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Technical information note

Measuring pH

One of the most important properties affecting the safety of fermented dairy products such as yoghurt and cheese is acidity. Acidification is an age old method of food preservation and can be achieved through fermentation, the direct addition of acids, or both.

The most common measure of acidity is pH, which measures acidity on a scale ranging from 1 to 14. A pH value of 1 is most acidic, pH 14 is most alkaline, while a pH of 7 is neutral. A difference of one pH unit represents a 10 fold difference in strength. For example, pH 4 is ten times more acidic than pH 5.

Effect of pH on microorganisms

The pH of a product affects the survival and growth of microorganisms during processing, storage and distribution. Most bacteria grow optimally around pH 7 and pathogens seldom grow in foods with a pH of less than 4.5. Hence, lowering the pH (by fermentation and/or addition of acid) is an effective method of limiting bacterial growth. Acidic foods are most commonly spoiled by yeast and moulds, which are more acid tolerant than bacteria.

The pH ranges in which bacteria are capable of growth are influenced by a number of factors such as type of bacteria, water activity, type of acidulant and temperature. As the pH deviates outside the optimal range for pH, growth will be increasingly restricted.

Fermentation of milk converts lactose into lactic acid during the manufacture of products such as yoghurt and cheese. The presence of lactic acid in properly fermented foods results in a level of acidity which inhibits the growth of pathogenic bacteria. Monitoring pH to ensure the desired level is achieved during processing is therefore a vital part of a food safety program for all fermented dairy products.

Product	pH range
Milk	6.7-6.9
Butter	6.1-6.4
Yoghurt	2.0-4.5
Brie	6.0-6.5
Cheddar	5.1-5.3
Cream cheese	4.6-5.1
Feta	4.1-4.5
Parmesan	5.2-5.3
Ricotta	6.0

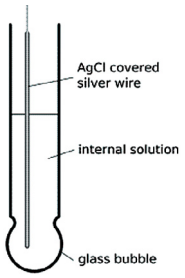
Table 2: pH values of some common dairy products

Micro-organism	Minimum pH for growth	Optimum pH for growth	Maximum pH for growth
B. cereus	4.9	6.0-7.0	10.0
Campylobacter spp.	4.9	6.5-7.5	9.5
E. coli	4.4	6.0-7.0	10.0
L. monocytogenes	4.4	6.0-8.0	9.6
Salmonella spp.	3.8	7.0-7.5	9.5
S. aureus (toxin production)	4.0 4.5	6.0-7.0 7.0-8.0	10.0 9.6

Table 1: Minimum, maximum and optimal pH for growth of food pathogens when other conditions are near optimum (FSANZ, 2013)

Measurement of pH

pH is measured using a pH meter which comprises an electrode and a meter (some incorporate both components in a single hand-held device). The instrument determines a pH value based on the concentration of hydrogen ions in the sample.



Instruments designed for use in food production environments and specifically for dairy products are commercially available. Many have electrodes capable of being inserted into semi-solid matrices such as cheese which allows accurate and convenient monitoring of such products.

Various types of pH meters are available, so for the best results, always follow the manufacturer's instructions on use and care of the electrode. Several factors impact on the accuracy of the pH measurement, including the calibration of the instrument, care and maintenance of the electrode, and the quality of the instrument.

Typical pH electrode

As most pH meters have a glass electrode, users need to ensure their use is limited to areas outside food production areas.

Key considerations when using a pH meter include the following:

Calibration

Calibration is an essential requirement for accurate pH measurement. A pH meter should always be calibrated using commercial buffer solutions of known pH prior to use. Ideally, calibration using buffers of two different pH values is performed (two point calibration). Where an acidic sample is to be measured, pH 7 and pH 4 buffers are used, while calibration with pH 7 and pH 10 buffers would be undertaken when measuring alkaline samples.

Most instruments automatically make the necessary internal adjustments during the calibration process. Care should be taken to avoid contaminating the buffers, and they should be replaced regularly, as recommended by the supplier.

Temperature

Measurement of pH is highly dependent on temperature. Most modern pH meters automatically compensate for this, however manufacturer's instructions should be followed closely. It is important that the sample is at a constant temperature and that the electrode is given time to correctly measure the temperature of the sample before recording the result.

Cleanliness of electrode/probe

Electrodes should always be thoroughly rinsed with distilled water after each measurement and carefully blotted dry.

Dairy products can easily foul the pH electrode due to a build-up of protein and milkfat. This may result in inaccurate pH readings. Specific electrode cleaning solutions are commercially available and it is important to ensure that an appropriate cleaning solution is used for the type of sample being measured.

Care of electrodes

Electrodes are fragile components with a limited lifespan, so they will require periodic replacement. Exposure to extreme temperatures or very acidic samples will reduce the lifespan of the electrode. A deteriorating electrode is characterised by slow response times and loss of repeatability.

Electrodes should not be allowed to dry out and should be stored in a designated storage solution (available from the manufacturer) or pH 7 buffer. If an electrode dries out it should be soaked until rehydrated.

pH electrodes are not suitable for use in measuring harsh substrates such as high salt, very hot or oily matrices. In such cases, pH test strips may be more suitable, although less accurate.

Inaccuracies in pH measurements can also result from a clogged junction, contaminated electrolyte, or physical damage.

Key points to consider

- Accurate monitoring of pH is essential during production of various dairy products to ensure that the control parameters in the food safety program are being achieved.
- The type of pH meter selected must be fit for purpose and capable of accurately and reliably performing measurements on the matrix being measured.
- pH meters should be calibrated prior to use, and reference buffers must be freshly dispensed, kept free from contamination and replaced regularly.
- Care and maintenance of electrodes is very important to ensure the ongoing accuracy of pH measurements. Electrodes must be kept clean and moist and replaced at the appropriate frequency.

References

FSANZ (2013) Agents of Foodborne Illness. Food Standards Australia New Zealand, Canberra

Further information

Further food safety technical information is available at **www.dairysafe.vic.gov.au**

Or contact Dairy Food Safety Victoria on **(03) 9810 5900** or **info@dairysafe.vic.gov.au**