**Higher Biology**

**Metabolism in Microorganisms**





There are several steps in the manufacture of cheese. The milk is pasteurized (heated to ) to kill most of the bacteria, then other bacteria are added to convert the milk sugar (lactose) into lactic acid and enzymes are added to clot the proteins in milk.

The milk clotting enzyme known as rennet (chymosin), which was used originally, always came from animals such as calves. Nowadays the rennet enzymes used in cheese making can come from a variety of different sources. Some people find it unacceptable to eat a product which has been made from animals and this led to the hunt for an alternative milk clotting product. Some fungi were found which produced enzymes which clotted milk proteins. These fungi can be grown in fementers and large amounts of the enzyme can be extracted. In more recent years the genes, which the calves contain, to allow them to make chymosin have been identified. These genes have been put into yeast cells and the yeast cells then produce GM chymosin identical to the animal enzyme.

It is possible to investigate the milk clotting stage using these rennet enzymes.

1. Place 20 cm³ of milk into a small beaker and measure the pH
2. Add 2 cm³ of 0.02% calcium chloride solution
3. Stir the beaker and warm to 3°C in a water bath.
4. Add 0.2 cm³ of rennet enzyme, stir and measure the pH
5. Every 30 seconds dip a clean glass slide into the milk and record when flecks of curd appear on the slide (clotting time)
6. Record the pH

This will give a base line clotting time – it would be advisable to repeat this procedure several times to establish an average time to clot.

The way in which rennet works is affected by many different factors or variables such as:

* The type of rennet which is used
* The pH of the production mixture
* The temperature of the milk
* The type of milk which is used
* The concentration of calcium chloride which is used in the production mixture
* The amount of salt which is added to the production mixture

Find out about some of these variables and decide on which one you will investigate. (help cards are available)

For more information cheese making the following film:

<http://www.youtube.com/watch?v=RIfRnjf1CCM> shows the cheese manufacturing process.

This link gives an overview of cheese making <http://www.rsc.org/chemistryworld/2013/11/cheese-chemistry>.

Data sheets giving more information about the microbial nature of fungal and the GM rennet can be found on the NCBE website:

<http://www.ncbe.reading.ac.uk/ncbe/protocols/pracbiotech/PDF/rennet.pdf>