**Lab 1: Ricotta cheese**

*Lab sections on Tuesday Sept 11 – Friday Sept 14*

In this lab we will use the acidic properties of vinegar to make ricotta cheese. As a way of understanding the cheese-making process better, we will then study the curdling of milk at different pH’s and temperatures, and combine our data into a phase diagram.

Equations of the week:



|  |  |  |
| --- | --- | --- |
|  | **Description** | **Units** |
| *[H+]* | Concentration of hydrogen ions | mol/L |



|  |  |  |
| --- | --- | --- |
|  | **Description** | **Units** |
| *Q* | Heat | J |
| *m* | Mass | g |
| *cp* | Specific heat | J/g˚C |
| *T* | Change in temperature | K |

**Part I: Ricotta and/or mató cheese**

When prepared with salt, this recipe makes a delicious homemade ricotta cheese. When prepared without salt, it is instead a traditional Catalan cheese called mató, that is usually eaten with honey. You can choose which of these cheeses you want to make by adapting the recipe below.

Materials:

* 1 induction burner
* 1 pot
* 1 strainer
* 1 whisk
* 1 thermometer
* measuring spoons
* cheese cloth
* 1 large bowl (for water bath)
* 1 medium bowl (for straining)

Ingredients:

* 1 liter whole milk
* 1 Tbsp white vinegar (15 ml)
* ½ tsp salt (2.5 ml)
* Honey
* Crackers

Procedure:

1. Prepare a big bowl with ice+water to put the pot in later.
2. Arrange the cheese cloth into **two single layers**, place it over a strainer, and put the strainer over a bowl as shown in the picture above.
3. Heat the milk while stirring (with salt if you chose to make ricotta, without salt if you chose to make mató). When the milk reaches 92˚C, remove the pot from the induction burner, add vinegar, and whisk rigorously.
4. Place the pot in the bowl of ice+water to cool down.
5. When the temperature reaches 36˚C, pour the contents of the pot onto the strainer covered with cheesecloth. This allows the whey to pass through, while the curds remain in the strainer. You may occasionally have to stir the curds **gently** to help the whey drain.
6. Fold the edges of the cheesecloth over the curds, and put everything (strainer+bowl) in the fridge until you have finished Part II.
7. Start working on Part II as you wait.
8. Eat with crackers. Add honey for the traditional version of Catalan mató.

**Part IIa: Curdled milk – pH dependence**

Materials:

* 1 microscope
* microscope slides
* cover slips
* pipette
* pipette tips
* eppendorf tubes and rack
* pH strips
* 2 water baths (60˚C and 90˚C)
* trash can for pipette tips
* plastic cups

Ingredients:

* milk
* vinegar
* water

Procedure:

1. Fill three plastic cups half way with milk, vinegar and water.
2. Using pH strips, measure the pH of all three solutions. Calculate the concentration of H+ ions in each solution. Record your results on the worksheet.
3. Label 5 eppendorf tubes A-E, and prepare the corresponding solutions as outlined on the worksheet (use the pipette to measure). Mix well, check the pH with pH strips, and record your values.
4. Label 5 new eppendorf tubes A-E, and add 500 µl of milk to each solution. Then add 500 µl of each solution from step 3. Shake gently to mix, measure the new pH, and examine the tube to see if the milk has curdled. Record your observations on the worksheet.
5. For the tubes that did not curdle, place them for ~1 minute in the 60˚C water bath. Then swirl the tubes around to see if they curdle.
6. For the tubes that did not curdle at 60˚C, place them for ~1 minute in the 90˚C water bath. Then swirl the tubes around to see if they curdle.
7. Record your results on the results chart, and plot on the provided phase diagram. Write “solid” versus “liquid” on either side of the line signifying the phase change on the phase diagram.
8. Throw out your tubes and move to Part IIb.

**Part IIb: Observing curdled milk under the microscope**

1. Using a pipetman, place a *small* drop of milk (~5µl) in the center of a microscope slide. Gently place a coverslip over the drop; do not press on the coverslip. The milk should spread out under the coverslip.
2. Observe the milk under the microscope. Start with the 10x objective lens and focus, before change to the 40x objective lens. You should be able to see the tiny fat globules jiggling around in the milk. Record what you see on the results chart.
3. Then repeat the same process: place a *small* drop of milk (~5µl) in the center of a microscope slide. Now add a *small* drop of vinegar (~5µl). Gently place a coverslip over the drop.
4. Observe the curdled milk in the microscope, paying particular attention to the behavior of the fat globules. Record what you see on the results chart.
5. Dispose of your microscope slides in the **broken glass** box, **not** in the regular trash.

**Lab 1: Worksheet**

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ TF: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Part IIa: Curdled milk – pH dependence**

1. Record your pH measurements below and calculate the corresponding H+ concentration.

pH of milk =

[H+] of milk=

pH of vinegar =

[H+] of vinegar=

pH of water =

[H+] of water=

2. Having more hydrogen ions in a solution makes it more acidic/basic (circle one)?

3. Record your measurements and observations below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |   |   |   |  |  ***Curdling? (yes/no)*** |
| **Sample** | **Water (µl)** | **Vinegar (µl)** | **Total Volume (µl)** | **pH** | **pH w/milk** | ***25˚C (room temp)*** | ***60˚C*** | ***90˚C*** |
| A | 0 | 1000 | 1000 |  |   |   |   |   |
| B | 900 | 100 | 1000 |  |   |   |   |   |
| C | 990 | 10 | 1000 |  |   |   |   |   |
| D | 999 | 1 | 1000 |  |   |   |   |   |
| E | 1000 | 0 | 1000 |  |   |   |   |   |

4. Plot your pH and temperature measurements on the chart below. Use the pH values from the “pH with milk” column in the table above. Hint: the phase change at a certain temperature will occur **between** the two pHs at which you do and do not observe curdling. Draw an approximate line showing where the phase transition occurs on the phase diagram, and write “solid” and “liquid” on either side of the line.

**Part IIb: Observing curdled milk under the microscope**

5. Draw a picture of what you observed looking at milk under the microscope.

6. Draw a picture of what you observed after you added vinegar.

7. Describe in words how the microscope image of milk changed after you added vinegar.