

CHEESEMAKING USING THE ARMFIELD CHEESE VAT

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INTRODUCTION

Cheese was probably made accidentally in the first instance by the carrying of milk in the stomachs of animals, when the milk clotting enzymes of the stomach converted the liquid milk into a solid mass. Cheesemaking was recognized very early as a convenient method of converting surplus milk into a product with a much longer life, occupying a smaller volume of a high nutritive value and both palatable and readily digestible.

Cheesemaking initially involves the use of certain bacteria under controlled conditions to form lactic acid followed by the removal of water and soluble constituents from the milk. These precise operations are carried out in a specially designed vessel, which allows accurate temperature control and careful agitation as well as fully hygienic processing.

The Armfield Cheese Vat (FT20-MkII) is a small-scale version of the industrial processing vessel in which these operations are carried out. Developed from the original design by a prominent dairy foods Research Institute, the vat, having a batch capacity of only 5 liters, is intended for use as a teaching aid in school and university laboratories. 'Cutting', 'scalding' and 'pitching' operations are carried out in the vat before the whey is 'drawn' through a special sieve arrangement. 'Consolidation and draining', 'milling' and 'salting' follow, again in the vat before the curd is packed into a mould for pressing.

A control console with comprehensive monitoring instrumentation is built into the plinth that houses the vat. Temperature control, agitator speed, pH and temperature indication are all included. Computer connections on the console allow coupling to a computer via the optional interface (FT20-MkII-90IFD). This allows continuous data logging of temperature, pH and agitator speed.

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EXPERIMENTAL PROCEDURE

OBJECT OF EXPERIMENT:

The yield and quality of cheese produced from a given batch of milk is of prime interest to the cheesemaker.

Using the Armfield Laboratory Cheese Vat a standard method of cheese production is possible. This allows comparison of yield and quality from differing milk compositions.

EQUIPMENT REQUIRED:

In addition to the Cheese Vat. and its accessories the following equipment will be required:

- Small thermostatically controlled oven
- Hotplate
- Refrigerator
- Freezer
- 1 Litre Glass Beaker
- Thermometer

Also a plentiful supply of chlorinated disinfectant, cleaning cloths and towels and a 10 litre container for milk and whey.

For cutting the curd in the vat a plastic or wooden knife should be used to prevent scratching the metal base.

SUMMARY OF THEORY:

Cheese production depends on a number of biological reactions which must occur in the correct sequence. Milk (preferably pasteurised) is held in the vat at a certain temperature and a lactic acid forming bacteria is added. This is usually a culture of *streptococcus cremoris* and *streptococcus lactis*. At a particular acidity *rennet*, a preparation of the enzyme rennin, is added to coagulate the protein.

Proteins in milk are numerous but can be classed into two main groups: casein and whey proteins.

Casein is a mixture of phosphoproteins which comprise about 80% of all the protein in milk, it exists as colloiddally dispersed bodies known as *micelles*. The casein micelle is composed of α_s - β -, K- casein. α_s -casein is coagulated by calcium ions and K-casein is insensitive to calcium. The K- casein exists on the outside of the micelle and so protects the α_s - casein from the action of calcium ions.

Rennet attracts the K- casein and makes it insoluble. Thus the α_s -casein is no longer protected from the calcium and combines and gels to form the CURD. The curd is then cut and heated to make it contract and expel the liquid whey which can be drained off to leave the curd in the vat.

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When whey is drained off, most of the water, lactose and whey proteins originally present in the milk are included.

	Composition of Cow's Milk (typical)	Composition of rennet whey
Water	87.3%	93%
Fat	3.8%	Up to 0.8%
Protein (Casein)	3.3% (2.8%)	Up to 0.9%
Lactose	4.9%	4.7%
Minerals	0.7%	0.6%
	100.0%	100%

Most of the proteins (coagulated) and fat remain in the curd. Further treatment of the curd involving 'cheddaring', salting, pressing and ripening allow the cheese to develop a characteristic texture and flavour.

PROCEDURE:

The Cheese Vat is designed for use with 5 litres (1.3 gallons) of milk. This will produce approximately 0.5kg of cheese.

The starter culture should have been prepared and stored in a refrigerator as detailed in section 'Operational Procedures'. Rennet is prepared from the enzyme rennin found in the stomachs of young calves. Vegetarian rennet is also available prepared from a similar enzyme to rennin but produced by certain micro-organisms. The rennet will have to be prepared in accordance with the manufacturer's instructions. Some rennets are received in a concentrated form and others in a dilute form.

Sterilize all equipment which will be in contact with the milk or milk products. This includes the cheese vat; paddle agitator; strainer, cheese knives, cheese moulds and all utensils.

It is best to use a standard chlorine based disinfectant for this but care must be taken to ensure all of the disinfectant has been completely rinsed off the equipment with cold potable water.

Start the circulator on the control console - the vat and console should have been previously set up for operation as detailed in the Installation, Assembly and Connection to Services sections. Set the circulator temperature set point to 31°C.

Add 5 liters of pasteurized whole milk to the vat. Start the paddle agitator and set the speed of the agitator to give approximately 15 traverses of the vat per minute.

When the contents of the vat reach 30°C (86°F) (the temperature of the contents of the vat will approach the temperature of the water being circulated in the jacket but will not

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quite reach this temperature) add 75mL (2.65 ounces) of the starter culture. Leave with agitation for 15 minutes. (1 ounce = 28.41 mL)

Add the rennet and continue stirring for five minutes.

Stop the agitator motor and remove the agitator paddle. This can be submerged in a dilute disinfectant solution until next required (remembering to rinse off before re-use).

Allow coagulum formation to occur for 45 mins. To avoid contamination during this period by airborne spores etc., it is advisable to cover the vat for this period. A lid is provided for this purpose.

Cutting the-curd after-this period of coagulation is a delicate operation. First use the vertical blade knife drawn lengthwise along the vat and then across it. Repeat this procedure with the horizontal blade knife. Care must be taken when immersing the knives and withdrawing them from the vat. The object is to convert the mass of curd into small individual cubes of approximately 1cm^3 .

Leave to 'heal' for 7 minutes.

Replace the agitator paddle (after cleaning and rinsing) and set the agitator motor to give 15 traverses per minute. Use the circulator temperature controller to increase the vat contents temperature from 30°C (86°F) to 39°C (102°F) over a period of 1 hour. This corresponds approximately to increasing the temperature setting on the controller by 2°C every 12 minutes. ($30^{\circ}\text{C} = 86^{\circ}\text{F}$; $39^{\circ}\text{C} = 102^{\circ}\text{F}$)

When at 39°C , leave with agitation for a further 1 hour.

Remove the agitator paddle. Using washed and rinsed hands, reach into the curds and whey and gently move as much curd as possible away from the vat outlet pipe. The cylindrical stainless steel strainer can now be located into the outlet pipe.

Allow to settle for 10 mins. This settling process is known as 'PITCHING'.

Positioning a suitable receptacle for collection of whey at the outlet valve discharge, carefully open the valve to allow drainage of the whey. The small quantity of curd trapped in the vat outlet can be caught in a kitchen sieve and returned to the vat.

Allow this whey drainage to continue for 10 mins. This draining process is known as 'DRAWING' the whey.

The curd is then milled into cubes of approximately $30 \times 20 \times 20\text{mm}$ using a plastic or wooden knife (to prevent scratching of the steel vat base).

Salt is then added (2.5% w/w) i.e. for approximately 0.5kg curd add 12gm of salt. Sprinkle on and mix in with fingers.

Leave to drain for 30 mins.

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NOTE: Since opening the vat outlet valve to drain the whey, the valve has remained in the fully open position.

PRESS: Pack the cubes of curd into the cheese press mould - all of the curd should fit into the mould. Press in the wooden follower. Install the mould and follower into the cheese press. The press is operated by pushing down on the upper cross bar against the spring tension - use maximum pressure and leave for approximately 8 hours.

Take the pressure off the mould then turn it upside down and place maximum pressure on it and leave for 3 days, turning daily.

Remove from the mould, rub well with lard and return to the press for 4 hours at maximum pressure to give a good finish to the coat.

Allow to dry in a cool well ventilated place for 24 hours.

At this point it is a good idea to melt cheese wax onto the cheese to prevent mould growth on the outside surface.

This cheese can be stored at approximately 7°C for 6 months although the flavour developed over only a few weeks can be acceptable.

Using an acid testing kit samples can be tested at the following stages during the cheesemaking process:-

At starting	0.14 to 0.16% acidity
At renneting	0.19 to 0.21% acidity
At cutting	0.14 to 0.16% acidity
At pitching	0.17 to 0.20% acidity
At drawing whey	0.21 to 0.23% acidity
At milling	0.75 to 0.85% acidity

A continuous plot of pH from the data logger facility can be obtained and the development of lactic acid can therefore be monitored in two ways.

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RESULTS:

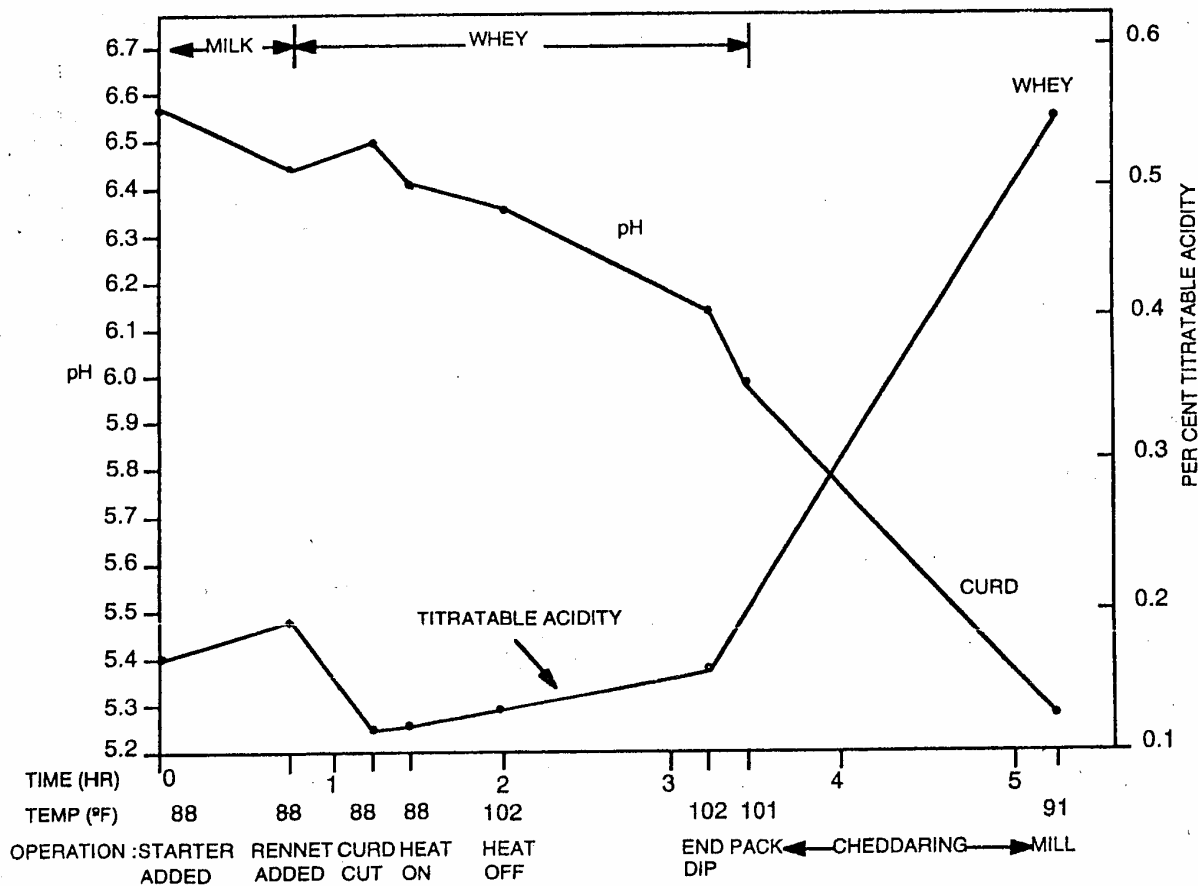
Due to its importance in bringing about the desired changes during cheese manufacture, the measurement of acid development by pH and titration is extremely informative.

Using the results obtained from acidity titration tests carried out at each stage of the process, and the pH plot from the data logger, plot a graph as follows:

NOTE: The curd pH can be found by detaching the pH probe from the vat and piercing the curd with the end point. This is an advantage not possible with the acid test kit.

Specimen.

Results:



Using batches of milk from cows having differing feed or the same cows feeding in different seasons, it is possible to prepare an accurate comparison of cheese yield and quality.