MILK – WHITE GOLD

Europagymnasium KLAGENFURT

www.europaymnasium.at

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TITRATION OF LACTIC ACID IN YOGURT

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CHAPTER 01

Research Questions
Research Goals
Theoretical Background

RESEARCH QUESTIONS

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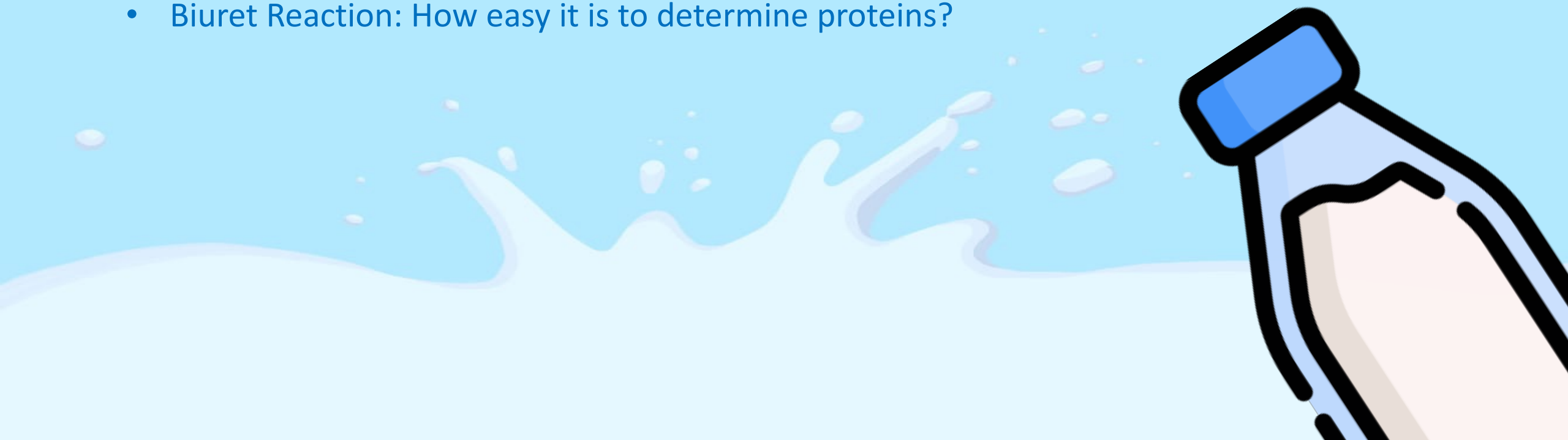
Chapter 2:

- What can acid do to ricotta?
- What is the science behind it?
- Biuret Reaction: How easy it is to determine proteins?



RESEARCH QUESTIONS

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Chapter 3:

- How is the surface tension in milk broken?
- What do tensides have to do with it?

Chapter 4:

- How much lactic acid is in yoghurt?
- How can we calculate the result of the titration?

RESEARCH GOALS

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Chapter 2

- Production of ricotta (and whey) from plain whole milk
- Understanding the principle of denaturation (coagulation of casein)
- Experience how to determine proteins
- Improving teamwork
- Gaining scientific experience

RESEARCH GOALS

Chapter 3:

- Discovering what an emulsion is and how it works

Chapter 4:

- Understanding the principle of titration
- Calculating how much lactic acid is in yoghurt

WHICH COMPONENTS IS MILK COMPOSED OF?

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- Milk is an emulsion of fat and water which is also a colloidal suspension of proteins.
- Milk contains different types of proteins floating in the liquid.
- Further components are minerals, sugars (i.e. lactose), vitamins...
- It contains fat in form of droplets with an average size of 3 to 4 micrometres.
- Bacteria are also included in raw milk which causes it to become sour.

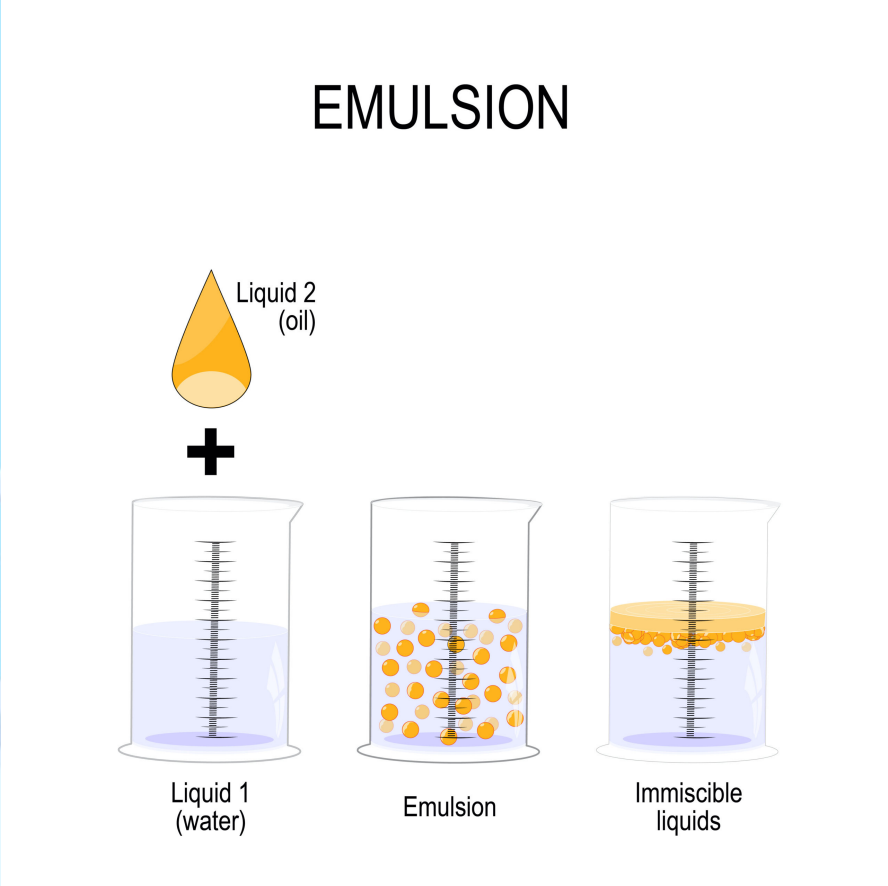

Figure 1. Principle of an emulsion [www.shutterstock.com]

WHY IS MILK WHITE ?

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- It contains many different types of proteins.
- The main type is casein.
- Micelles are formed.
- They scatter light because of their small diametre-

- Effect: The milk seems to be white.

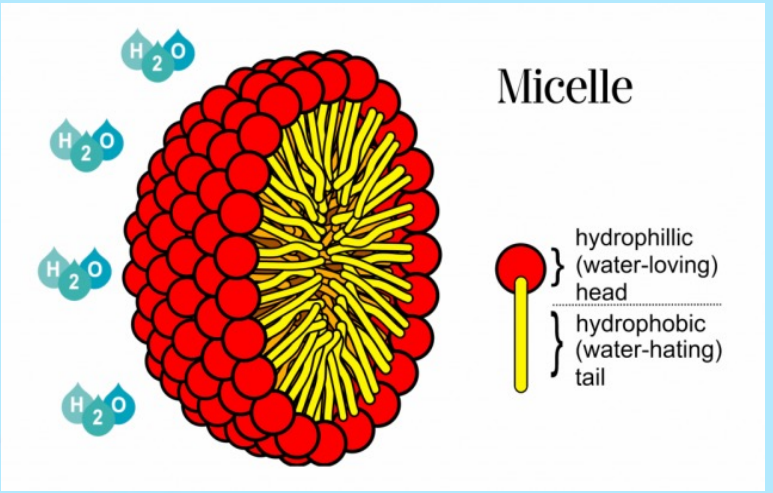

Figure 2.Structure of a micelle [www.beauty-euro.com]

LACTOSE

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- A sugar found in milk
- Can be fermented to form lactic acid
- Lactose-intolerance: inability to digest lactose

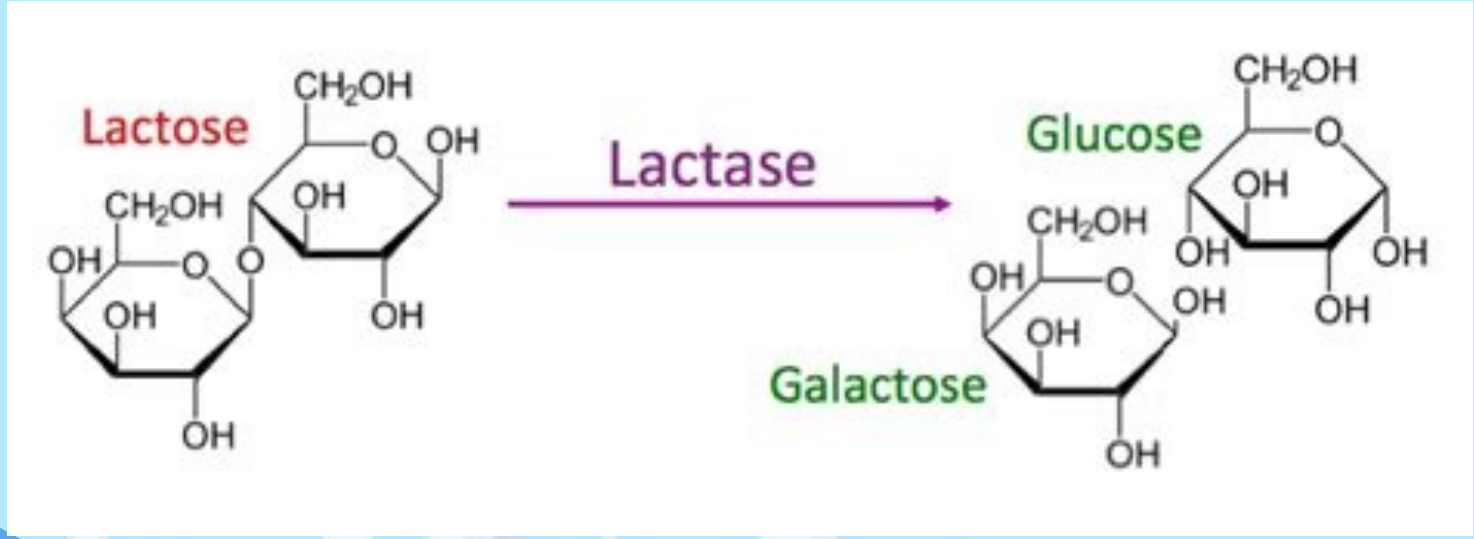

Figure 3.Enzymatical decomposition of lactose [www.apotheke-balsthal.ch]

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EMPIRICAL DATA

Experiments

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CHAPTER 02

- Production of Ricotta
- Determination of milk proteins in cream cheese

QUESTIONS & GOALS

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Research questions

- What can acid do to ricotta?
- What is the science behind it?

<u>Biuret Reaction:</u>

- How easy it is to determine proteins?

Research goals

- Production of ricotta (and whey) from plain whole milk
- Understanding the principle of denaturation (coagulation of casein)
- Experience how to determine proteins
- Improving teamwork
- Gaining scientific experience

WHAT MATERIALS DO I NEED TO PRODUCE SELF-MADE RICOTTA?

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Raw Materials:

- Milk: the higher the fat content, the more ricotta you get.
- Since the milk is heated to 80°C anyway, it can also be raw.
- Of course, whey is also be obtained as a by-product.
- Acidifier: freshly squeezed lemon juice, apple or white wine vinegar.

Helpful Utensils:

- Thermometer: to find the right temperature for the heated milk.
- Sieve + tea towel: are needed to separate the whey (liquid) from the curd (solid).

Ingredients:

- In addition to a total time of 25 minutes until the ricotta is made, you also need:
  1: 2 litres of whole milk **2:** 6 tablespoons lemon juice (approx. 2 lemons)

PREPARATION

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- Pour milk into a saucepan and heat it. Stir regularly with a wooden spoon so that the milk is heated evenly.
- Using a thermometer, heat the milk to 80°C and add lemon juice.
- The milk will now begin to curdle (the protein and the whey separate from each other) and a curd forms on the surface.

Figure 4. Heating [photos taken by students]

Figure 5. Denaturation of the casein [photos taken by students]

- Continue heating the milk to 90°C.
- Take the pot off the stove and let it cool down a bit for 10 minutes.
- Once this is done, all you have to do is place the curds in a bowl using a sieve and tea towel and separate the ricotta from the whey. The finished ricotta can be used immediately.

Figure 6. Separated proteins and wheat [photos taken by students]

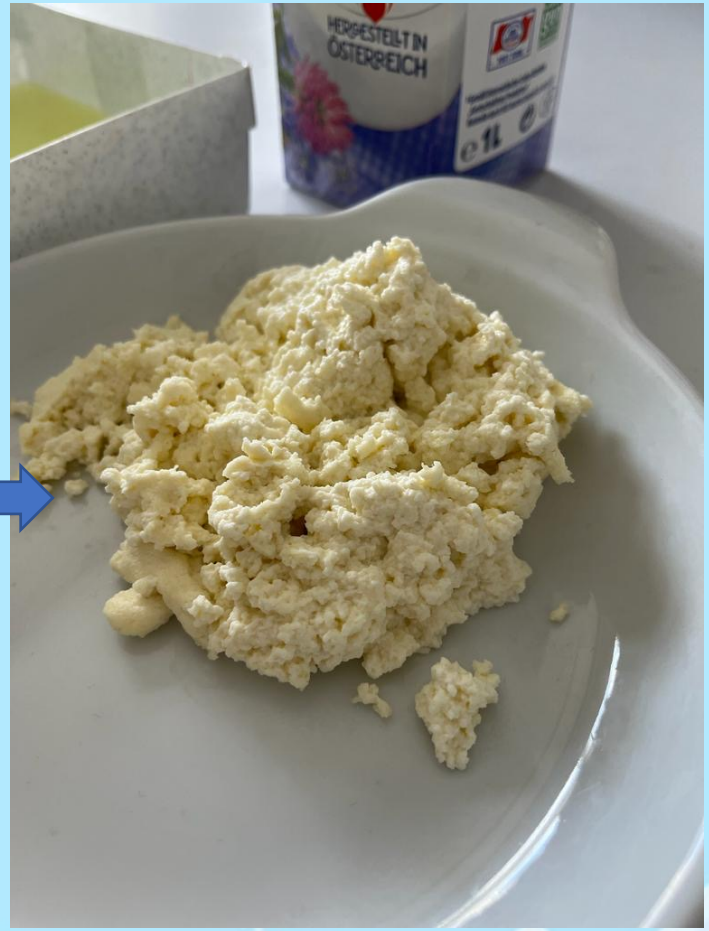

Figure 7. Fresh ricotta [photos taken by students]

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WHAT HAPPENS?

- By adding acid, milk separates into its solid and liquid components
- After removing the whey, all that's left is cream cheese (the protein)

Science behind it:

- Milk is mostly made up of water, in which carbohydrates, proteins (e.g. casein), vitamins and trace elements are dissolved
- It also contains fat in the form of small droplets

DISCUSSION

The fat and protein content (diagram) of milk depends on:

- Where it comes from?
- Which variety it is?

Whole milk from the cow contains among other components proteins and an average of around 3.5% fat.

By adding acid, milk separates into its solid (cream cheese) and liquid (whey) components: the proteins change their shape and denaturate.

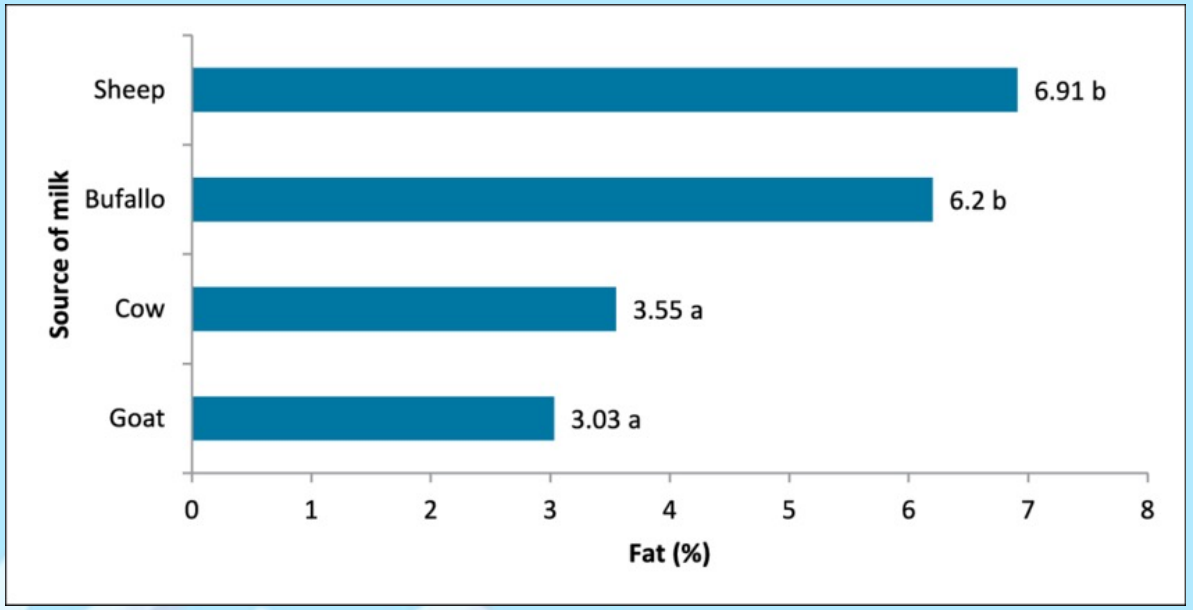

Figure 8. Fat content of selected milk sources [www.researchgate.com]

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BIURET REACTION
Qualitative determination of proteins

Proving that ricotta contains proteins

WHAT MATERIALS DO I NEED TO DETECT PROTEINS?

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Materials:

- Glass rod
- Beaker (with the ricotta)
- Measuring zylinder
- Pipettes

Biuret chemical:

- Sodium hydroxide solution (NaOH 10%)
- Copper sulfate solution ($CuSO_4$)

PROCEDURE

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- The ricotta from the beaker is placed in the measuring cylinder and diluted with water
- 3ml of colourless concentrated sodium hydroxide solution (NaOH) is added to the ricotta.
- Then a few drops of the light blue copper-(II)-sulfate solution are added.
- The mixture becomes purple.

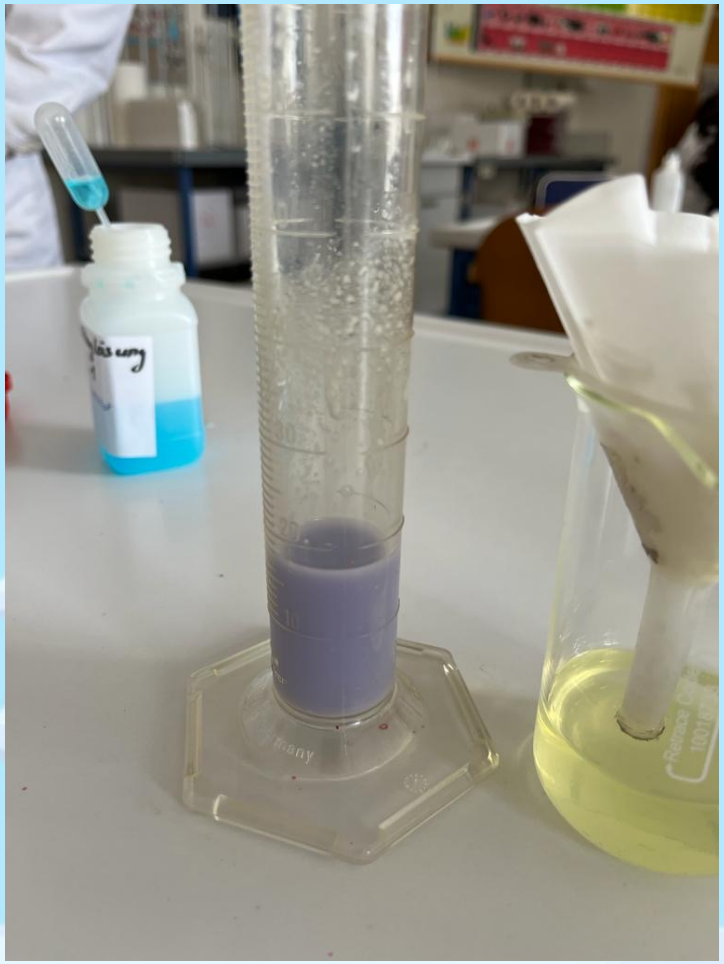

Figure 9. and 10. Ricotta reacts with $NaOH/CuSO_4$ [photos taken by students]

DISCUSSION

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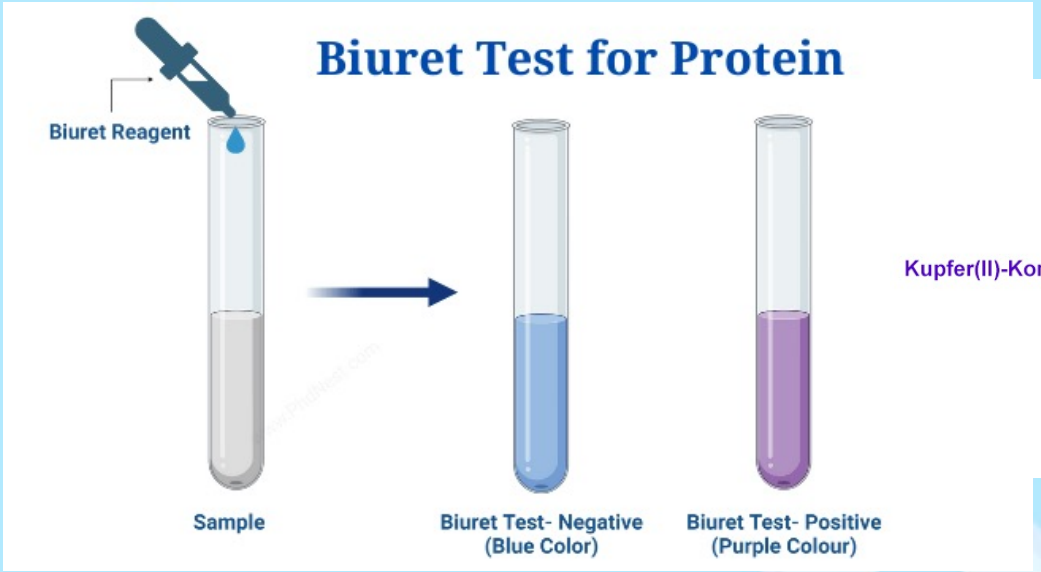
The casein, which is a protein, reacts with the Biuret reactants by building a purple complex due to the peptide bonds.



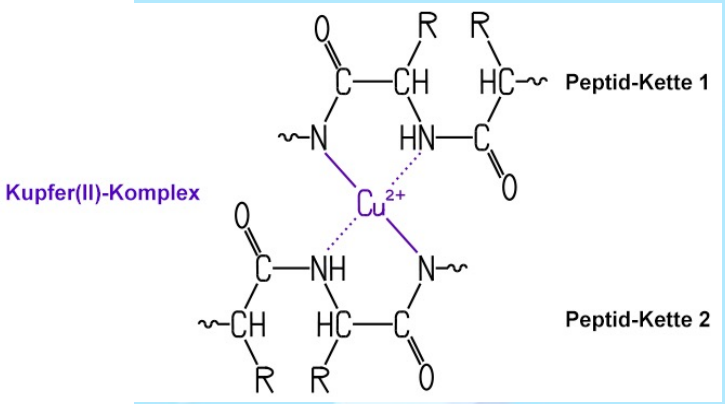


Figure 11. Biuret Reaction [https://www.phdnest.com/wp-content/uploads/2021/09/Biuret-Test-for-Protein-2-1.png and https://www.seilnacht.com/Lexikon/biuret2.gif]

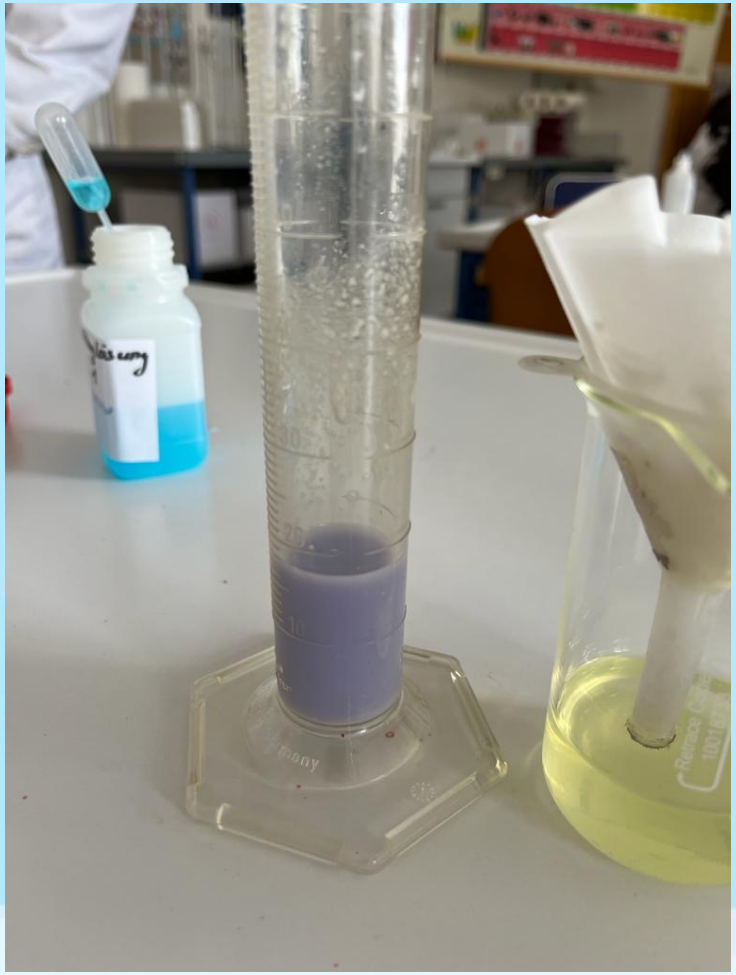


Figure 12. Biuret reaction with self-made ricotta [photos taken by students]

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CHAPTER 03

DANCING COLOURS & EMULSION

QUESTIONS AND GOALS

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Research questions:

- How is the surface tension in milk broken?
- What do tensides have to do with it?

Research Goal:

- Discovering what an emulsion is and how it works

MATERIALS

- ¼ litre whole milk
- plate
- Washing up liquid (dish soap)
- Water

Figure 13. Materials for dancing colours [photos taken by students]

- Food colour
- Small beakers with water and food colours
- Cotton swabs
- Pipettes

HOW TO DO IT!

- Pour some milk into the plate until the bottom is covered.
- Mix the food colour with a few spoons of water until the food colour is not thick anymore.
- Add a few drops of each food colour with a pipette to the milk.
- Make sure the drops of paint are close together and roughly in the center of the plate.
- Dip one cotton swab into the milk until it is well wetted.
- Touch the dots of colour with the in milk wetted cotton swab.
- Dip another cotton swab in dish soap and touch the paint dots again with the cotton swab.

Figure 14 . Process of the experiment dancing colours [video taken by students]

OBSERVATION

Figure 15 . Video of the experiment dancing colours [video taken by students]

- When the milk is touched by the cotton swap with just water on it, nothing happens.
- When the milk is touched by the cotton swap with dish soap on it, the colours burst away on the surface of the liquid.

DISCUSSION

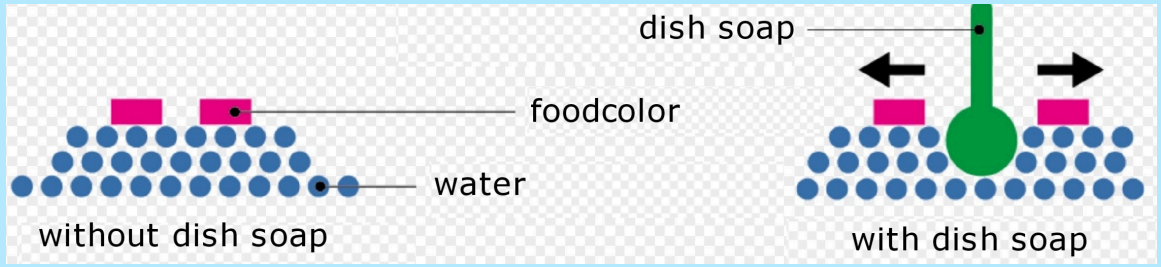

Figure 16 . Colour on milk [https://www.simplyscience.ch/kids/experimente/fliehende-farben#modal-28328]

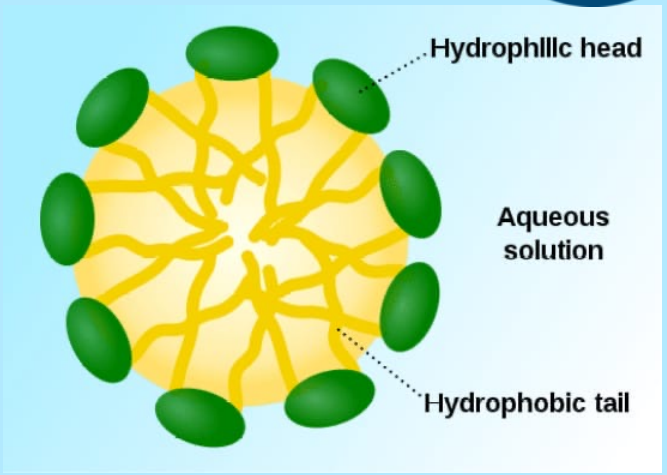

Figure 17. Structure of a micelle [https://en.wikipedia.org/wiki/Micelle]

- Adding water has no effect on the milk
- Milk contains water and fat
- Tensides: molecules with hydrophilic head and hydrophobic tail
- Fat and water get separated
- Soap molecules push water away = movement

- Tensides form micelles
  - heads of tensides on the outside and tails on the inside (fat gets trapped inside)
  - If soap is put in again = no/smaller reaction
- Fat gets closed in by micelles
- Fat flees from the lipophobic heads

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CHAPTER 04

TITRATION – Quantitative determination of lactic acid

QUESTIONS AND GOALS

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Research questions:

- How much lactic acid is in yoghurt?
- How can we calculate the result of the titration?

Research goals:

- Understanding the principle of titr ation
- Calculating how much lactic acid is in yoghurt

MATERIALS

- Erlenmeyer flask
- Distilled water
- Indicator: phenolphtaleine
- Sample 1: yoghurt 3,5 % fat
- Sample 2: yoghurt 1 % fat

Figure 18. Yoghurt [https://www.oekotest.de/static_files/images/article/Joghurt-selber-machen-ist-ganz-unkompliziert-_Shutterstock-Sea-Wave_11664_16x9.jpg]

- Burette
- NaOH: sodium hydroxide solution with concentration = 0,1 mol/litre
- Pipettes + peleus ball
- Scales + spoon

PROCEDURE

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1. At first 20g of sample 1 is transferred into the Erlenmeyer flask.
2. 20ml of distilled water is added
3. Finally 5 drops of phenolphtaleine to the Erlenmeyer flask are added

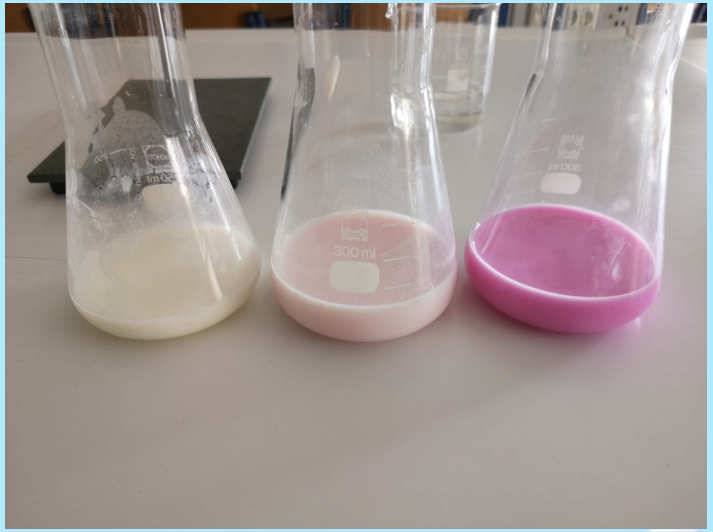
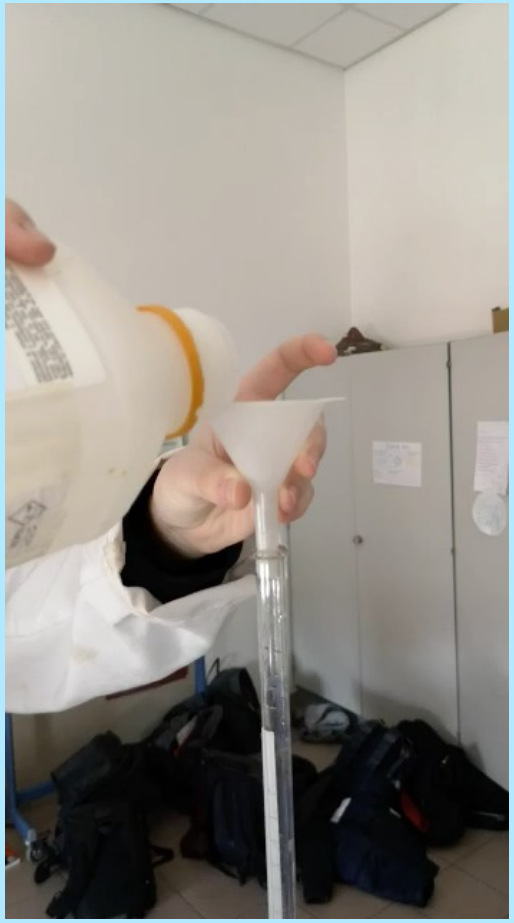


Figure 19. Colour change during the reaction [photo taken by students]

4. Equivalence point: titrate with 0.1M NaOH (in the burette) until a weak pink colour appears
5. Read the volume in ml
6. Repeat the titration with sample 2



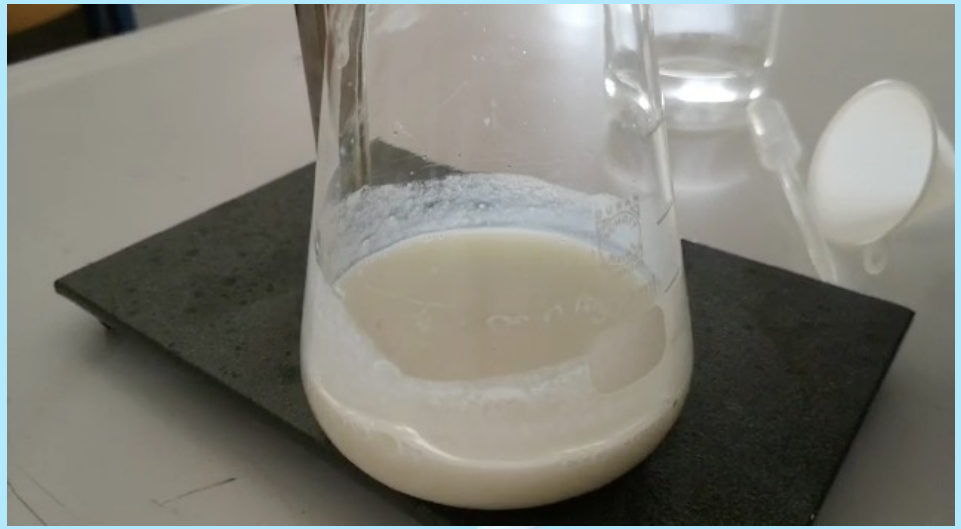


Figure 20. and 21. Videos of the titration [Videos taken by students]

The titration with NaOH to determine the lactic acid content of yoghurt

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WHAT HAPPENED ?

The sodium hydroxide neutralizes the lactic acid which is contained in the yoghurt until the equivalence point (dramatical pH-value change).

The indicator phenolphthaleine offers it in changing the colour to a weak pink which shows an alkaline pH-value

CALCULATION AND DISCUSSION

The lactic acid in yoghurt is produced by the lactic acid bacteria through fermentation.

The consumption of 1 ml sodium hydroxide solution, c (NaOH) = 0.1 mol/ L corresponds to a mass of 9 mg lactic acid.

<u>Results:</u>
Sample 1 contains 1,24% lactic acid.
Sample 2 containa 2,07% lactic acid.

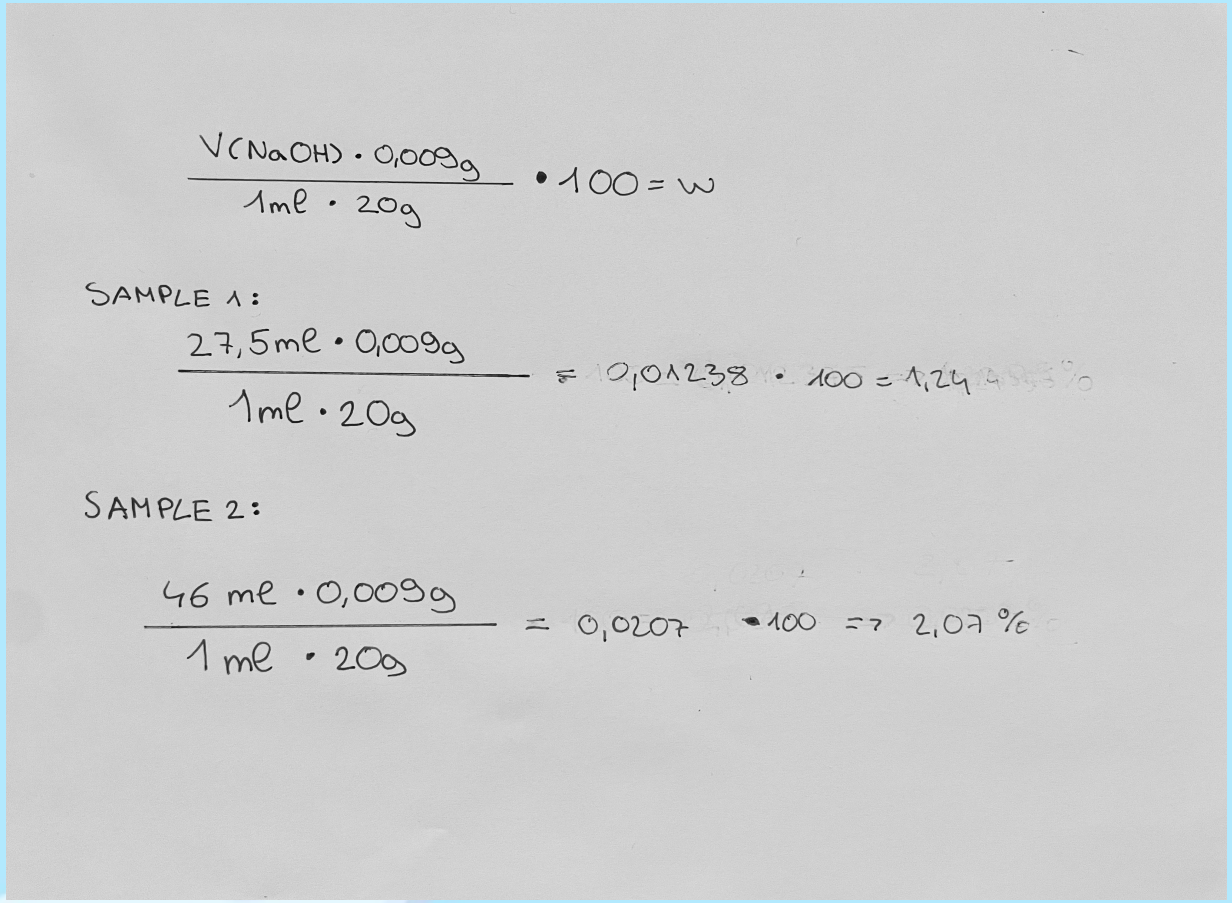

Figure 22. Calculation of the titration [photo taken by students]

PROJECT RESULTS SUMMARY

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- Learning scientific contents about the white gold milk
- Production of ricotta (cream cheese) and determination of milk proteins by Biuret reaction
- Experience and introduction to the subject of emulsions by means of experiments
- Studying the titration with the determination of lactic acid in whole milk

- Gaining scientific knowledge
- Experience practical laboratory work
- Improving teamwork

LITERATURE

Wie werden die Quellen angegeben?

Compound Interest (2018): https://www.compoundchem.com/2018/06/02/milk/
Autor (Jahr): URL--> siehe Padlet
Autor (Jahr): URL--> siehe Padlet
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