

Water Activity and Shelf-Stable Meat Products

How to Profit from
this Required
Measurement



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LAB
BY DECAGON

Water activity. You have to measure it. But you can also profit from it, and this guide will show you how.

USDA inspectors expect to see water activity as a critical control point (CCP) in HACCP plans, typically during drying and packaging.

A water activity below 0.85 is an FSIS regulatory requirement for shelf stability according to **HACCP Model 10 - Generic HACCP Model for Heat Treated, Shelf Stable Meat and Poultry Products**.

Other moisture measurements, including MPR and moisture content, are “not safety considerations” and aren’t included in HACCP plans.

The USDA explains, “Product **water activity** is best correlated to inhibition of each pathogen’s growth.”

But why?

Locking Up Water

As Marianski so vividly puts it in *The Art of Making Fermented Sausages*, controlling water activity “is like stealing food from the bacteria.” Lowering water activity “locks up” water, ultimately making it impossible for bacteria to reproduce.

Let’s look at this in more detail.

Listeria, E. Coli, Staph, and Salmonella are tiny organisms, and like any organism they need water to grow and reproduce.

They get that water by sucking it in through the cell membrane that surrounds them.

This suction power comes from **energy differences** between the water outside and the water inside the cell.

How Water Moves

It’s easy to see that water moves from high

to low energy: picture molecules from high energy boiling water steaming into the lower energy atmosphere.

Energy differences between a cracker and a piece of cheese are less extreme, but as the cheese sits on the cracker, water molecules will move from the cheese, in which the water has a higher energy, to the cracker, in which the energy is lower.

This principle holds true at the molecular level too, and pathogenic bacteria use it to pull water from the higher water energy environment outside the cell to a lower water energy environment within the cell.

Creating Osmotic Stress

If you lower the water energy outside the cell enough, it causes “osmotic stress”: the cell can’t take up water and becomes dormant.

Osmotic stress doesn’t kill pathogenic bacteria, it just makes them unable to reproduce. Water activity is simply a measure of the energy status of water in a material. You can use it to see if the water in a piece of jerky has enough energy to support a particular strain of bacteria.

Different pathogens cope with osmotic stress in different ways. That’s why Staph, say, is able to survive at lower water activities than Listeria.

Control Microbial Growth

Lowering water activity doesn’t kill bacteria, but after a kill step like heat treatment, water activity will control bacterial growth, and that’s why it’s the FSIS’s moisture measurement of choice.

It can be much more, however. Water activity has significance beyond FSIS, the FDA, and HACCP. It’s a powerful way to measure and understand water in your product.

Moisture Super-Spec

There's a guy in our office who likes his jerky to be just a little tougher than old shoe leather. Most other people in our taste tests preferred a moister, more easily chewed product.

Only you know your market and the texture you're aiming for. But water activity specs should be part of your **recipe for consistency**. Because once you've identified the water activity sweet spot--the point at which your jerky is safe and savored--you want to turn that point into a moisture super-spec.

Right Every Time

The beauty of water activity is that you actually know when it's done--done right--and you can dry to that exact point every time.

- you can measure during drying to make sure that each batch reaches that point
- you know you have satisfied safety requirements
- you know that you are not over- or under-drying your product

A Quick and Easy Measurement

Traditional moisture content measurements are nearly impossible to make during the drying process. Water activity can be measured at the line in 5 minutes or less.

A Test Anyone Can Run

If you can microwave a burrito, you can measure water activity to 0.003 a_w . Really. No science degree required.

Consistency Batch to Batch

Unlike other moisture measurements, water activity is standards based. This makes it easy to comply with HACCP procedures that require verification, and it also makes it easy to compare values from batch to batch, between processing locations, and even between suppliers and buyers. It's beautiful: a moisture number tied to safety on one side and standards on the other.

Prevent Losses from Over-Drying

In product testing, we found that over-drying jerky is easy to do if you don't monitor water activity. **Even small variations have an effect on quality and profits.** In fact, we found that a small difference in water activity spec was like tossing a quarter into each bag of jerky before shipping.

You can calculate what inconsistency in drying could be costing you.

www.aqualab.com/over-drying

Strategies for a Safe Product

We tested a wide variety of shelf stable meat products in our lab. These products were controlling water activity using a number of different humectants, including salt, soy sauce, and sugar. Only one contained glycerine, a very common humectant.

As these products show on the back cover chart, there are many strategies you can use to get to a safe water activity.

Sophisticated Formulation

This guide is about the basics of water activity and shelf-stable meats. If you're interested, you can go much deeper in understanding and controlling moisture in your product. For example:

- learn how to control water activity by **adding humectants** (salt, sugar, soy sauce)
- model what happens when you **vary drying time and temperature**
- **determine the shelf life** of your product
- understand what happens if a product is stored at **high temperatures or humidities**
- **evaluate packaging materials** and understand the interaction between packaging and shelf life
- discover how **wetting up or drying out** your product affects its water activity

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Water activity of Processed Meats

Type	% Moisture	Water Activity
Italian Sausage Crumbles	51.18	0.9714
Turkey Sausage Snack Slices	55.02	0.9404
Beef Steak Tender Bites - Teriyaki	37.45	0.8664
Beef Jerky	40.66	0.8655
Beef Steak - Sweet Bourbon BBQ	36.07	0.8524
Chicken Nuggets - Flamin' Buffalo	40.51	0.8344
Pepperoni (slices)	25.89	0.8344
Beef Jerky - Original	32.37	0.8336
Primal Strips - Hot & Spicy	26.04	0.8309
Natural Buffalo Jerky - Original	24.9	0.8286
Turkey Jerky - Original	28.52	0.8221
Original Beef Jerky	27.7	0.8198
BBQ Pork Jerky	23.55	0.8151
Slim Jim Twin Pack - Original	17.23	0.7903
Organic Beef Jerky - Teriyaki	25.59	0.7899
Beef Jerky - Original	25.05	0.7836
Beef Jerky - Original	28.4	0.7768
Beef Jerky - Original	27.19	0.7764
Bacon Jerky	18.58	0.7542
Jerky Chew - Original	29.46	0.733
Pepperoni Stick - Original	11.06	0.7094
Natural Salmon Jerky - Original	16.43	0.7094
Beef Jerky - Old Fashioned	20.13	0.6701
Natural Ahi Tuna Jerky - Original	14.74	0.6069
Beef Jerky Slab	13.95	0.5798