

Interpreting Water Activity Lab Results for Food Producers

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What is water activity?

The water activity (a_w) of a food measures the amount of free water available to participate in chemical and microbial reactions. “Free water” is water that is not bound to other molecules within the food, such as proteins or carbohydrates. It can support the growth of bacteria, yeasts, and molds while also influencing chemical reaction rates (such as lipid oxidation) and physical properties (such as odor or color). Water activity is measured on a scale ranging from 0.0 to 1.0, with 1.0 representing pure water (Table 1).

Table 1. Water activity values of common foods.

Food	Water Activity
Fresh fruit and vegetables, milk	0.98-1.00
Processed cheeses, bread	0.93-0.98
Fermented sausages	0.83-0.87
Jams	0.75-0.80
Dried fruits	0.60-0.75
Powdered milk, spices	0.20-0.60

How is water activity linked to safety, spoilage, and shelf-life?

Water activity is one of many elements contributing to the growth of microorganisms in food. Different

species of bacteria, yeasts, and molds require varying amounts of free water to support their growth. Because of this, water activity may be reduced to slow or prevent the growth of microorganisms (Table 2).

Table 2. Minimum water activity values for the growth of common microbial contaminants.

Bacteria	Water Activity
<i>Clostridium botulinum</i> Type E	0.97
<i>Escherichia coli</i> , <i>Salmonella</i>	0.95
<i>Clostridium botulinum</i> Types A, B	0.94
<i>Bacillus cereus</i>	0.93
<i>Listeria monocytogenes</i>	0.92

Decreases in microbial contamination and/or growth will allow products to maintain quality and safety for longer.

Additionally, water activity contributes to the chemical stability of foods (Figure 1).

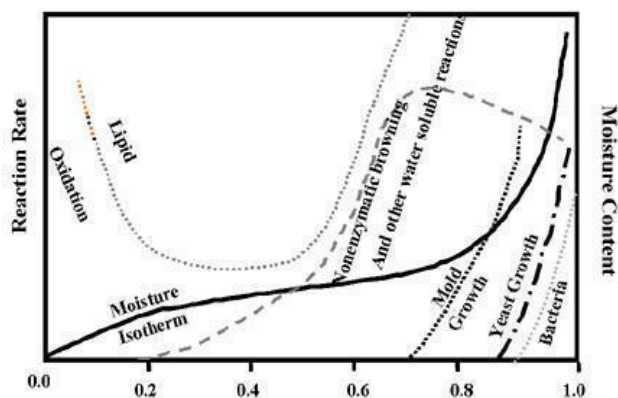


Figure 1. Water activity versus chemical and microbial reaction rates.

Lipid oxidation, which occurs over time when fats are exposed to water or oxygen, occurs at a slower rate as water activity decreases. Products containing oxidized lipids develop stale and rancid odors and flavors. It is important to note that lipid oxidation rates begin to rise again when water activity drops below 0.40.

What is a water activity-controlled food?

The Food and Drug Administration (FDA) recognizes foods with a water activity level below 0.85 as “water activity-controlled”. This means there is not enough water in the food to support the growth of harmful microorganisms. While some yeasts and molds may grow in foods with a water activity less than 0.85, it is currently understood that pathogenic bacteria cannot.

Water activity-controlled foods are exempt from the FDA acidified food regulations (21 CFR Part 114). Producers are exempt from filing as an acidified food producer for recipes which qualify as water activity-controlled (21 CFR Part 114).

How to tell if your food is water activity-controlled?

The only way to know if your food qualifies as a water activity-controlled food is to have the water activity of the food product accurately tested. Accurate determination of water activity requires the use of a specialized meter. Since purchasing the instrument is not cost effective for many small and mid-size producers, products may be submitted to

the Food Producer Technical Assistance Network (FPTAN) in the Department of Food Science and Technology at Virginia Tech for affordable water activity testing. An evaluation request form is available through the Virginia Cooperative Extension website:

https://vce.az1.qualtrics.com/jfe/form/SV_eUKzGAEQg0W7i9n.

A detailed description of the product recipe should be filled out on the form. Producers must list the ingredient name, amount used, description, and brand name for each ingredient in their formulation (Figure 2).

Ingredient	Amount	Unit	Description	Brand
Tomatoes, diced	500	grams	canned with salt	Contadina

Figure 2. Excerpt of product evaluation request form ingredient description.

Submitting the evaluation request form is free of charge and a producer is under no obligation to use the testing service provided by the FPTAN laboratory just by submitting a request. If a producer decides to submit samples for evaluation, the cost of services will be sent via an invoice after services have been rendered (Table 3).

Table 3. Type and cost of services offered through the Food Producer Technical Assistance Network.

Service	Cost (\$)
Product Evaluation, Process Validation, and Scheduled Process Report for Acidified Foods	\$125/product for the first product and \$75/product for subsequent products submitted at the same time
Food Product Evaluation and Report (includes pH and water activity analysis; no scheduled process report issued)	\$75/product
Nutrition Facts Label Calculation	\$75/product

pH Analysis only	\$40/product
Water Activity Analysis only	\$45/product

Other services including label review or ingredient statement assistance outside of the laboratory evaluation and report are available at a rate of \$61/hour, to the nearest half hour.

Questions about pricing or FPTAN services should be directed to the program's director, Melissa Wright, at foodbiz@vt.edu.

How to use your FPTAN water activity results and report?

Product evaluation and scheduled process reports provided by the FPTAN offer food producers guidance on the applicable regulatory requirements for their product(s) based on testing results. Evaluation will identify which regulations the producer must follow. Additional services may be requested to assist producers in meeting these regulations.

To use your results and report to identify whether or not your food product can be classified as water activity-controlled, open the report to the introductory section and look for the table detailing the water activity data for the product. If **all** of the water activity measurements listed are below 0.85, the food product can be classified as a water activity-controlled product. If **any** of the water activity measurements listed are at or above 0.85, the food product cannot be classified as a water activity-controlled product. An example is provided below (Figure 3).

Product Name	Water Activity	Classification
Snickerdoodle Cookies	0.6990	Water-Activity Controlled; Exempt

Figure 3. Example water activity result table in a product evaluation report provided by the Food Producer Technical Assistance Network.

How often should you check the water activity of your food product?

Products should be resubmitted for water activity testing when changes to the recipe or processing methods have been made. Changes to the recipe may include adding ingredients, removing ingredients, or changing the quantity of current ingredients. However, since there are many factors outside of the recipe and processing methods that can impact a food product's water activity, food producers should also consider periodically verifying the water activity of their food products throughout the year even if no changes to the recipe or processing methods have been made.

Additional resources

Commonwealth Scientific and Industrial Research Organization (CSIRO) Division of Food Science and Technology. 1995. Water Activity in Food. Available at: <https://pmp.errc.ars.usda.gov/WaterActivity.aspx>. Accessed July 2, 2024.

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2024

FST-485NP