Evaluation of commercially available near-infrared reflectance spectroscopy prediction models for nutrient prediction of DDGS

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STORY IN BRIEF

The objective of this study was to evaluate the accuracy of a commercially available near infrared reflectance spectroscopy **(NIRS)** prediction model for corn dried distillers grains plus solubles **(DDGS)**. DDGS are a byproduct of the ethanol industry and are used in feedlot diets as a protein source for cattle. DDGS samples (n = 27) used in this study were collected upon arrival to a feedlot in Western Canada and scanned using a commercial prediction model specific for DDGS. Once scanned, samples were sent to Oklahoma State University where lab analysis was performed. Linear regression analysis was conducted to test the validity of the prediction model for DDGS of both CP and ADF. Samples were split into high, medium, and low groups for both CP and ADF linear regression analysis. It was determined that the commercially available NIRS technology used in this study was able to predict ($R^2 = 0.77$, $P < 0.05$) CP of DDGS across a broad range of CP content; however, it was more accurate at predicting CP at lower CP ranges ($R^2 = 0.76$, $P < 0.05$). The prediction model used in this study was not effective at predicting ADF across a broad range of samples ($R^2 = 0.02$, $P = 0.47$). Contrary to CP predictions, the prediction model was more effective at predicting ADF content at a higher range ($R^2 = 0.49$). The accuracy of the CP prediction model at lower CP ranges can possibly be attributed to the population of samples used to build the model. Compositionally, the equation population was more similar to the lower end of the study population. The inaccuracy of the ADF prediction model could possibly be attributed to the small number of samples (n = 36) used to build that model.

Key words: DDGS, feedlot, near infrared reflectance spectroscopy

INTRODUCTION

Corn dried distillers grains plus solubles (DDGS) are available to producers as a co-product of the ethanol industry and are used as a protein and energy source in feedlot diets across North America (Arias et al., 2012). Belyea et al. (2004) observed significant variation in nutrient composition of DDGS from year to year, specifically CP, fat, and ADF. NIRS is a technology available to feedlot managers for nutrient prediction of various feedstuffs. It is a secondary technology that is calibrated against a reference method, usually wet chemistry, and operates under the principle that compounds in natural products absorb near infrared light at characteristic wavelengths (Foss North America, 2005). The scan that is generated is interpreted by a prediction model and translated to provide the composition of the sample. It is rapid, non-destructive, can be used on-site, and has the potential to be accurate. Furthermore, it has the capability to perform several chemical analyses simultaneously (Brown and Moore, 1987). The application of this technology in feed formulation has been investigated (Leeson et al., 2000) and shown to be useful in predicting total and available nutrients of various ingredients and compound feeds. Commercially available prediction models can be purchased for various commodities from independent companies and applied to specific production scenarios. These prediction models must be validated with samples of commodities specific to those production

scenarios in order to ensure their accuracy. The objective of this study was to evaluate the accuracy of current commercially available prediction models for ADF and CP content of DDGS.

MATERIALS AND METHODS

Sample Collection and Wet Chemistry Analysis. Truckloads of DDGS (n=27) were sampled independently upon arrival to a feedlot in Western Canada and samples were scanned using commercially available NIRS technology (InfraXact, FOSS North America, Eden Prairie, MN) to predict CP and ADF. Samples were then sent to Oklahoma State University where laboratory analysis was performed. CP and ADF were determined using AOAC official methods 990.03 and 973.18, respectively. All analyses were performed in duplicate. For CP, a coefficient of variation of 2% was used to determine acceptability of samples and subsequent re-runs (Galyean, 2010). For ADF, a coefficient of variation of 5% was used.

Statistical Analysis. Linear regression analysis was performed for each parameter for all samples using WinISI Software (FOSS North America) to determine the relationship between NIRS predictions and laboratory determined values. Samples were ranked by laboratory CP value (min = 21.43%, max = 26.08%) and split into three equal sized (n = 9) groups: high, medium, and low. Samples were independently ranked by laboratory ADF value (minimum = 13.74%, maximum = 19.74%) and subsequently split into three equal sized groups: high, medium, and low. Linear regression analysis was then performed for each group for each parameter to determine if the prediction model was more effectively predicting CP or ADF at various levels of composition. Figure 1 shows the NIRS scans generated by all samples in study population.

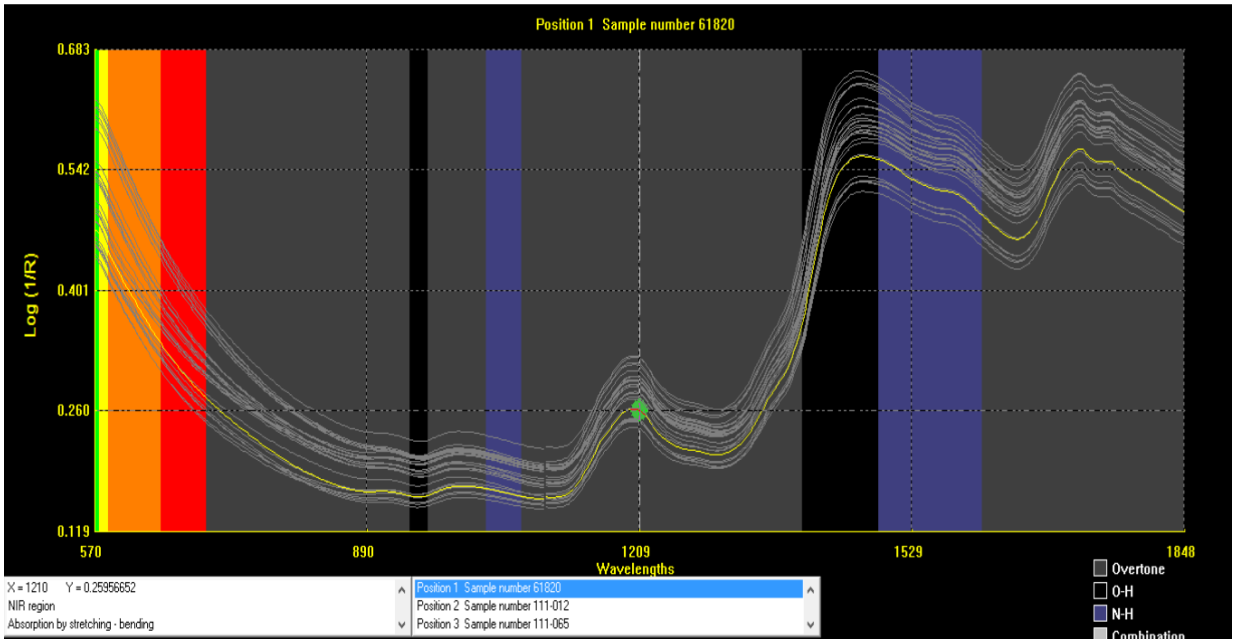

Figure 1: Spectra representation of all DDGS samples in the study population.

RESULTS AND DISCUSSION

The simple statistics of both the equation population and the study population are shown in Table 1. The large number of samples (n = 1,214) used to build the CP prediction model could possibly explain its improved prediction precision over the ADF prediction model which was developed using a much smaller number of samples (n = 36). The prediction accuracy was shown to decrease as the CP content of the samples increased as shown in Figures 2 and 3. Coefficient of determination of the regression model was highest for low CP samples (R^2 = 0.82, P < 0.05, Figure 2), then medium CP samples (R^2 = 0.71, P < 0.05, Figure 3), and worst for the high CP samples (R^2 = 0.30, P = 0.12) (data not shown).

Table 1: Simple statistics of equation and study populations

	Equation				Study			
Parameter	N	Mean	SD	R^2	N	Mean	SD	R^2
CP, %	1214	26.83	1.77	0.80	27	23.44	1.05	0.77
ADF, %	36	12.46	1.99	0.55	27	16.74	1.36	0.02

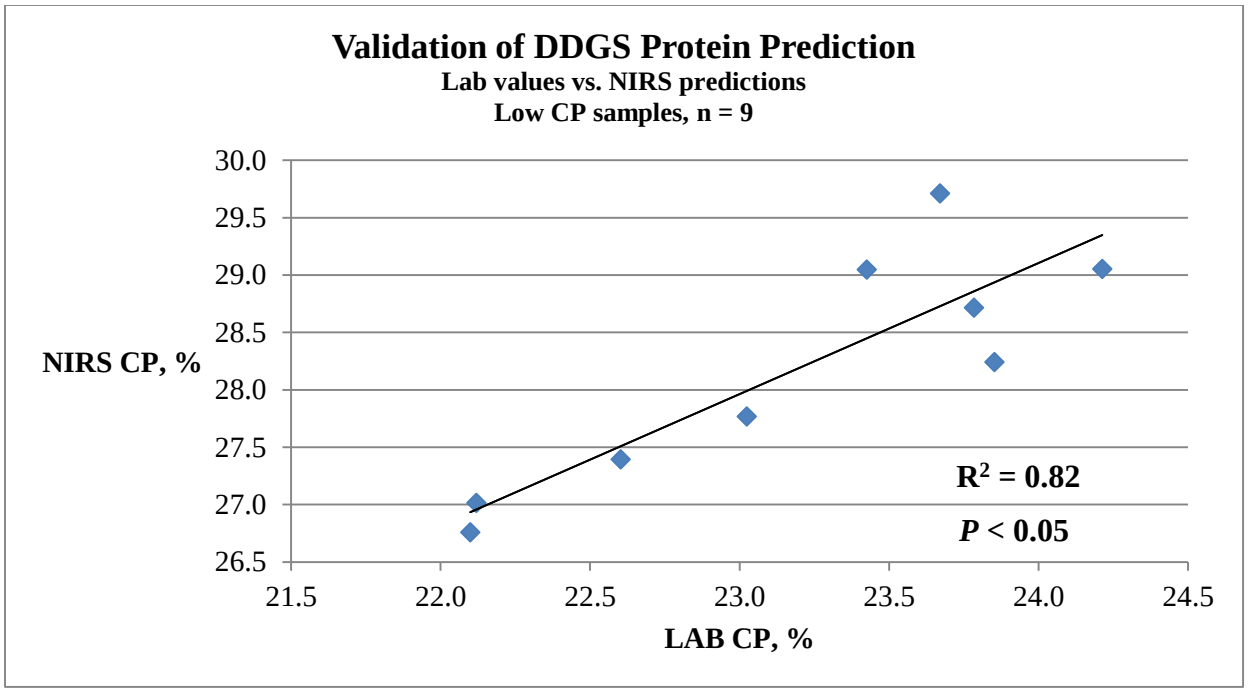

Figure 2: Linear regression analysis for low CP samples.

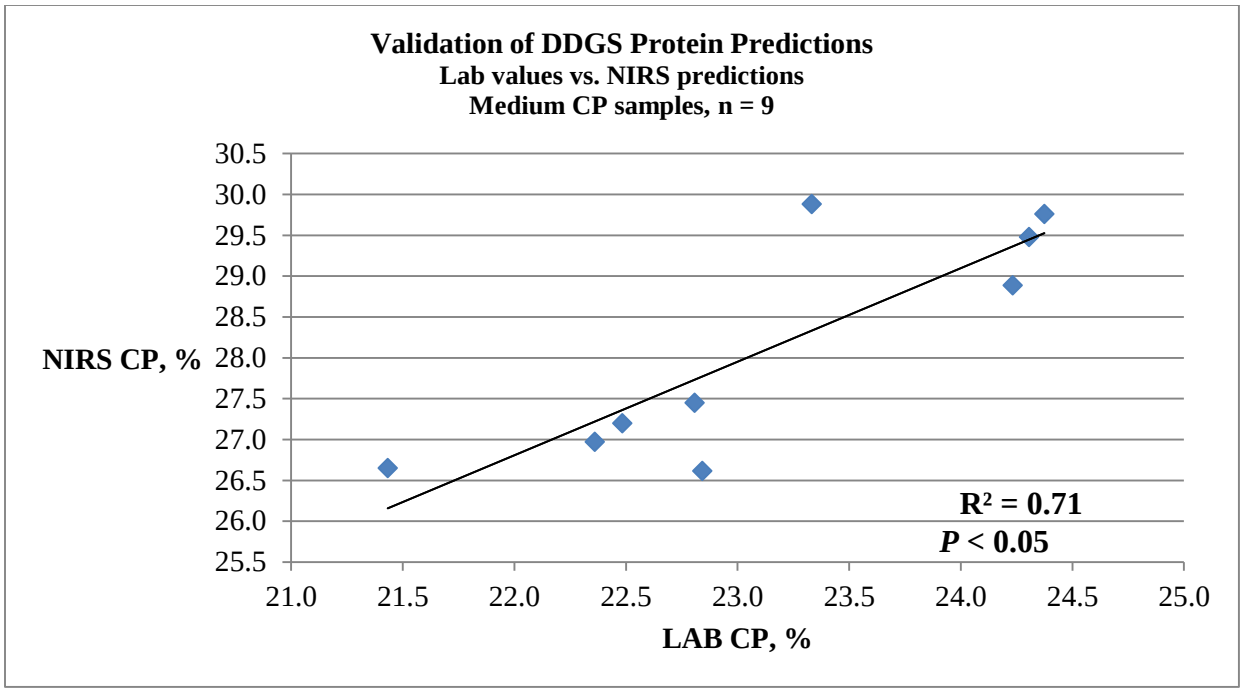

Figure 3: Linear regression analysis for medium CP samples.

Accuracy of the ADF prediction model was worse than that of CP (R^2 = 0.02, P = 0.47) as shown in Figures 3 and 4. The accuracy of the model increased as ADF content increased; however, the only relationship that was significant ($P < 0.05$) was the high ADF sub-population (Figure 5). Interestingly, the ADF content of the equation population (mean = 12.46) was lower than that of the study population (mean = 16.74). NIRS technology is generally very accurate at predicting samples similar to those used to build the calibration. Conversely, it is typically ineffective at predicting samples that are compositionally dissimilar to those used to build the calibration (Foss North America, 2005). Given that the samples used in this study were independent of those used to build the model, these results are supported by findings of Duncan et al. (1987), who indicated that equations are best validated by analyzing samples from the same population but not used in the calibration. Improved prediction accuracy might be seen if more samples are added to the prediction model to make the equation more robust. These samples should have an ADF content that is more representative of those being utilized in feedlot production in order for the prediction model to add value to production systems.

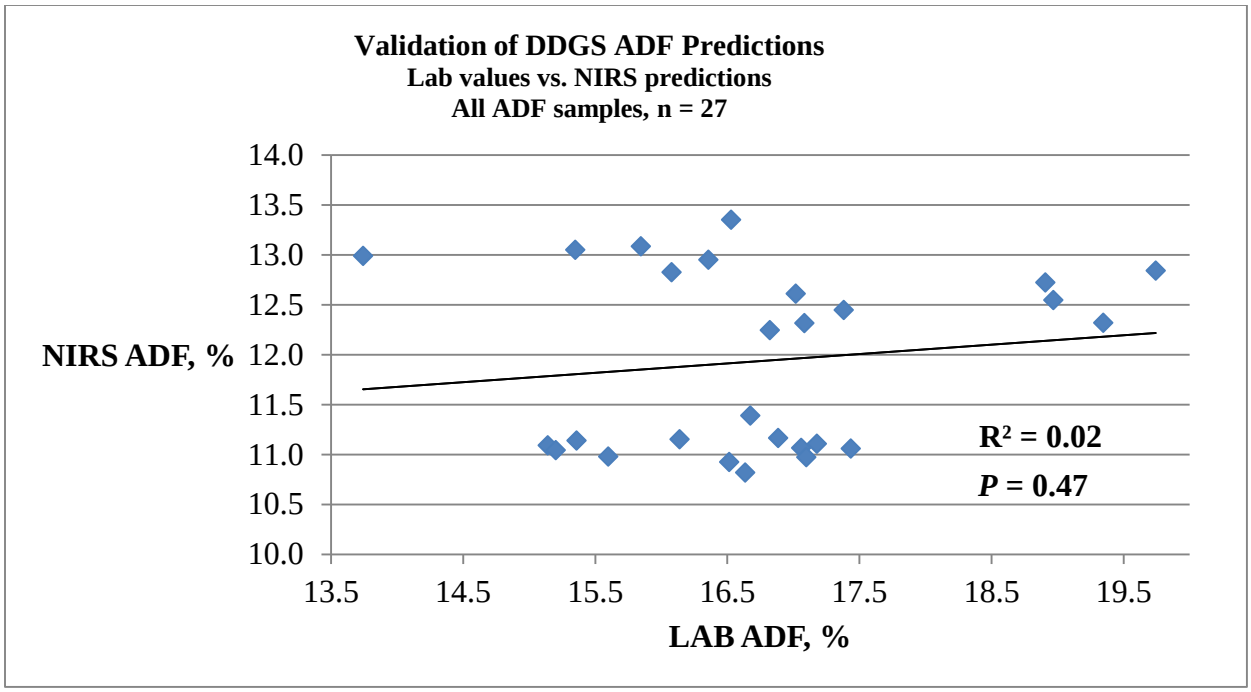

Figure 4: Linear regression analysis for ADF of all samples.

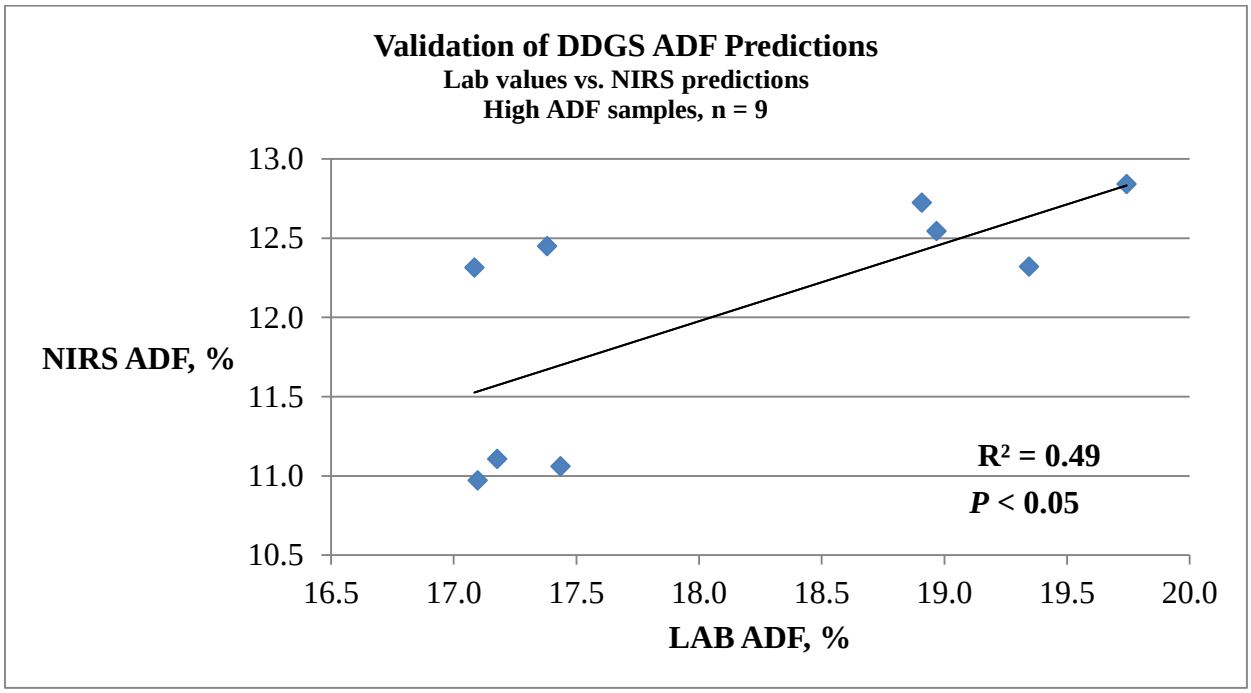

Figure 5: Linear regression analysis for high ADF samples.

In order for NIRS technology to add value to current production systems, commercially available prediction models must be validated with samples of commodities specific to that feedlot. The current model for CP is adequately predicting CP of DDGS but would be more effective if additional samples were added to the calibration. The current ADF prediction model used in this

study does not adequately predict ADF across a broad range of ADF content and must be improved before it should be used in production scenarios. Once improved, this technology can be used for rapid, on-site prediction of nutrient composition of DDGS.

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