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Technical information note

Water activity and its relevance

Water activity (A_w) is a measure of the available water in a food matrix. Water which is not bound to food components is available for microbial growth, so reducing the water activity is a reliable method of limiting the growth of pathogenic and spoilage organisms.

Water activity is measured on a scale from 0 (completely dehydrated) to 1.0 (pure water). This value represents the ratio of the water vapour pressure of the food to the water vapour pressure of pure water under the same conditions. Most foods have a water activity in the range of 0.2 (for very dry foods) to 0.99 (for moist fresh foods).

Water activity and microbial growth

In the absence of other inhibitory factors, all types of microorganisms will proliferate in foods with water activities greater than 0.95. However their ability to grow at lower values is dependent on a number of factors such as type of organism, temperature, pH and presence of preservatives. Bacteria will not grow at a water activity of less than 0.87, while yeasts and moulds are capable of growth at much lower levels (down to 0.7). Minimum water activity for growth of some important food pathogens are provided in Table 1.

Micro-organism	Minimum water activity for growth
B. cereus	0.93
Campylobacter spp.	0.987
E. coli	0.95
L. monocytogenes	0.92
Salmonella spp.	0.94
S. aureus (toxin production)	0.83 0.87

Table 1: Minimum water activity for growth of pathogens when other conditions are near optimum (FSANZ, 2013).

The moisture content of a dairy product is not a good indicator of water activity. Ingredients such as sugar and salt bind water, making it unavailable for microbial growth. Hence, moist foods with a high sugar and salt content will have a lower water activity compared to foods with the same moisture content but lower concentrations of salt and sugar. The moisture content and water activity of some common dairy products is shown in Table 2.

Product	Water content	Aw
Milk	88%	0.993-0.995
Dried Milk Products	2-4%	0.1-0.3
Butter (unsalted)	16%	>0.97
Butter (salted)	14%	0.91-0.94
Whole milk plain yoghurt	82-84%	0.97-0.99
Condensed milk (evaporated milk)	73%	0.98-0.99
Sweetened condensed milk	27%	0.77-0.85
Brie	45-49%	0.97-0.98
Cheddar	36-37%	0.90-0.95
Feta	50-57%	0.95
Parmesan	18-30%	0.85-0.92

Table 2: Approximate water content and water activity of some common dairy products (Ruegg, 1985, Dairy Processing Handbook, 2015).

Different dairy products can have highly variable water activities due to different production techniques (such as drying, salting, ripening and ingredients). There is often variation between the water activities of the same product due to the differences in conditions during preparation of individual batches.

In some dairy products such as dried powders, water activity is reduced to levels which cannot support microbial growth, enabling a very long shelf life. While bacteria are generally unable to grow in such products, some species can remain viable for long periods of time. Growth can then occur once the water activity is increased, such as when milk powders are reconstituted. A number of outbreaks have resulted from the contamination of infant milk powders with Salmonella and *Cronobacter sakazakii* (Motarjemi & Lelieveld, 2014). Reducing water activity is a control step NOT a kill step, and is a critical control point for products relying on this parameter for safety.

Measurement of water activity

Instruments for measuring water activity vary in their precision, calibration, stability of calibration and the accuracy of their sensor. Reliable results are only obtained from a correctly operated and calibrated instrument.

The most common method of measuring water activity involves allowing a food to come to equilibrium with a small headspace in a tight enclosure, and then measuring the relative humidity. Water activity is equal to equilibrium relative humidity (ERH) divided by 100 (a_w = ERH/100).

Instruments for measuring water activity are available from laboratory suppliers. Where testing is done in-house, the instrument should be operated and maintained according to the manufacturer's instructions, and calibration solutions should always be used. Commercial laboratories also offer testing services and it is important that the laboratory demonstrates competency in the testing method.

Key points to consider

- Water activity is an important predictor of microbial growth in food products.
- Bacteria, yeasts and moulds will grow prolifically at water activities greater than 0.95, particularly when other conditions such as pH and temperature are optimal.
- Dairy manufacturers need to understand how water activity affects the microbial safety and shelf life of their products.
- Measurement of water activity should be undertaken by a competent analyst.

References

Dairy Processing Handbook (2015) **Tetra Pak Processing Systems**, Sweden

FSANZ (2013) **Agents of Foodborne Illness. 2nd ed**, Food Standards Australia New Zealand, Canberra.

Motarjemi et. al. (2014) **Milk and Dairy Products. In Food Safety Management**. Motarjemi Y. and Lelieveld H. Eds. Academic Press. London. UK (p 111)

M. Ruegg (1985) Water in dairy products related to quality, with special reference to cheese. In **Properties of Water in Foods**. Volume 90 of the series **NATO ASI Series** pp 603-625

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**