? Why would someone denature keratin? (2 pt)