ANIMAL SCIENCE (HS)

Macromolecules in dairy

Focus question	What macromolecules are found in milk? How do these macromolecules differ between various types of milk products? How does milk rate as a complete nutritional food?
Vocabulary	Monomer, monosaccharide, disaccharide, polysaccharide, starch, amino acids, protein, lipid

Nutrients occur in varying amounts within all the foods we eat. Dairy products, such as milk, yogurt, and cheese all contain lipids, carbohydrates, and proteins. However, different forms of dairy products will contain each of these nutrients in varying amounts. The varied amounts of nutrients in different dairy products determine how the food fits into a balanced, nutritious diet.

The basic components of the three major classes of macromolecules that we need as nutrients all include the elements carbon, hydrogen and oxygen. The differences come from the presence of additional elements, the number of atoms of each present in the molecule, and the arrangement of these atoms. Carbon, hydrogen and oxygen, when arranged in rings, form sugars, or monosaccharides such as glucose. These monosaccharides (monomers of carbohydrates) can be combined to form larger molecules, such as disaccharides or even polysaccharides (such as starches). When the same elements are arranged in chains, they form lipids (both saturated and unsaturated fats). Adding nitrogen to the molecule results in the formation of amino acids, which form complex structures known as proteins.

Materials

- Whole milk
- Skim milk
- 2% milk
- Heavy cream
- Half and half
- Distilled water
- Graduated cylinders/serological (or disposable) pipettes
- Funnel
- 4 test tubes
- Test tube holder
- Hot plate
- Cell well plate
- Large beaker with water for water bath
- Lugol's solution (iodine)
- Benedict's solution (or glucose test strips)
- Protein test strips (or Biuret solution)
- Sudan III solution

Procedure

Make a data table to compare the macromolecules found in each milk sample.

Monosaccharide indicator standard test (glucose)

1. Label each of the wells with the type of milk samples (whole, skim, 2%, heavy cream, half and half, and distilled water).
2. Add 1 mL of the whole milk sample to a test tube with the matching label.
3. Add 1 mL of Benedict's solution to the milk.
4. Use Vortex to give sample a quick mix (or cover with parafilm and invert test tube). Record sample color in data chart.
5. Place test tube containing food sample and Benedict's solution in a boiling water bath and heat for 2 minutes. Record sample color in data chart.
6. The glucose present in the solution reacts with the copper sulfate in the Benedict's reagent creating copper oxide, which results in an orange to red-brick precipitate. The intensity of the color depends on the concentration of glucose present in the sample.
7. Rate the precipitate color change and record sample data in the chart.
   0: no color change/negative, 1: weak/positive, 2: strong/positive, 3: very strong/positive
8. Alternatively, dip the glucose test strip into the dairy samples for 1–5 seconds.
9. Wait 5 minutes and compare the color of the test strip to the color chart.
10. Record sample color in data chart.
11. Repeat this process with the remaining samples.

Complex carbohydrate indicator standard test (starch)

1. Label the wells in the cell plate with our samples: whole milk, skim milk, 2% milk, water, heavy cream, and half and half.
2. Add 1 mL of each of the samples to the corresponding well.
3. Record the initial color of each sample in the data table.
4. Add 1 drop of Lugol's iodine solution to each well.
5. A bluish-black color indicates a positive test for starch.
6. Rate the precipitate color change and record sample data in the chart.
   0: no color change/negative, 1: weak/positive, 2: strong/positive, 3: very strong/positive.

Protein indicator standard test

1. Label the wells in the cell plate with our samples: whole milk, skim milk, 2% milk, water, heavy cream, and half and half.
2. Add 1 mL of each of the samples to the corresponding well.
3. Dip a protein test strip into the filtrate to compare to the color chart on the bottle.
4. Alternatively, add 1 drop of Biuret solution. Compare color change. If protein is present, the solution will turn purple.

Lipid indicator test

1. Label the wells in the cell plate with our samples: whole milk, skim milk, 2% milk, water, heavy cream, and half and half.
2. Add 1 mL of each of the samples to the corresponding well.
3. Record the color of each sample in the data table.
4. Add 1 drop of Sudan III to each of the wells.
5. A bright red color indicates the presence of lipids.

Reflection

1. Which dairy product contained the most protein?

2. Which dairy product contained the most lipids (or fats)?

3. Did any of the samples contain glucose? Which ones?

4. Did any of the samples contain starches? Which ones?

5. Create an infographic about the classes of nutrient macromolecules and examples of which ones are found in dairy products and in what amounts.

Rubric for self-assessment

Skill	Yes	No	Unsure
I generated data to compare nutrient content differences between various dairy products.			
I constructed an infographic to show the differences in macromolecule content between dairy products.			
I can explain how milk or other dairy products can be part of a nutritious diet.			