BATNA2 University
Faculty of Natural and Life Sciences (L1)
Academic year 2023-2024

Lab Practical 1: Titration of total acidity of Milk

❖ Objectives

At the end of this lab practical, the student will be able to:

- **To work** on the concept of acid and base in an aqueous solution, acid-base titration, equivalence point, and indicator.
- **To perform** a volumetric analysis using the colorimetric titration technique.
- **To determine** the concentration of lactic acid in a commercial milk sample.

❖ Principle

The principle of this experiment is to determine the **Dornic degree** of milk D°.

I- Theoretical part

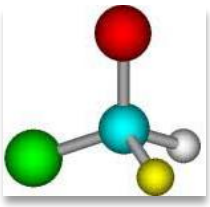
I-1-Definitions

➢ Lactic acid

- **Lactic acid** is a mono-hydroxyl acid (2-hydroxypropanoic acid). Its chemical formula is $C_3H_6O_3$.
- **Lactic acid** is the main constituent of milk. The bacteria in milk, in the presence of heating convert lactose to glucose and galactose, which is subsequently converted to lactic acid.
- **Lactic acid** is used extensively in the food and pharmaceutical industry for its acidifying and bacteriostatic properties.

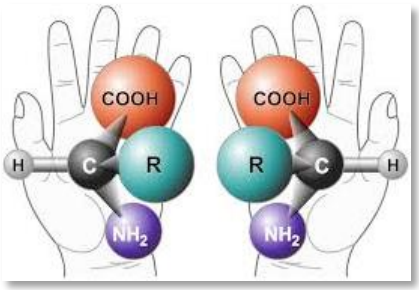
➢ Isomers

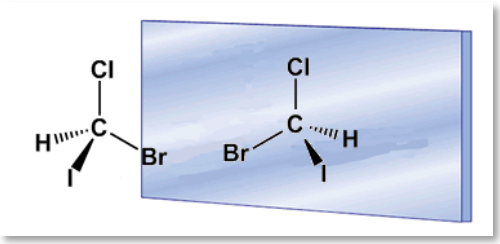
- Are different compounds that have the same molecular formula (brute).



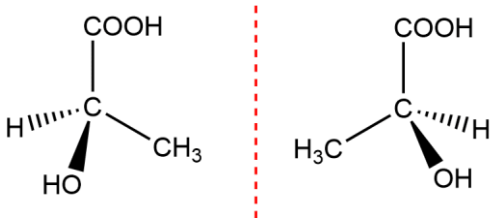
➢ Asymmetric carbon

- An **asymmetric carbon** is a carbon atom that is bonded to 4 different types of atoms or groups of atoms.
- The 4 atoms and/or groups attached to the carbon atom can be **arranged in space in two different ways** that are **mirror images** of each other, and which lead to *left-handed* (**S** or **L**) and *right-handed* (**R** or **D**) versions of the same molecule.
- Molecules that cannot be **superimposed** on their mirror image are said to be **chiral**.





Lactic acid is chiral, consisting of two optical isomers. One is known as L-lactic acid or (S)-lactic acid and the other, its mirror image, is D-lactic acid or (R)-lactic acid.

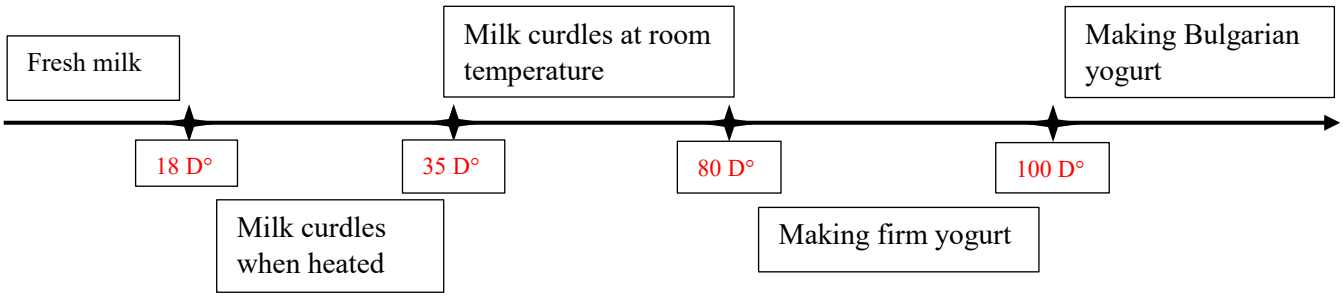


- **Dornic degree**

The acidity measure (expressed in Dornic degree) makes it possible to control the quality of raw milk: 1Dornic degree (1°D) is equal to 0.1g of lactic acid per liter.

$$D = \frac{Cm}{0.1}$$

Cm: mass concentration in g/L



- **Lactic acid Titration**

The amount of lactic acid in milk will be measured using colorimetric titration.

In a titration, **lactic acid in milk** serves as the analyte, and sodium hydroxide (NaOH) is used as the titrant.

I-2- Acid-base titration

- **Titration reaction**

$$CH_3CH(OH)COOH_{(aq)} + NaOH_{(aq)} \longrightarrow CH_3CH(OH)COONa_{(aq)} + H_2O_{(l)}$$

(acid) + (base) ⟶ (salt) + (water)

- **Use of indicator to obtain the equivalence point**
  - The equivalence point is reached by adding NaOH base to milk (lactic acid).
  - Add a few drops of phenolphthalein solution to the Erlenmeyer flask to find the equivalence point.
  - Phenolphthalein is colorless in acidic environments and pink in basic environments.
  - At the beginning of the experiment, the color of the solution is the color of milk (because the colored indicator is colorless in the acidic environment). When the solution is slightly pink, it means enough base has been added to react with all the acid. This color change is the titration equivalent point.

To calculate the concentration of milk we use the formula:

$$N_{Acid} \times V_{Acid} = N_{Base} \times V_{Base} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

N_{Acid}: unknown normality of acid in the Erlenmeyer flask.

N_{Base}: known normality of base in the burette.

$$N = x \times C \ (x = 1)$$

Equation (1) becomes as follows: $C_{Acid} \times V_{Acid} = C_{Base} \times V_{Base}$.

$$C_{Acid} = C_{Base} \times V_{Base} / V_{Acid}$$

C_{Base}: known concentration of **NaOH** in the burette.

C_{Acid}: unknown concentration of acid **$CH_3CH(OH)COOH$** solution in the Erlenmeyer flask.

- To calculate the mass concentration, we use the formula:

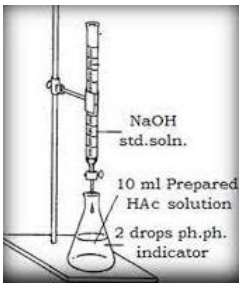
$$C_m = M_{CH3CH(OH)COOH} \times C_{Acid}$$

Lactic acid: $C_3H_6O_3$, $M_{CH3CH(OH)COOH} = 3M_C + 3M_O + 6M_H = (3\times12) + (3\times16) + (6\times1) = 90$ g/mol.

I- Practical part (Experimental protocol)

Material	Products
- Erlenmeyer flask, - Graduated cylinder - Graduated burette, -Funnel.	- NaOH solution, Milk - Colored Indicator, Distilled water.

To begin the experiment, carefully:



- Measure 5 ml of milk solution using a graduated cylinder.
- Transfer the measured volume to an Erlenmeyer flask.
- Add 1-2 drops of colored indicator (phenolphthalein).
- Fill the burette with 0.05 mol/L NaOH solution.
- Titrate the acid solution by adding NaOH solution drop-by-drop until the color changes (stop at the first permanent pale pink color).
- Take note of the volume of NaOH poured at the equivalency point.

Report

The report must contain:

-A cover page according to the model below.

- A detailed response to the questions at the end of the Lab Practical session.

Dr. FERHAT M and **Dr. BENCHERCHAR I**