METER
FOOD

CANNABIS VALIDATION:

CURRENT PRACTICE

The primary or standard method for measuring moisture content in cannabis is oven loss-on-drying. The generally accepted practice is to weigh the cannabis sample, dry it at 105 F (40 C) for 3 hours in a vacuum oven, and weigh again to determine wet basis moisture content. All secondary methods for determining moisture content, including methods which dry at higher temperatures or for shorter times, should be validated against the standard method.

This report contains results from validating the Isotherm-Determined Moisture Content method (1 Minute Moisture) in dried cannabis bud. For details on how the method works, please see Isotherm-Determined Moisture Content: Validation Methodology.

LIMITATIONS OF SECONDARY METHODS

When a sample is dried to remove the moisture, weight is also frequently lost due to decomposition, chemical reactions, and the loss of volatile compounds. Cannabis moisture content measurements are susceptible to volatilization errors even at low temperatures. Methods such as NIR spectroscopy, rapid moisture analyzers, and capacitance probes which use modeling to determine the measurement may give inaccurate results if the model is not valid for the sample being read or if they are not correctly calibrated to the specific sample type.

All secondary methods, including 1 Minute Moisture, must be validated. We validated the 1 Minute Moisture model for 9 different strains of Cannabis and evaluated the data using criteria generally accepted by the FDA, ISO, AOAC, and other standards-making bodies for validating secondary methods. The results are reported in this document.

The full procedure used to validate the 1 Minute Moisture model can be found in Isotherm-Determined Moisture Content: Validation Methodology.

CANNABIS-SPECIFIC VALIDATION DATA

Nine unique cannabis samples were used to develop the model. As part of the validation process, a sample was then run using the full procedure given in Isotherm-Determined Moisture Content: Validation Methodology.

All samples were run at 25ºC at ambient pressure and humidity.

MOISTURE CONTENT MEASUREMENT VALIDATION RANGE: 0.2 - 0.7 AW

This is the range for which the statistical data is valid.

MOISTURE CONTENT MEAN ABSOLUTE ERROR (MAE): 0.2440

This is the arithmetic average of the absolute errors between the predicted moisture content and the observed value measured using the standard method (oven loss-on-drying). In this case, it means that the 1 Minute Method will give a measurement within plus or minus 0.24% of the actual value as compared to reference.

MOISTURE CONTENT ROOT MEAN SQUARE ERROR (RMSE): 0.3017

RMSE is another common way of describing model fit. Root mean square error is the standard deviation of the prediction errors. It describes how concentrated the data is around the line of best fit. Because RMSE is proportional to the size of the square of the error, larger errors have a disproportionately large effect when compared to the MAE, and the RMSE is typically larger. In this case, the RMSE and MAE are quite close, showing that there aren't many outliers and confirming that the 1 Minute Method will give a measurement within plus or minus 0.3% of the actual value as compared to reference.

R2: 0.9954

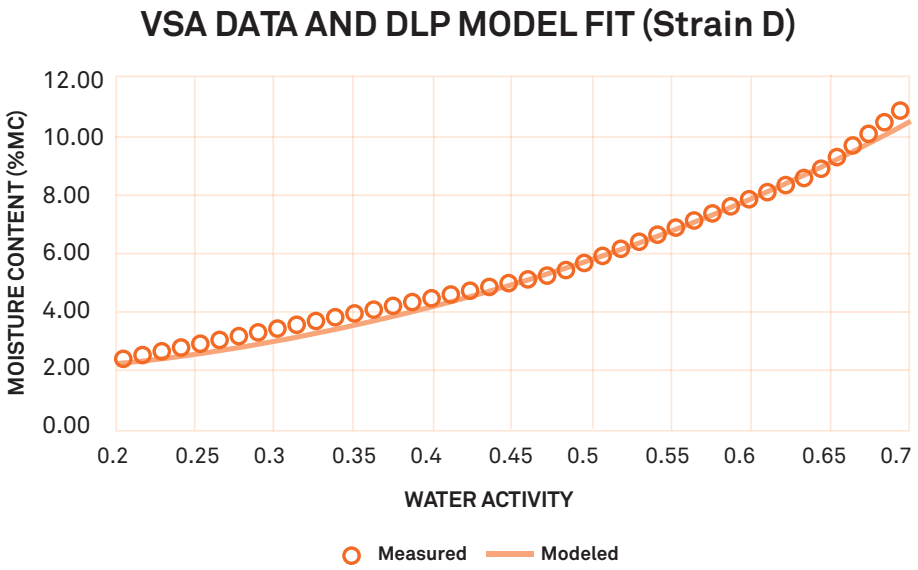
R2 is the percent of variance explained by the model. 99.5% of the variance is explained by the model.

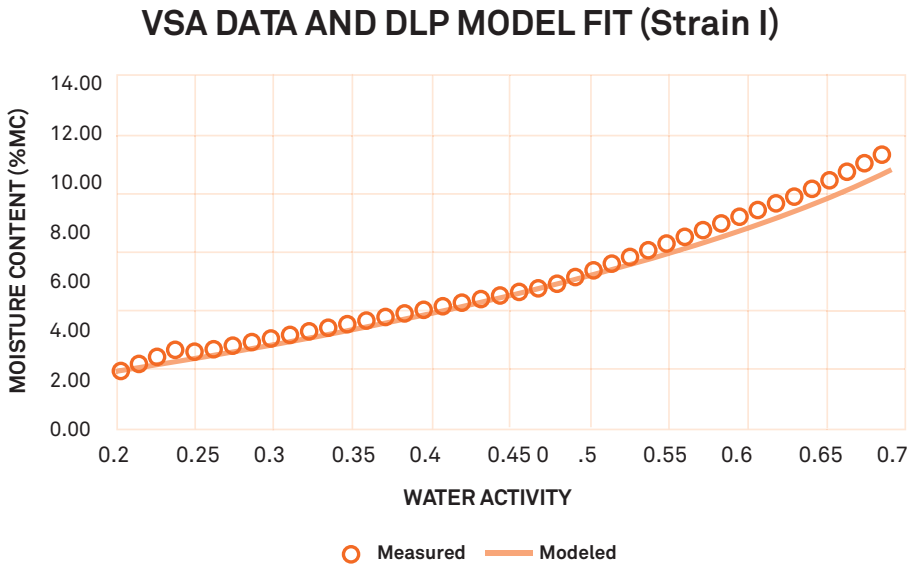
PRECISION: ±0.01 %MC

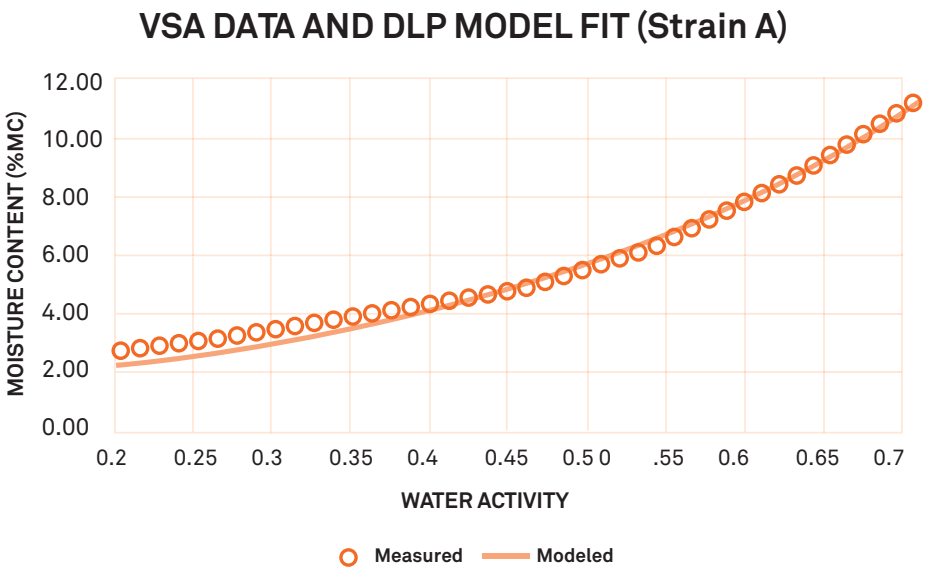
SELECTIVITY

Traditional moisture methods, including the primary reference method, are not perfectly selective. When a highly volatile sample such as cannabis is heated, some of the weight loss quantified as moisture will actually be loss of volatile compounds such as terpenes. In the following chart, selectivity of the 1 Minute Method is shown by R2 values of 9 different strains ranging in terpene content from 18 - 29.3%.

Name	Mean Absolute Error	RMSE	R^2	Total Terpenes (mg/g)	%THCA	%CBD
Strain A	0.2203	0.2514	0.9948	na	29.3	0.0
Strain B	0.3927	0.4771	0.9983	na	26.7	0.0
Strain C	0.2342	0.2666	0.9973	na	28.8	0.0
Strain D	0.1049	0.1444	0.9970	13.84	22.6	0.1
Strain E	0.2637	0.3880	0.9832	11.52	24.1	0.1
Strain F	0.3572	0.4106	0.9986	14.32	27.6	0.1
Strain G	0.3542	0.3991	0.9985	4.39	22.4	0.0
Strain H	0.1098	0.1288	0.9975	9.35	21.3	0.0
Strain I	0.1590	0.2498	0.9933	10.83	18.0	0.0
Average	**0.2440**	**0.3017**	**0.9954**	-	-	-

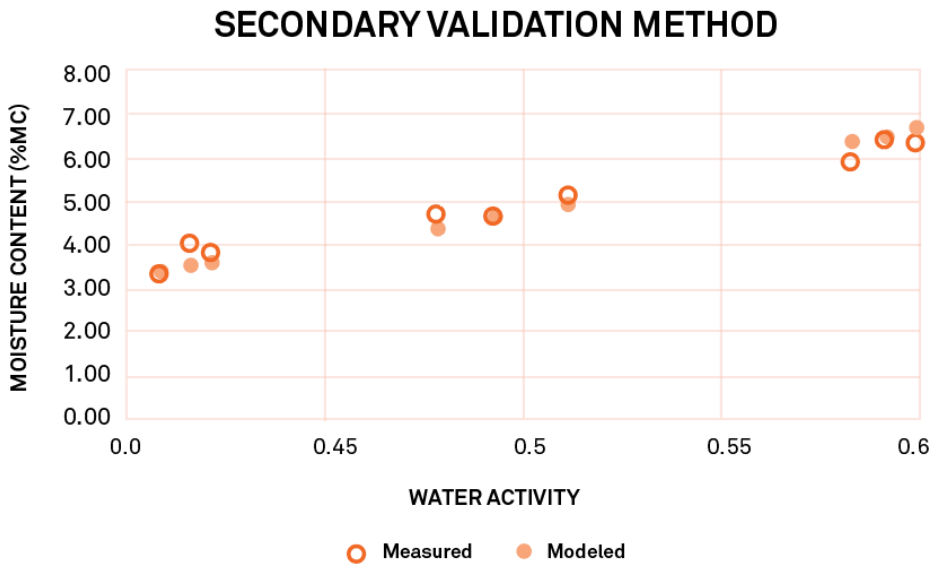

VSA DATA AND DLP MODEL FIT (Strain D)
MOISTURE CONTENT (%MC)
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
WATER ACTIVITY
Measured
Modeled


VSA DATA AND DLP MODEL FIT (Strain I)
MOISTURE CONTENT (%MC)
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0.2
0.25
0.3
0.35
0.4
0.45 0
.5
0.55
0.6
0.65
0.7
WATER ACTIVITY
Measured
Modeled

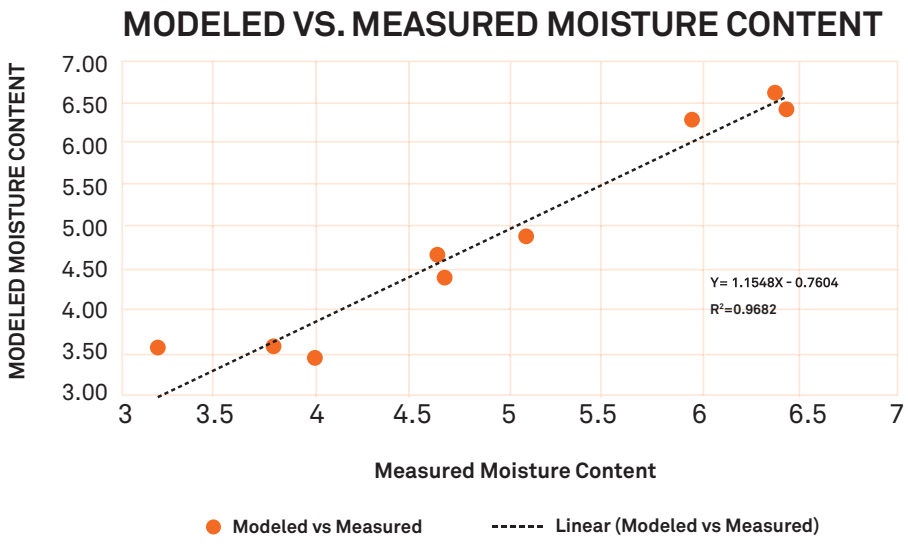


White data points are the VSA measured data. The purple line is the DLP model fit to that data. These three figures show a range of fits across different strains. Strain D shows the lowest mean average error. Strain I shows an MAE somewhere in the middle, and strain A shows a high MAE.

METHOD VALIDATION



Samples were collected from a randomly-selected strain and allowed to equilibrate in humidity chambers at different water activities. Measured moisture content values were then compared to moisture contents predicted using the model.



Linearity: modeled vs. measured moisture content is plotted against a perfectly linear fit. This figure shows the overall performance of the method. The method achieved an R2 of 0.97. This data takes into account all sources of variation including sample-to-sample variation.

CONCLUSION

All loss-on-drying methods, including the primary reference oven method, have inherent variability which is impossible to quantify. A number of factors, including sample volatilization and the destructive nature of the reference measurement, limit the performance of any secondary calibrated method. Water activity is a primary, standards-based measurement and the most direct way of measuring moisture in cannabis. The 1 Minute Moisture method is a valid way of connecting moisture content measurements to water activity, and as such will provide more precision and repeatability than can be achieved by other methods.