

Water Activity (a_w) “REAL” versus Theoretical

What is REAL water activity?

Water activity or a_w is the partial vapor pressure of **water** in a substance divided by the standard state partial vapor pressure of **water**. In simplified terms, a_w is the measure of “free” water in food or other product of interest that is available to support the growth of microorganisms including spoilage organisms.

The dilemma faced by many companies is that many foods take quite some time (sometimes hours) to actually reach this equilibrium. Factors such as particle size, food makeup (fats, proteins, temperature, salt content, etc.) can all affect how long it takes a sample to reach the “TRUE” equilibrium and therefore the TRUE water activity.

Many [water activity meter](#) suppliers based on customer demands, have developed software that takes several readings, and then projects the final water activity. These projections might give results in 5 minutes or less, but they are not “REAL” water activity readings. As soon as you start doing software projections you introduce significant error.

In the case of Water Activity, the error of such projections is no less than $\pm 0.015 a_w$. This conflicts directly with many claims of accuracies of as good as $\pm 0.001 a_w$ to $\pm 0.003 a_w$. As per the FDA, even $0.003 a_w$ is “theoretical.” The use of a chilled mirror makes this accuracy theoretically possible. But as per the FDA studies, water activity changes by $\pm 0.005 a_w$ for every 0.1°C variance between the product and the headspace being measured¹. Yet, the best of these meters only claim to control temperature by $\pm 0.2^\circ\text{C}$ or $\pm 0.01 a_w$.

Most a_w meters use software that actually projects the a_w number. When using the QUICK mode, even these companies state that you should only expect an accuracy of $\pm 0.015 a_w$ not the theoretical $\pm 0.003 a_w$! These facts throw the entire food industry into a conundrum if you are actually using 3 decimals. You can no longer trust the accuracy claims of your expensive water activity meters.

Adding the errors from software projections, and temperature variances alone (we have not even discussed other variables yet), your ultra-precise(?) water activity meter could be off by over $\pm 0.025 a_w$! The regulatory bodies know this already and for this reason their requirements only show 2 decimals. Based on this, it could take you hours to get “REAL” water activity.



GOOD NEWS. Scigiene comes to the rescue with our NEW [Humimeter AW3 water activity](#) kit. In order to speed up true a_w readings, we properly homogenize a larger sample. The larger sample reduces variance seen by taking too small a sample, and the finer grind gives a much greater surface area for moisture transfer, for faster and more accurate TRUE water activity in under 5 minutes.

This will give true accuracy and not software generated guessing!

Our [Humimeter AW3](#) contains a small fan that speeds up the true

equilibrium and prevents RH stratification that occurs in other makes.

Finally, to eliminate the temperature variance we use a thermally insulated sample holder to reduce/eliminate temperature variance, and thereby increasing our accuracy even further.

Another critical issue is the lack of frequent calibration due to the cost of single use standards. Scigiene has developed reusable a_w **gravimetric** standards to encourage frequent and easy calibration, as well as certified single use standards, that can be used periodically to validate the meter and the reusable daily standards. This may be the single most important part of our program!

Theoretical 3 decimal accuracy claims, would require a new meter with a clean sensor and just calibrated at precise temperatures. Chilled mirror RH sensors are extremely delicate and most people do not clean them, so their meter waits for a year until it is sent back to the supplier for cleaning and



recertification. In the interim, drift over and above those discussed is occurring. In these instances, daily calibration checks are paramount. Scigiene offers cost effective solutions with our dual standard kits!

WATER ACTIVITY (a_w) OF SOME COMMON FOODS

Liverwurst	0.96
Cheese Spread	0.95
Red Bean Paste	0.93
Caviar	0.92
Fudge Sauce	0.83
Soft Moist Pet Food	0.83
Salami	0.82
Soy Sauce	0.80
Peanut Butter 15% total moisture	0.70
Dry Milk 8% total moisture	0.70

Microorganism Inhibited

	a_w
Clostridium botulinum E	0.97
Pseudomonas fluorescens	0.97
Clostridium perfringens	0.95
Escherichia coli	0.95
Clostridium botulinum A, B	0.94
Salmonella	0.93
Vibrio cholerae	0.95
Bacillus cereus	0.93
Listeria monocytogenes	0.92, (0.90 in 30% glycerol)
Bacillus subtilis	0.91
Staphylococcus aureus	0.86
Most molds	0.80
Clostridium botulinum E	<0.60

References:

1. "Water Activity (a_w) in Foods, Inspection Technical Guides", Food and Drug Administration (Updated 01/27/2015)



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