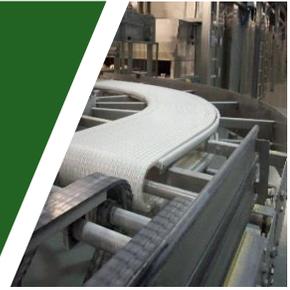


# Water Activity vs. Water Content



## FACT SHEET #33

Water is present in all food. It usually takes two forms:

- free or available water
- water that is bound to different molecules such as proteins and carbohydrates

Available water in food can support the growth of bacteria, yeast and mold, which can affect the safety and quality of food. Knowing the available water value of a food product or ingredient is necessary when conducting a hazard analysis.

### Water Activity ( $a_w$ )

- measurement of the availability of water for biological reactions
- expression :  $a_w = P/P_0$   
P: vapour pressure in a food  
P0: vapour pressure of pure water

### Water Activity of Common Food Products

| Foods                           | $a_w$     |
|---------------------------------|-----------|
| fresh meat, fish and vegetables | 0.99      |
| raw fruits                      | 0.98      |
| cooked meat, bread              | 0.91-0.98 |
| moist cakes                     | 0.90-0.95 |
| sausages, syrups                | 0.87-0.91 |
| flours, rice, beans, peas       | 0.80-0.87 |
| salami                          | 0.82      |
| jams, marmalades, jellies       | 0.75-0.80 |
| dried fruits                    | 0.60-0.65 |
| dried spices, milk powder       | 0.20-0.60 |
| biscuits, chocolate             | <0.60     |

### Water Content (Moisture Content)

- measurement of the total water contained in a food including available water and bound water
- expression:  $Mw \text{ (wet basis)} = \frac{w-d}{w} \times 100$
- Mw: moisture content on a wet percent basis  
w: wet weight      d: dry weight

### Water Content of Common Food Products

| Foods            | % Water |
|------------------|---------|
| apple            | 84      |
| orange           | 87      |
| broccoli         | 91      |
| beef, raw        | 73      |
| chicken, raw     | 69      |
| beef, cooked     | 62      |
| chicken, cooked  | 62      |
| salami, beef     | 60      |
| bread            | 36      |
| jams/preserves   | 30      |
| beef jerky       | 23      |
| wheat flour      | 11      |
| cookies/biscuits | 6       |

## Relationship between Water Content and Water Activity

The relationship between water content and water activity is complex and related to the relative humidity of the food and its water content. This relationship must be determined for each specific food item.

Water content on its own is not enough information to determine food safety or predict product shelf life.

### Factors that Influence Water Activity

- Drying**  
 Water activity is decreased by physically removing water, ex: beef jerky.
- Solutes**  
 Water activity is decreased by adding solutes such as salt or sugar, ex: jams.
- Freezing**  
 Water activity is decreased by freezing, ex: water is removed in the form of ice.
- Combination**  
 One or more factors can be combined for a greater influence on water activity, ex: salting and drying fish.

### When and How to Test

There are a variety of tests for determining water content and water activity:

|                       | Useful when  | Method  |
|-----------------------|--|---|
| <b>Water Activity</b> | <ul style="list-style-type: none"> <li>determining the safety or shelf stability of a product</li> </ul>                                 | 1) Health Canada - Compendium of Analytical Methods<br>2) Water Activity Meters |
| <b>Water Content</b>  | <ul style="list-style-type: none"> <li>confirming the end point of a drying process</li> <li>knowing the dry weight of a food</li> </ul> | 1) Official Methods of Analysis of AOAC International<br>2) Moisture analyzers  |

### Typical Water Activity Limits for Organisms

| Group of Micro-Organisms  | Minimum $a_w$ required for growth         |
|---|---|
| most gram-negative bacteria   | 0.97                                      |
| most gram-positive bacteria   | 0.90                                      |
| most yeasts   | 0.88                                      |
| <i>Staphylococcus aureus</i>  | 0.86<br>(produce toxin at 0.93)           |
| Halophilic bacteria<br>(grow best at high salt concentrations)                      | 0.75                                      |
| Xerophilic moulds<br>(grow on dry foods)  | 0.62-0.60                                 |
| Osmophilic yeasts<br>(grow in high concentrations of organic compounds, ex: sugars) | 0.62-0.60                                 |
| <i>Penicillium cyclopium</i><br>(produce Ochratoxin)                                | 0.82-0.85<br>(produce toxin at 0.87-0.90) |
| <i>Aspergillus flavus</i><br><i>Aspergillus parasiticus</i><br>(produce Aflatoxins) | 0.82<br>(produce toxin at 0.83-0.87)      |
| <i>Penicillium expansum</i><br>(produce Patulin)                                    | 0.81<br>(produce toxin at 0.99)           |
| <i>Penicillium patulum</i><br>(produce Patulin)                                     | 0.81<br>(produce toxin at 0.95)           |
| <i>Aspergillus ochraceus</i><br>(produce Ochratoxin)                                | 0.77<br>(produce toxin at 0.85)           |
| most moulds   | 0.80                                      |

For more information on food safety please contact the Food Safety and Inspection Branch at [foodsafety@gov.mb.ca](mailto:foodsafety@gov.mb.ca) or call 204-795-8418 in Winnipeg.