Water Activity Best Testing Practices
Chocolate Syrup

Executive Summary
Chocolate syrup can easily be tested for water activity with little concern for varying testing practices. None of the test conditions evaluated in this study caused significant differences in the measured water activity value for chocolate syrup and no advantage was found in not taking the first reading from the instrument. The water activity of chocolate syrup did not even change with temperature. Therefore, best testing practice for chocolate syrup, regardless of ambient conditions, is to place enough sample in the cup to cover the bottom, place sample in instrument at 25 °C, and record the value once the water activity reading is completed. Expected test times should be around 3 to 5 minutes.

Introduction
The AquaLab research and development team now has water activity best testing practices available for chocolate syrup. The objectives of this study were to:

1. Observe the impact of ambient humidity on water activity testing results when using normal testing practices.

2. Compare the water activity average values, test time and repeatability across several water activity instruments.

3. Determine if an advantage in precision is gained by extending read times up to an hour when using dew point instruments instead of using the initial value provided in the normal ~5 minute test time.

4. Identify the value of the custom mode testing option in Series 4 instruments and find which setting provides the best precision.

5. Observe the impact of test temperature on water activity test results.

Materials and Methods
The water activity instruments used for testing included 1 AquaLab Series 3TE Chilled Mirror Water Activity Instrument and 2 AquaLab Series 4TEV Chilled Mirror Water Activity Instruments. Each instrument was verified daily using unsaturated salt solutions at 0.25 a_w, 0.5 a_w, 0.76 a_w, and 1.00 a_w. All testing was conducted on three replicates taken from three independent samples. Humidity was controlled using a glove box and all sampling and testing was conducted in the glove box. Humidity in the glove box was constantly monitored. Sampling was done as quickly as possible. The ambient humidities included in the study were 30% RH, 50% RH and 70% RH. At each humidity, testing was conducted on replicates of chocolate syrup in three sections.

Section 1 consisted of tests accomplished using just the AquaLab instruments. An initial water activity reading was recorded when the first test ended as indicated by the instrument, but then the instrument was set to continue taking measurements up to approximately 1 hour. The initial and final mean water activity and standard deviation across the three samples were compared using Analysis of Variance (ANOVA) to see if a significant advantage is gained in the AquaLab instruments by extending the test time. All tests in Section 1 were done at 25 °C.

Section 2 consisted of utilizing the custom feature in the AquaLab Series 4 instruments. This mode allows setting stability specifications for ending a test, which consists of identifying a water activity range that must be met by a specified number of tests. For example, the

custom setting could be three tests and 0.003 a_w. Once started, the instrument will then continue taking tests until three results are within ±0.003 a_w of each other. To determine the preferred custom mode to achieve the highest combination of repeatability and speed, four custom mode settings were compared including: three tests within ±0.001 a_w, five tests within ±0.001 a_w, three tests within ±0.003 a_w, and five tests within ±0.003 a_w. Testing was conducted using 1 Series 4TEV instrument on three replicates from three samples. The mean water activity and standard deviation across all three samples was then compared using ANOVA to determine if one custom mode setting provides significantly better performance than another setting. All tests in this second set were done at 25 °C.

Section 3 consisted of observing the effect of temperature on the water activity readings of the product of interest. Water activity is temperature dependent, but the level of sensitivity depends on the product. To investigate the effects of temperature, each replicate from each of three samples was evaluated for water activity at 15 °C, 25 °C, and 45 °C. Mean water activity and test time were compared for each temperature at each humidity level to determine if temperature resulted in significant differences in water activity.

Results

Section 1

Keep in mind that the samples were only exposed to ambient humidity with no moisture barrier for short time during sampling. However, the starting humidity in the testing chamber of each instrument would be at ambient humidity when each test begins.

The results in Figure 1 indicate that the water activity test results for chocolate syrup were not impacted by ambient humidity. In addition, the standard deviation of repeated readings was less than ±0.003 a_w at all ambient humidity levels (Figure 1). The results suggest that the water activity of chocolate syrup is 0.84 a_w regardless of the ambient humidity and acceptable test results can be obtained in as little as 4 minutes.

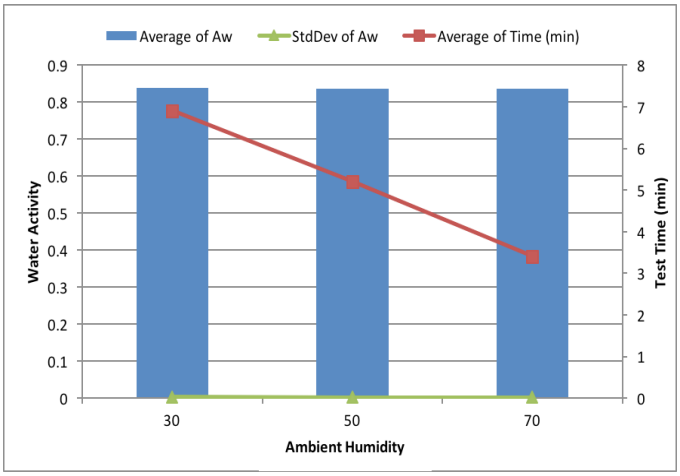

Figure 1. Average water activity, test times, and standard deviations of readings at 30%, 50%, and 70% relative humidity.

No significant advantage was gained by extending the test time on the AquaLab instruments to 60 minutes to more closely match the test time of the competitor instruments (Figure 2). Tukey's multiple mean test of initial and final values for each AquaLab instrument at each humidity level did not show significant differences and standard deviations were all below ±0.005 a_w. This indicates that the results do not change if the test is run for 5 to 8 minutes versus running for one hour, debunking the idea that correct readings can only be obtained from continuous reads or long read times. In addition, standard deviations were not consistently better for long read times, indicating that letting the instrument take readings for extended test times does not improve the repeatability of test results (Figure 2).

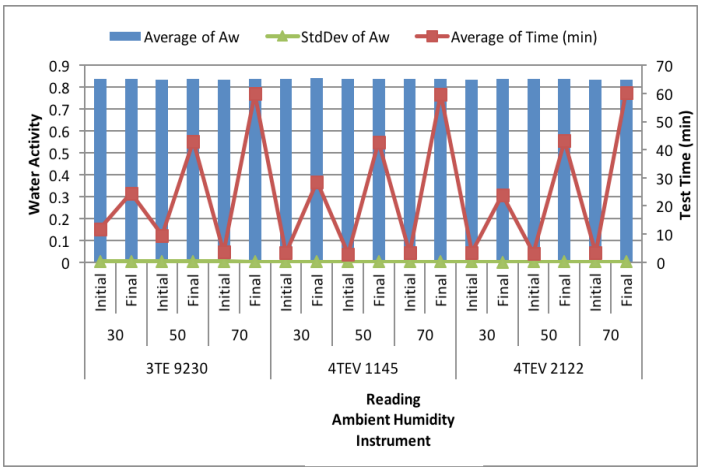

Figure 2. A comparison of average water activities, average test times, and standard deviations for initial and final (after 60 minutes) test results using three different water activity instruments at three different ambient humidities.

Section 2

As with section 1, no differences were found in the value or standard deviation of water activity tests when using any of the custom settings indicating no reason to use the custom mode when measuring the water activity of chocolate syrup (data not shown).

Section 3

Water activity is temperature dependent, but the level and even direction of the dependency is very product specific. The results in Figure 4 indicate that the water activity of chocolate syrup is not temperature dependent.

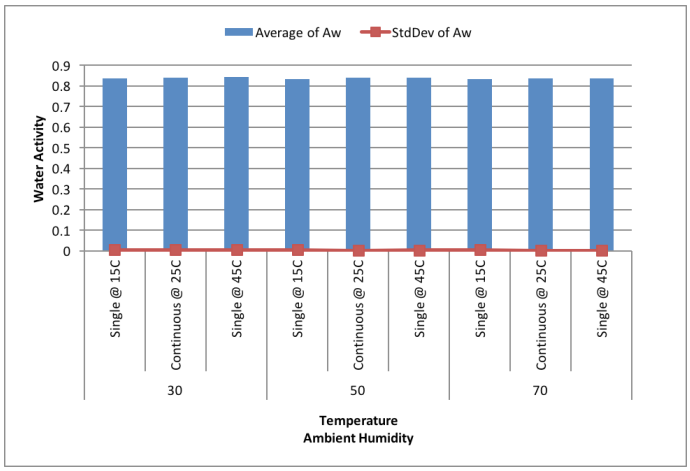

Figure 3. Average water activity and standard deviation values for chopped Chocolate syrups at four different ambient humidities and three different temperatures.

Conclusion

Considering that the variability of water activity values for chocolate syrup measured across all conditions in this study was 0.838 ±0.003 a_w, it can be concluded that no special testing practices are needed to achieve high accuracy and repeatability when measuring the water activity of chocolate syrup. In addition, the water activity of chocolate syrup was shown to not be temperature sensitive. Test times should be expected to be 3 to 5 minutes.

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