

LABORATORY PRACTICAL 1

Molecular Transformations of Milk During Cheese and Yoghurt Production

1. Introduction

Milk is a complex biological system composed mainly of water, proteins, fat, lactose, minerals and vitamins. The major milk proteins are divided into two groups: caseins, representing approximately 80% of total milk proteins; and whey proteins, representing approximately 20%. Caseins are organized into colloidal structures called casein micelles. At the normal pH of milk, approximately 6.6–6.7, these micelles remain dispersed and relatively stable. Milk can be transformed into cheese or yoghurt by destabilizing this protein system. Three important mechanisms can cause this transformation:

1. Enzymatic coagulation by rennet
2. Acid coagulation
3. Lactic acid fermentation by starter cultures

2. Objectives

- Distinguish between enzymatic and acid coagulation;
- understand the importance of calcium ions (Ca^{2+}) during rennet coagulation;
- compare the texture, whey separation, pH and appearance obtained by different treatments.

5. Materials

Milk and biological materials: Pasteurized whole or semi-skimmed milk; rennet; food-grade calcium chloride (CaCl_2); vinegar; lemon juice; cheese starter culture; yoghurt starter culture (*Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *Bulgaricus*).

Laboratory equipments: Thermometer; pH meter; water bath; cheesecloth or filter cloth; funnels; incubator.

PART A – RENNET COAGULATION: Rennet-coagulated cheese

1. Measure 100 mL of milk into a clean beaker.
2. Heat gently to approximately 32–35°C.
3. Measure and record the initial pH.
4. Add the appropriate quantity of diluted rennet.
5. Mix gently for approximately 20–30 seconds.
6. Stop stirring.
7. Incubate at approximately 32–35°C.
8. Record the time at which coagulation becomes visible.
9. Observe the firmness of the curd.
10. Cut the gel into small cubes.
11. Allow whey to separate.
12. Filter through cheesecloth.

PART B – Direct acid coagulation: Production of acid-coagulated fresh cheese

1. Measure 200 mL of milk into a beaker.
2. Record the initial pH.
3. Heat the milk to approximately 80–90°C without excessive boiling.
4. Remove the beaker from the heat.
5. Slowly add vinegar / lemon juice while stirring gently.
6. Add the acid gradually.
7. Observe the formation of white curd particles and yellow-green whey.
8. Measure the pH and continue acid addition until clear coagulation occurs: $\text{pH} \approx 4.6$
9. Allow the mixture to stand for 5–10 minutes.
10. Filter through cheesecloth and separate the curd from the whey.

PART C – Fermented fresh cheese: Cheese production using starter cultures

1. Measure 200 mL of pasteurized milk.
2. Record the initial pH.
3. Warm the milk 30–32°C
4. Add the recommended amount of starter culture.
5. Mix gently and cover the container.
6. Incubate at 30°C.
7. Measure pH periodically
9. Continue fermentation until substantial acidification and coagulation occur.
10. Filter the resulting coagulum through cheesecloth.
11. Allow whey to drain.
12. Record final curd mass.

PART D – Yoghurt production: Production of yoghurt using starter cultures

1. Measure 200 mL of milk.
2. Record the initial pH.
3. Heat the milk to approximately: 90–95°C for about 5 minutes
4. Cool the milk to approximately: 42–45°C
6. Add the yoghurt starter and mix gently.
7. Transfer the milk to a clean container.
8. Incubate at 42–44°C and avoid shaking the container during gel formation.
9. Monitor the pH.
10. Stop fermentation when a firm gel and an appropriate acidic pH (4.5–4.6).
11. Cool the yoghurt rapidly.