Near Infrared Spectroscopy (NIRS) Calibrations for Moisture in High Moisture Corn Co-Products

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Summary and Implications

Corn co-products from the ethanol industry have become a common feed ingredient in Midwest feedlot diets. However, nutrient composition, especially moisture, can vary by as much as 15% from load to load even from the same ethanol plant. Knowing the exact moisture content of the co-product is advantageous for proper ration formulation and cattle efficiency. This study demonstrates that near infrared spectroscopy (NIRS) technology shows promise for rapid, accurate assessment of moisture in wet corn co-products.

Introduction

In 2013, 40% of the total distillers grains from dry grind ethanol fermentation were classified as either Wet Distillers Grains (WDG) or Modified Distillers Grains with soluble (MDGS) MDGS has syrup added back. The wet coproduct of corn wet milling is Wet Corn Gluten Feed (WCGF). New processes have emerged to extract oil and fiber from these co-products, so that when livestock producers receive these feedstuffs, composition is uncertain. Especially moisture (and therefore dry matter) varies widely from lot to lot.
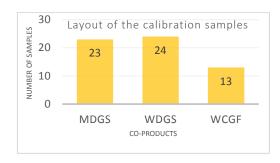
This study was done to determine if NIRS (near infrared spectroscopy) instruments could rapidly predict moisture values, to make adjustments for the ration on the day that the feed is delivered rather than waiting to get laboratories' results. Unexpected ration errors can upset the performance and the health of the animals.
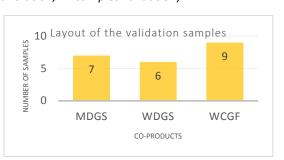
Moisture values also allow the cattle feeder to estimate the shelf life of the product and how to mix the distillers grains in order to store it. This is important to avoid spoilage, which can be injurious for the health of the cowherd.

There are several reasons to use wet co-products. The cost of the dry distillers grains is higher per unit of net energy. Wet distillers grains have 150% net energy value on a dry matter basis of the corn grain, while the dried distillers grains have 110%, also on a dry matter basis. Balancing dry matter in rations depends on accurate moisture tests.

Materials and Methods

Calibration and validation of the instruments (n=60 samples calibration, 22 samples validation)

1) MDGS (Modified Distiller Grains with Solubles) averaged 55 % moisture (45%DM) with a range of 40 to 60% DM

2) WDGS (Wet Distillers Grains) averaged 65% moisture (35%DM) with a range of 32 to 40% DM

3) WCGF (Wet Corn Gluten Feed) averaged 56% moisture (44%DM) with a range of 41 to 47% DM

Samples were scanned in 8 NIR instruments. The spectra were compared with the reference values (American Feed Ingredients Association reference method; 5 g dried for 2 hr at 105C). Data were analyzed in the software

Unscrambler X (Camo, Oslo, Norway) with partial least squares regression. At the end, an equation was obtained to make moisture prediction with each instruments. In order to verify the accuracy of the prediction, calibration was validated on new samples.

New samples were analyzed by the instruments with the new calibration models installed. If the amount of error is acceptable relative to the calibration error, the calibration is validated.

Instruments

Zeiss, Corona extreme
Diode Array

Bruker, Matrix-I
FT-NIR

Unity Scientific, SpectraStar XL
Monochromator

Foss, DS2500
Monochromator

Bruins Instruments, AgriCheck
Monochromator

Perten DA 7200

Bench-top units---

JDSU, MicroNIR Pro 1700
Diode array

Thermo Scientific,
MicroPhazir AG, MEMS

Portable Units--

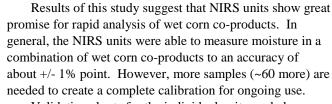Instruments are referred to in the results by number. Numbers were assigned randomly, not in the order of the pictures above. Some units did not use all the validation samples because some samples were too small for them.

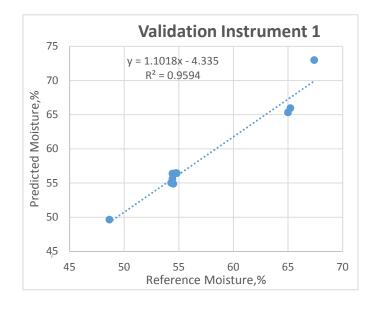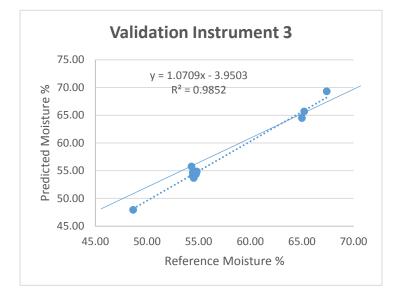| Instruments	**CALIBRATION n=60; 40%-70%**		**VALIDATION n=22; 48%-70%** SEP ; RMSEP (Standard error of prediction) (Root mean square of the standard error of prediction)
	R-Square	**SECV** (Standard error of cross-validation)	
1 Bench	0.97	1.20	0.67 ; 0.63
3 Bench	0.97	1.25	0.95 ; 0.68
5 Bench	0.99	0.62	0.37 ; 0.35
6 Bench	0.97	1.26	0.93 ; 0.87
7 Bench	0.98	0.85	1.01 ; 1.05
8 Bench	0.98	0.98	0.61 ; 0.63
2 Portable	0.97	1.23	0.83 ; 0.84
4 Portable	0.98	1.03	0.66 ; 0.66

Results

If the SECV and SEP are nearly equal, or the SEP is less than SECV, the calibration passes independent validation. In all but one case, 7, this is true.
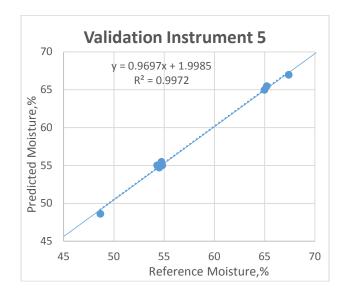
If the SEP and RMSEP are close to each other, there is no slope in the calibration. In all but one case, 3, this is true. The portable units had similar statistics to the average of the benchtop units. One benchtop unit, 5, performed significantly better than all other units.

Results of this study suggest that NIRS units show great promise for rapid analysis of wet corn co-products. In general, the NIRS units were able to measure moisture in a combination of wet corn co-products to an accuracy of about +/- 1% point. However, more samples (~60 more) are needed to create a complete calibration for ongoing use.
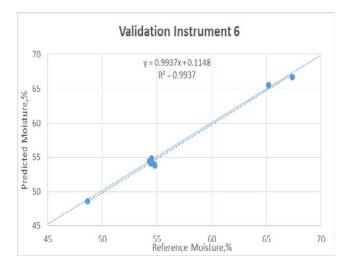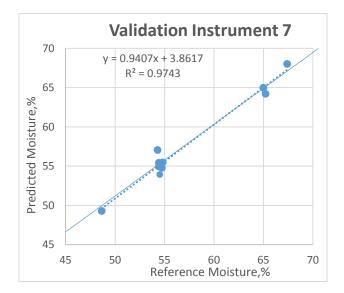
Validation charts for the individual units are below, first for the 6 benchtop units, then for the two portable units.

Validation Instrument 1
y = 1.1018x - 4.335
R² = 0.9594

Validation Instrument 3
y = 1.0709x - 3.9503
R² = 0.9852

Validation Instrument 5

$y = 0.9697x + 1.9985$
$R^2 = 0.9972$

Validation Instrument 6

$y = 0.9937x + 0.1148$
$R^2 = 0.9937$

Validation Instrument 7

$y = 0.9407x + 3.8617$
$R^2 = 0.9743$

Validation Instrument 8

$y = 1.0079x - 0.8232$
$R^2 = 0.9906$

Validation Instrument 2

$y = 0.9705x + 1.8842$
$R^2 = 0.9791$

Predicted Moisture,%
Reference Moisture,%

Validation Instrument 4

$y = 0.997x + 0.1973$
$R^2 = 0.9915$

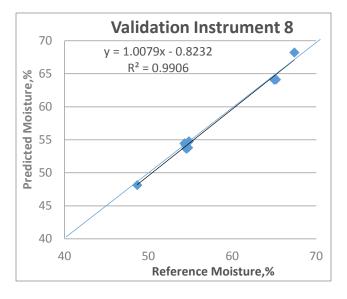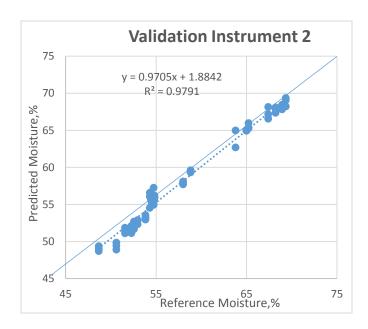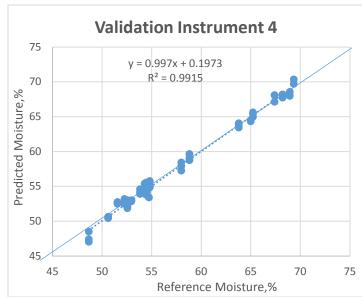Predicted Moisture,%
Reference Moisture,%

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