FOOD SCIENCE AUSTRALIA
A JOINT VENTURE OF CSIRO AND AFISC

Food Science Australia Fact Sheet
February 2000

Water Activity

Water activity in food
Water in food which is not bound to food molecules can support the growth of bacteria, yeasts and moulds (fungi). The term water activity (a_w) refers to this unbound water.

The water activity of a food is not the same thing as its moisture content. Although moist foods are likely to have greater water activity than are dry foods, this is not always so; in fact a variety of foods may have exactly the same moisture content and yet have quite different water activities.

The typical water activity of some foodstuffs

Type of product	**Water Activity** (a_w)
Fresh meat and fish	.99
Bread	.95
Aged cheddar	.85
Jams and jellies	.8
Plum pudding	.8
Dried fruit	.6
Biscuits	.3
Milk powder	.2
Instant coffee	.2

Measuring water activity (a_w)
The water activity scale extends from 0 (bone dry) to 1.0 (pure water) but most foods have a water activity level in the range of 0.2 for very dry foods to 0.99 for moist fresh foods.

Water activity is in practice usually measured as equilibrium relative humidity (ERH).

The water activity (a_w) represents the ratio of the water vapour pressure of the food to the water vapour pressure of pure water under the same conditions and it is expressed as a fraction. If we multiply this ratio by 100, we obtain the equilibrium relative humidity (ERH) that the foodstuff would produce if enclosed with air in a sealed container at constant temperature. Thus a food with a water activity (a_w) of 0.7 would produce an ERH of 70%.

Predicting Food Spoilage
Water activity (a_w) has its most useful application in predicting the growth of bacteria, yeasts and moulds.

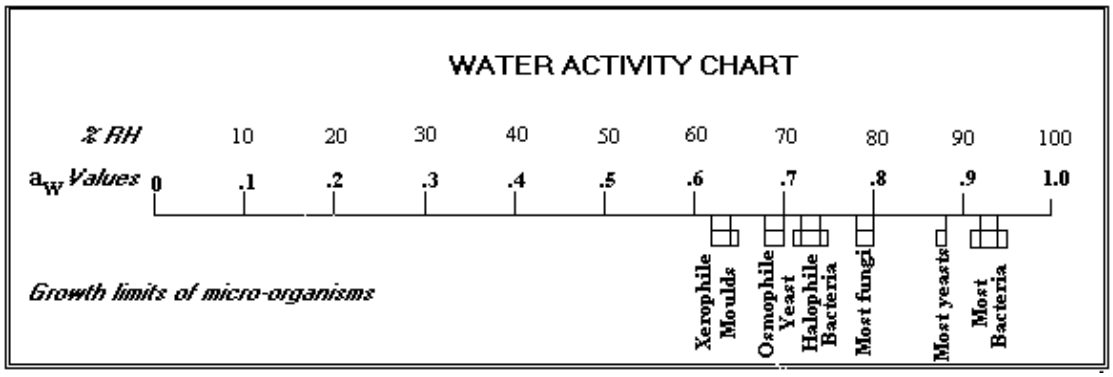
For a food to have a useful shelf life without relying on refrigerated storage, it is necessary to control either its acidity level (pH) or the level of water activity (a_w) or a suitable combination of the two. This can effectively increase the product's stability and make it possible to predict its shelf life under known ambient storage conditions.

Food can be made safe to store by lowering the water activity to a point that will not allow dangerous pathogens such as *Clostridium botulinum* and *Staphylococcus aureus* to grow in it.

The diagram below illustrates the water activity (a_w) levels which can support the growth of particular groups of bacteria, yeasts and moulds. For example we can see that food with a water activity below 0.6 will not support the growth of osmophilic yeasts. We also know that *Clostridium botulinum*, the most dangerous food poisoning bacterium, is unable to grow at an a_w of .93 and below.

The risk of food poisoning must be considered in low acid foods (pH > 4.5) with a water activity greater than 0.86 a_w.

Staphylococcus aureus, a common food poisoning organism, can grow down to this relatively low water activity level. Foods which may support the growth of this bacterium include cheese and fermented sausages stored above correct refrigeration temperatures.



Semi-moist foods
For foods with a relatively high water activity correct refrigeration is always necessary. These include most fresh foods and many processed foods such as soft cheeses and cured meats.

However many foods can be successfully stored at room temperature by proper control of their water activity (a_w).

These foods can be described as semi-moist and include fruit cakes, puddings and sweet sauces such as chocolate and caramel.

When these foods spoil, it is usually the result of surface mould growth. Most moulds cease to grow at a water activity level below about 0.8, but since some moulds will grow slowly at this a_w, it is usually recommended that products of this type do not have an a_w greater than 0.75.

While this will not ensure complete freedom from microbial spoilage, those few yeasts and moulds which do grow at lower water activities need only to be considered when special shelf life conditions must be met For example a commercial shelf life over twelve months might be required for confectionery; in these circumstances an a_w below 0.6 would be required.

Testing water activity (a_w)
A number of electronic instruments are available for measuring water activity (a_w).

A reliable method based on refractometry has been developed at the Sydney Laboratory and kits are available for sale by Food Science Australia. A refractometer with a precision of 0.001 is adequate.

Alternatively product samples may be tested for you at the Sydney Laboratory.

(For details of both kits and testing services contact Dr Bob Steele on (02) 9490 8333).

©Food Science Australia, 16 Julius Avenue Riverside Corporate Park Delhi Road (PO Box 52) North Ryde NSW 2113 Australia