Achieving Constant Weight in the TrueDry CV9

By Dr. Brady Carter

Moisture content is a measure of the quantity of water in a product reported on either a wet or dry basis. Moisture content provides valuable information about yield and purity, making it important from a financial standpoint. In addition, moisture content provides information about texture since increasing levels of moisture provide mobility and lower the glass transition temperature. In theory, moisture content determination is simply a comparison of the amount of water in a product to the mass of everything else in the product. While it is simple in theory, further investigation of moisture content demonstrates that for such a simple concept, it is an extremely complex process to actually obtain reliable results.

When is the test done?

Due to the absence of a scientific definition of "dry", all moisture methods suffer from an ambiguity in knowing when a test is complete. The Food Analysis Handbook recommends drying until weight stops changing (Bradley 2010). The instructions given to determine if weight has stopped changing are to take two weight readings 30 minutes apart and determine if they are within a specified limit of each other. An example of a 0.1-0.2 g weight change limit for a 5 gram sample is given, but no specific values are provided. Many standard methods from organizations such as AOAC, AACC, ISO, ASTM, and SSA state to dry to constant weight, but typically do not specify a limit and instead provide an estimated test time. These recommended test times purposefully are set to be conservatively long to increase the likelihood that the sample has ceased releasing water when the test is ended. The main reason for choosing to list test times over drying to constant weight is that the process to determine if weight has stopped changing when using a conventional oven is tedious and time consuming to a point of rendering it unlikely even by the most dedicated lab technician. The process requires removing the samples, cooling them in a desiccator for 30 minutes, weighing, and then placing back in the oven and repeating the process again to allow comparisons between the weight readings. The demand on a lab technician with multiple tasks is too great to be reasonable. The solution would be to automate the process of determining constant weight.

The Solution: The AquaLab TrueDry CV-9

The AquaLab TrueDry CV9 utilizes a unique design combined with a sound scientific understanding of moisture loss to create the ideal loss-on-drying moisture analyzer that can dry to constant weight. A turntable approach enables high sample throughput by analyzing up to 9 samples simultaneously using any loss-on-drying reference method. The temperature of each sample is controlled individually using controlled contact drying and the weight loss of each sample is tracked over time. An easy to use test setup interface makes it simple to match any loss-on-drying reference moisture method without the need to use extreme temperatures to predict the moisture content.

With the TrueDry system, to dry to constant weight instead of to a recommended test time, the user simply sets a desired weight change limit, or trigger value, expressed as a percent change in weight vs. time. The more stringent or smaller the weight change limit, the longer the test time, but the more likely to have achieved constant weight. The TrueDry system will track the weight of each of the 9 samples individually and will make a comparison between each reading until the percent weight change falls below the trigger value. The instrument will continue testing until the rate of weight change for all samples has reached the trigger value, which will end the test. The only work required by personnel is to setup the test and load the

samples, the rest is done automatically. This makes it reasonable to dry all samples to a constant weight, giving meaning to the word "dry". It has the added benefit of typically reducing test time since as stated earlier, recommended test times for standard methods have to be conservatively long to ensure constant weight.

What is an appropriate trigger value?

The TrueDry sets a default trigger value to indicate constant weight at 0.001%/min. This value will work for most samples, but may need to be adjusted to achieve the same results as the recommended test time. To provide more specific recommendations for trigger values, AquaLab's Research Department conducted an investigation to compare the moisture content results of several products when trigger values of increasing stringency are used.

Table 1 provides a list of the products tested and the recommended temperature and test times for the products according to the Swiss Food Manual. Nine replicated samples of each product were analyzed for moisture in a conventional oven using the settings in Table 1. In addition, 9 replicated samples of each product were analyzed for moisture in the TrueDry using trigger values (%wt change/min) of 0.06, 0.01, 0.005, and 0.001. Moisture contents from the oven and each trigger value were then compared using Tukey's means comparison to determine which trigger value settings gave moisture readings statistically the same as the oven.

Table 1. Recommended temperature and testing times based on the Swiss Food Manual for the products used in the study.

Sample	Test Temperature	Recommended Time
Coffee	103°C	360 Minutes
Flour	130°C	120 Minutes
Bread	130°C	90 Minutes
Yogurt	87°C	240 Minutes

Figures 1-4 show the test times vs moisture contents for the various trigger values compared to the oven moisture contents for all of the products. Figure 1 indicates that for Coffee, the mean moisture contents determined when using the 0.01 and 0.005 trigger values were not significantly different from the oven moisture. However, the test time when using these trigger values were significantly lower than the standard method. While the recommended test time was 360 minutes, the test time for 0.01 trigger was 45.7 minutes and 58.3 minutes for a 0.005 trigger. These results would suggest that by using the TrueDry and setting a trigger value of 0.01, a moisture content that is equivalent to the recommend test time can be determined, but in only 45 minutes.

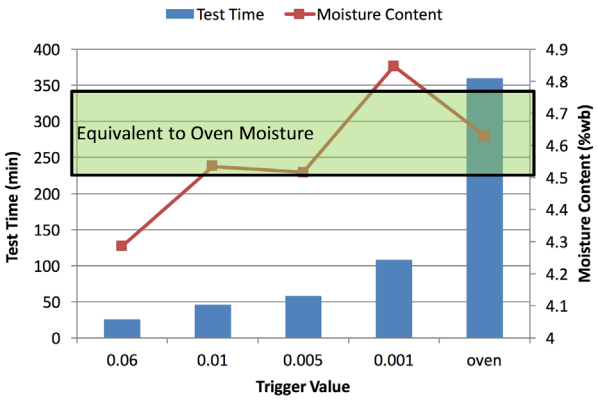

Figure 1. Average moisture content values and test times for Coffee when using different trigger values and in a conventional oven. The colored box indicates the moisture values that are statistically equivalent to the oven moisture.

Figure 2 indicates that for Flour, both the 0.06 and 0.01 triggers generated mean moisture content values that were not significantly different from the oven moisture, but again in much less time. While the recommend test time for flour was 120 minutes, the test times for 0.06 and 0.01 triggers were only 30.8 minutes and 38.0 minutes respectively. A test that would normally require 120 minutes can be completed in the TrueDry in just 30 minutes with no significant change in results.

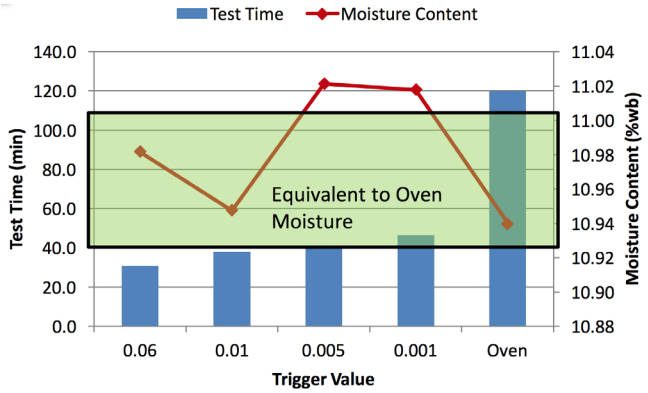

Figure 2. Average moisture content values and test times for Flour when using different trigger values and in a conventional oven. The colored box indicates the moisture values that are statistically equivalent to the oven moisture.

For Bread, Figure 3 shows that all trigger values except 0.06 produced mean moisture content values that were not significantly different from the oven moisture. However, only the 0.01 trigger achieved equivalent results in a shorter time than the recommended test time. The test completed in 75 minutes when using the 0.01 trigger while the recommended test time is 90 minutes. While not as significant of a time savings as seen for the other product, 15 minutes compounded over multiple readings will result in tremendous time savings while not sacrificing the integrity of the results.

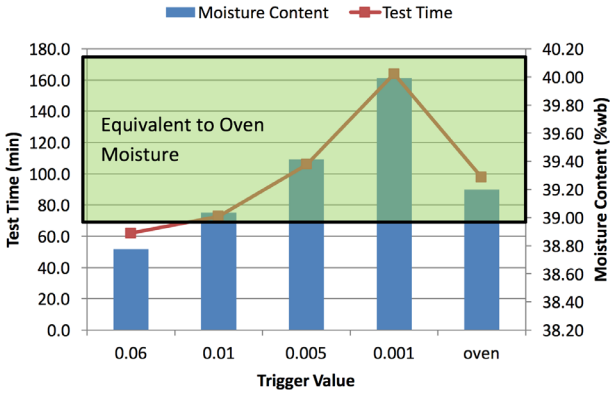

Figure 3. Average moisture content values and test times for Bread when using different trigger values and in a conventional oven. The colored box indicates the moisture values that are statistically equivalent to the oven moisture.

Figure 4 indicates that for Yogurt, none of the triggers generated mean moisture content values that were equivalent to the oven moisture. However, the figure does indicate that a trigger value between close to 0.001 should produce similar results, but may not result is significant time savings over the recommended test time of 240 minutes. Consequently, for yogurt, setting the timeout value on the TrueDry to the recommended test time of 240 minutes would be better than using a trigger value. That said, the TrueDry still offers the automation advantage and will test 9 samples simultaneously using the recommended test time.

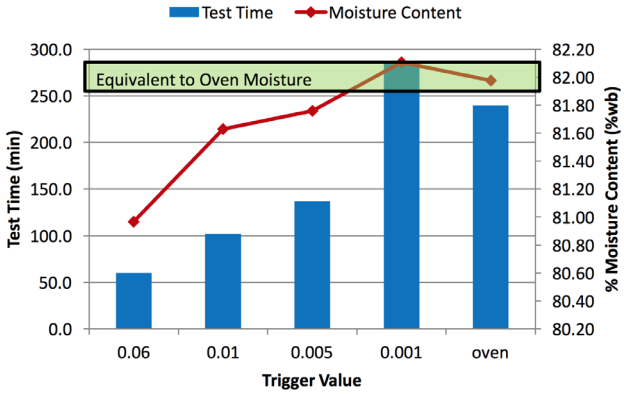

Figure 4. Average moisture content values and test times for Yogurt when using different trigger values and in a conventional oven. The colored box indicates the moisture values that are statistically equivalent to the oven moisture.

The TrueDry has the added advantage of producing more repeatable results when compared to oven testing due to its tighter temperature control and eliminating user error. Table 2 indicates that in general, the repeatability of the measurements increased as the trigger value was set more stringently. Further, with the exception of the 0.06 trigger, the repeatability of the TrueDry was equal to or superior to the oven for all the trigger settings.

Table 2. Standard deviations of moisture content measurements when using different trigger values and the recommended test settings in a conventional oven.

Sample	0.06	0.01	0.005	0.001	Conventional Oven
Coffee	0.070	0.094	0.047	0.041	0.013
Flour	0.091	0.047	0.035	0.028	0.072
Bread	0.659	0.254	0.338	0.758	0.608
Yogurt	0.158	0.148	0.074	0.062	0.076

Conclusion

In general, the results of this study would indicate that drying to constant weight by utilizing a trigger value and an automated system such as the AquaLab TrueDry CV9 is superior to using a conventional oven and recommended test times from standards. The TrueDry offers a substantial labor and time savings while giving equivalent results to standard test times. In this study, the 0.01 trigger would have given equivalent results to the recommended test times for all products except yogurt with equal or better repeatability and in much less time. These results suggest that a 0.01%wt change/min is a good default setting for most products, keeping in mind that for some products, the trigger value may need to be adjusted or dropped in favor of the recommended test time. For more information on trigger value settings or for assistance in determining the ideal trigger setting for your product, contact AquaLab Support at 509-332-5601 or support@aqualab.com

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