Variation in Nutritive Value of Commercial Broiler Diets

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ABSTRACT : The classical energy balance method was used to measure the apparent metabolisable energy (AME) of four batches of broiler starter and finisher diets produced by two commercial feed companies. The results showed there was little variation in protein content between batches, but NDF content varied from 13.3% to 15.5% between batches of diet. The batch variation in chemical composition differed between feed manufacturers. While there was no difference in AME and feed conversion ration (FCR) between batches of starter diets produced by company A, FCR and AME ranged from 1.76-1.94 ($p<0.001$) and 11.38-11.90 MJ/kg air dry ($p<0.05$), respectively, for diets produced by company B. Similar results were found in a second experiment. There was no difference in AME, dry matter digestibility (DMD) and FCR between batches for finishing diet produced by company B, but a large variation occurred for the finisher diets from company A ($p<0.01$), where the ranges of FCR, AME and DMD were 1.95-2.30, 10.5-12.3 (MJ/kg air dry) and 58-68%, respectively. FCR was correlated with AME. AME was negatively related to the content of fibre in the diet, but positively related to DMD. The preliminary results based on 24 samples showed that near infrared spectroscopy (NIR) has the potential to predict FCR, intake, AME and DMD of commercial broiler diets, with R^2 being 0.93, 0.89, 0.95 and 0.98, respectively. The standard error of cross validation was below 0.2 for AME and only 0.06 for FCR. ***(Asian-Aust. J. Anim. Sci. 2003. Vol 16, No. 6 : 830-836)***

Key Words : Apparent Metabolisable Energy, Near Infrared Spectroscopy, Poultry Feed, Feed Quality

INTRODUCTION

Feed quality and consistency are key issues for the broiler industry. It is well recognised that a change of diet often results in depression of bird performance. Such a negative impact may be associated with changes in the type of ingredients included in the diet and/or the suppliers of the ingredients. In particular, growing conditions, grain variety, grain storage and processing methods of by-products can cause a significant variation in the nutritive value of feed ingredients (Hughes and Choct, 1999).

Feed manufacturers draw on a large amount of information on nutritive value of individual ingredients to formulate diets to meet the particular requirements of chickens. Often the actual nutritive value (e.g. apparent metabolisable energy-AME) of the complete diet does not match the expected diet specifications because the nutritive value of individual ingredients is not additive, possibly due to the interactions between ingredients. If the variation in nutritive value is significant between batches and feed companies, a feed quality monitoring system will be required by the feed companies to ensure that poultry growers are provided consistent quality of feed. However, the traditional methods for analysing chemical composition and AME of poultry feed are time-consuming, labour intensive and costly. Thus a rapid assay for feed quality is required by the broiler industry to monitor the quality of complete diet and to be used as a tool for quality control.

The current study was undertaken to; 1) explore the variation in chemical composition and AME of commercial broiler diets and 2) examine the potential for using near infrared spectroscopy to predict the nutritive value of commercial poultry feed.

MATERIALS AND METHODS

Feeds

Commercial broiler diets (starter and finisher) manufactured by two feed companies (A and B) were purchased from an independent feed retailer at two-weekly intervals. All feed was stored at 4°C before the AME bioassay. Four broiler diets (starter) were assessed in Experiment 1, and 4 starter and 4 finisher diets from each commercial feed company were evaluated in experiment 2. All diet samples were analysed for crude protein, gross energy, crude fibre, neutral detergent fibre, acid detergent fibre and crude fat (AOAC, 1980). Amino acid profile was determined using a high performance liquid chromatography (Waters 2610).

AME bioassay

Location : The experimental work was done at the Poultry Research Unit, Pig and Poultry Production Institute, Roseworthy Campus, Adelaide University. Two experiments were conducted, each over a 7-day period. Experiment 1 commenced in July 2001 and Experiment 2 commenced in October 2001. Gross energy and dry matter contents of feed and excreta samples were determined in the PPPI Nutrition Research Laboratory.

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Table 1. Chemical composition of broiler diets (starter) produced by two commercial feed manufacturers tested in Experiment 1

Nutrient	Company A		Company B		Statistics	
	Means	SD	Means	SD	$t_{0.05}$	P
Proximate (%)						
Crude protein	20.1	0.7	21.2	0.5	2.64	0.04
Crude fat	4.9	0.4	10.9	0.7	14.71	0.00
ADF	6.3	0.6	7.6	0.3	3.84	0.02
NDF	14.7	1.0	18.5	0.6	6.78	0.00
Crude fibre	3.7	0.4	4.8	0.2	4.47	0.01
Amino acid (g/kg)						
Cyst(e)ine	7.0	0.8	7.3	2.9	0.18	0.87
Methionine	4.3	0.3	6.4	0.5	7.51	0.00
Aspartic acid	13.8	0.3	15.2	0.9	2.99	0.05
Threonine	6.2	0.2	7.0	0.3	4.14	0.01
Serine	9.5	0.3	10.3	0.4	3.18	0.02
Glutamic acid	39.1	0.6	40.6	2.1	1.40	0.24
Glycine	14.1	0.9	13.8	0.6	0.62	0.56
Alanine	10.6	0.6	11.8	0.4	3.26	0.02
Valine	8.7	0.5	10.0	0.5	3.67	0.01
Isoleucine	6.6	0.2	6.9	0.3	1.78	0.13
Leucine	12.7	0.5	14.4	0.5	4.52	0.00
Tyrosine	5.3	0.5	5.8	0.4	1.70	0.14
Phenyalanine	7.4	0.5	8.5	0.7	2.75	0.04
Histidine	4.2	0.2	5.4	0.1	13.51	0.00
Lysine	10.7	0.5	11.5	0.5	2.64	0.04
Arginine	12.3	0.7	13.9	0.8	2.93	0.03
Proline	14.9	0.7	14.5	0.9	0.71	0.50

ADF: acid detergent fibre, NDF: neutral detergent fibre, SD: standard deviation.

(i) Birds, housing and management : Cobb 500 broilers were obtained from a local commercial hatchery. Chickens were raised to 22 days of age in two floor pens in a controlled temperature room. Male and female chickens were reared separately on a commercial starter diet. At 22 days of age, chickens were transferred in groups of five to 48 metabolism cages for Experiment 1 and to 96 cages for Experiment 2. The cages were located in a controlled-temperature room kept at 22-25°C. Experimental diets were fed for seven days. The first three days enabled the chickens to adapt to the feeds. Feed intake was measured during this period. During the following four days feed intake was measured and all excreta collected and dried. Birds were weighed at the start and end of the seven-day period.

The AME values of diets was determined in a classical energy balance study involving measurements of total feed intake and total excreta output and subsequent measurement of gross energy values of feed and excreta by isoperibol bomb calorimetry.

Near Infrared spectroscopy (NIR) calibration development :

(i) NIR scanning: NIR reflectance spectra for all diet samples were recorded using a Foss NIRSystem model 6500 Spectrophotometer (FossNIRSystem Inc., Silver Spring, MD, USA) and Intrasoft International (ISI) WINISI software (FossNIRSystem Inc., Silver Spring, MD, USA). Diet samples were milled through a 1 mm sieve. NIRS scanning was performed via a transport module in reflectance mode over the wavelength range of 400-2,500 nm at 2 nm intervals using a small ring cup. Examination of final spectra was conducted on second derivatives using SNV and Detrend scatter correction.

(ii) Population structuring; Principal Component Analysis (PCA) was used to identify patterns in the group of spectra that contributed most to the variation among the spectra. An average Mahalanobis distance (Global H) was calculated and H values for individual samples were standardised by dividing by the average H value. Any sample with a spectrum more than 3.0 standardised units above the mean of the sample set was regarded as a spectral outlier. No samples were excluded from the calibration set.

(iii) Calibration development; The applied calibration technique involved a SNV and Detrend scatter correction method and modified partial least squares (MPLS) regression of derivatised spectra. The superlative math treatment was 2, 5, 5, 1. The calibration equations were produced for the 1.100 – 2.500 nm segment of wavelengths. The Standard Error of Cross Validation (SECV) was used as a measure of accuracy of calibrations in each case. Final equations were chosen in accordance with a combination of the lowest SECV and the highest 1-VR value (coefficient of determination for cross validation). Calibration equations were developed for each of the four constituents of interest the batches of commercial diets.

Statistics

The main statistical factors in this study were feed manufacturer and batch of feed. The data on chemical composition were analysed using a t-test, and the effect of feed manufacturer and batch on nutritive value of commercial diets were assessed using the general linear model procedure in Systat software (Walkson et al., 1996). The comparison of batch effect was nested within the manufacturer.

RESULTS

Chemical composition

In experiment 1, there was little variation in protein content between batches, but NDF content varied from 13.3% to 15.5% between batches of diet from company A. The batch variation in ADF, NDF and crude fibre was less for diets produced by company B. However, diets produced by company B had higher ($p<0.05$) protein, fat and fibre contents than those produced by company A. The content of methionine, aspartic acid, threonine, serine, histidine, lysine

Table 2. Chemical composition of commercial broiler diets (starter and finisher) produced by two feed manufacturers tested in Experiment 2

Trial	Starter diet						Finisher diet					
	Company A		Company B		Statistics		Company A		Company B		Statistics	
	Means	SD	Means	SD	$t_{0.05}$	P	Means	SD	Means	SD	$t_{0.05}$	P
Proximate (%)												
Crude protein	20.2	0.6	20.5	0.6	0.85	0.43	20.2	1.2	17.7	0.7	3.66	0.02
Crude fat	5.2	0.9	7.3	0.3	4.62	0.01	5.4	0.6	5.1	0.8	0.57	0.59
ADF	5.8	0.7	7.7	0.5	4.43	0.01	7.8	0.9	6.2	0.2	3.71	0.03
NDF	14.0	1.0	17.9	0.9	5.90	0.00	16.8	1.2	14.6	0.4	3.53	0.03
Crude fibre	3.3	0.2	4.4	0.2	7.28	0.00	4.6	0.7	3.6	0.1	2.60	0.08
Amino acid (g/kg)												
Cyst(e)ine	8.2	1.6	10.1	1.2	1.89	0.11	6.4	1.7	7.5	1.1	1.10	0.32
Methionine	3.4	0.6	3.7	0.4	0.83	0.44	4.2	0.8	2.7	1.8	1.46	0.22
Aspartic acid	14.5	0.9	13.8	0.9	1.13	0.30	14.2	1.7	11.3	1.5	2.64	0.04
Threonine	6.8	0.3	7.1	0.3	1.33	0.23	6.4	0.2	6.0	0.1	4.13	0.01
Serine	10.5	0.3	10.1	0.2	2.46	0.06	10.6	0.4	8.9	0.5	5.53	0.00
Glutamic acid	40.9	1.5	41.2	0.6	0.37	0.73	42.2	2.9	40.1	0.3	1.43	0.25
Glycine	14.3	0.7	14.3	0.7	0.11	0.92	14.7	0.4	10.1	1.4	6.14	0.01
Alanine	11.1	0.4	11.7	0.3	2.64	0.04	10.6	0.2	9.0	0.9	3.31	0.04
Valine	9.4	0.4	9.9	0.2	2.42	0.07	8.9	0.3	8.3	0.3	3.10	0.02
Isoleucine	6.6	0.6	6.4	0.2	0.55	0.61	7.0	0.6	5.6	0.2	4.69	0.01
Leucine	13.7	0.2	14.4	0.4	3.08	0.03	13.1	0.7	12.1	0.5	2.16	0.08
Tyrosine	5.7	0.2	5.8	0.4	0.54	0.61	6.2	0.6	4.8	0.5	3.74	0.01
Phenylalanine	8.3	0.4	8.8	0.3	2.04	0.09	8.2	0.5	7.7	0.4	1.57	0.17
Histidine	4.7	0.1	5.4	0.1	8.79	0.00	4.3	0.2	4.6	0.2	1.65	0.15
Lysine	11.3	0.2	11.4	0.5	0.69	0.52	9.6	0.4	9.7	0.2	0.22	0.84
Arginine	13.4	0.8	11.8	0.3	3.63	0.03	14.2	2.0	10.1	1.8	3.06	0.02
Proline	15.7	0.5	16.0	1.0	0.59	0.58	15.9	0.6	14.5	0.5	3.61	0.01

ADF, acid detergent fibre; NDF, neutral detergent fibre, SD, standard deviation.

and arginine were also higher ($p<0.05$) for diets from company B (table 1).

In experiment 2, similar variation in protein, fibre and amino acid contents was observed between batches of starter diets produced by both companies (table 2). The starter diet from company B had a higher content of fat, fibre and some amino acids (e.g. alanine, leucine, histidine). There was variation between batches in protein (18.6-21.1%), fat (4.5-5.9%) and NDF (15.1-17.8%) content of the finisher diet produced by company A, but the batch variation in protein, and fibre content was less for diets produced by company B. The content of protein, ADF, NDF and most amino acids was lower for diet produced by company B compared to company A.

Digestibility and feed conversion ratio

In experiment 1, there was no difference in AME and feed conversion ration (FCR) between batches of starter diets for company A, although a 3% unit variation in dry matter digestibility (DMD) was observed. FCR and AME ranged from 1.76-1.94 ($p<0.001$) and 11.38-11.90 MJ/kg air-dry ($p<0.05$), respectively, for diets produced by company B. In experiment 2, the quality of feed manufactured by company A was also consistent, while a significant difference in AME between batches occurred ($p<0.05$) for the diets from company B (table 3).

No difference in AME, DMD and FCR between batches was found for finishing diet produced by company B, but a large variation occurred for the diets from company A ($p<0.01$), where the ranges of FCR, AME and DMD were 1.95-2.30, 10.5-12.3 (MJ/kg air dry) and 58-68%, respectively (table 4).

Prediction of nutritive value of commercial broiler feed

After analysing the relationships between nutritional quality and chemical composition using pooled data from the two experiments, it was found that FCR was correlated with AME. AME was negatively related to the content of fibre in the diet, but positively related to DMD. The relationships are as follows;

$FCR=4.360-0.203\times AME$ ($R^2=0.623$; n=24; p=0.001)
$AME=5.814+9.314\times DMD$ ($R^2=0.59$; n=24; p=0.001)
$AME=13.888-0.307\times ADF$ ($R^2=0.394$; n=24; p=0.001)
$AME=13.358-0.099\times NDF$ ($R^2=0.161$; n=24; p=0.05)

Table 3. Feed conversion ratio (FCR), apparent metabolisable energy (AME, MJ/kg), dry matter digestibility (DMD, %) of different batches of commercial broiler diets (starter) manufactured by two companies (A and B)

Mill	Batch	FCR	AME (air basis)	AME (dry matter)	DMD
Experiment 1					
A	1	1.94	11.89	13.55	0.69a
A	2	1.90	11.81	13.30	0.66b
A	3	1.93	11.81	13.41	0.67b
A	4	1.91	11.91	13.52	0.67b
Means		1.92	11.86	13.45	0.67
SEM		0.025	0.081	0.092	0.004
P value		0.647	0.720	0.232	0.000
B	1	1.90a	11.61ab	13.00a	0.59b
B	2	1.91a	11.79a	13.15ab	0.59b
B	3	1.94a	11.38b	12.80a	0.58b
B	4	1.76b	11.90a	13.44b	0.61a
Means		1.88	11.67	13.10	0.59
SEM		0.025	0.126	0.142	0.005
P value		0.000	0.044	0.031	0.004
Experiment 2					
A	1	1.89	11.94	13.46	0.65c
A	2	1.91	12.23	13.77	0.68b
A	3	1.91	12.17	13.63	0.68b
A	4	1.89	12.46	13.93	0.71a
Means		1.90	12.20	13.70	0.68
SEM		0.031	0.155	0.175	0.008
P value		0.964	0.159	0.299	0.001
B	1	1.92	11.75b	13.27	0.63
B	2	1.97	11.84bc	13.34	0.63
B	3	1.95	12.24a	13.53	0.64
B	4	1.94	12.12ac	13.40	0.62
Means		1.94	11.98	13.39	0.63
SEM		0.023	0.123	0.137	0.005
P value		0.585	0.033	0.613	0.396

Values followed with different letters in each column within company are significantly different.

$$AME = 13.786 - 0.493 \times \text{Crude fibre} \quad (R^2 = 0.457;\ n = 24;\ p = 0.001)$$

The preliminary results based on 24 samples showed that NIR has the potential to predict FCR, intake, AME and DMD of commercial broiler diets, with R^2 being 0.93, 0.89, 0.95 and 0.98, respectively (table 5). The standard error of cross validation was below 0.2 for AME and only 0.06 for FCR.

DISCUSSION

There were significant differences in chemical composition of the broiler starter diets manufactured by the feed companies, and between feed batches. Nevertheless,

Table 4. Feed conversion ratio (FCR), apparent metabolisable energy (AME; MJ/kg), dry matter digestibility (DMD, %) of different batches of commercial broiler diets (finisher) manufactured by two companies (A and B)

Mill	Batch	FCR	AME (air dry)	AME (dry matter)	DMD (%)
A	1	2.26ab	10.89b	12.30b	0.60a
A	2	2.18b	10.66bc	12.04bc	0.59b
A	3	2.30a	10.53c	11.88c	0.58b
A	4	1.95c	12.28a	13.63a	0.68c
Means		2.17	11.09	12.46	0.61
SEM		0.036	0.124	0.139	0.005
P value		0.000	0.000	0.000	0.000
B	1	2.05	11.70	12.99	0.65
B	2	2.04	11.75	12.93	0.65
B	3	2.08	11.86	13.06	0.65
B	4	1.95b	11.96	13.15	0.65
Means		2.03	11.82	13.03	0.65
SEM		0.046	0.139	0.154	0.006
P value		0.305	0.596	0.762	0.907

Values followed with different letters in each column within company are significantly different

the chemical composition of the starter diets produced by both companies met the labelled diet specifications for crude fat (≥3%) and crude fibre content (≤6%). The exception was crude protein, which was slightly lower than specified for company A (20.1% vs 21%). While company A did not specify the content of protein, crude fibre and crude fat in their finisher diet, the average content of protein, crude fat and crude fibre of diets produced by both companies met the recommendations by company B (≥18%, ≥3% and ≤6% for protein, fat and fibre, respectively). The variation in chemical composition, especially fibre content (e.g. NDF and ADF) was reflected in the variability of dietary AME which in turn affected FCR. The AME values varied from 11.8 to 12.5 MJ/kg and FCR from 1.76 to 1.97 in the two experiments for starter diet. The AME values for starter and finisher diets were lower than the Australian standard nutrient specifications for starter (12.85 MJ/kg) and finisher (13.5 MJ/kg) Cobb broilers, respectively.

Many factors contribute to the variation in AME in a complete broiler feed. Dietary ingredients can vary according to genotype, growing environment, storage, processing and other management factors (Hughes and Choct, 1999). For example, AME of wheat for poultry ranges from 12.1 to 16.6 MJ/kg DM for north American wheats (Sibbald and Slinger, 1962; Schumaier and McGinnis, 1967), 13.0 to 15.2 MJ/kg DM for UK wheats (Wiseman and Inborr, 1990) and 10.4 to 15.9 MJ/kg DM for Australian wheats (Mollah et al., 1983; Rogel et al., 1987). When inclusion rates of some of these wheats are above 50% in broiler diets, the birds will develop sticky and

Table 5. Statistics of the NIR calibration equations developed for determination of apparent metabolisable energy (AME, MJ/kg), feed conversion ratio (FCR) and dry matter digestibility (DMD, %) of commercial broiler diets

Constituent	N	Mean	SD	R^2	SECV	1-VR
Intake	24	123.97	8.33	0.89	4.17	0.76
FCR	24	1.98	0.12	0.93	0.06	0.75
AME (air dry)	24	11.77	0.48	0.95	0.19	0.86
DMD	24	0.64	0.04	0.98	0.01	0.95

SD, standard deviation; SECV, standard error of cross validation; 1-VR, coefficient of determination for cross validation

watery droppings accompanied by poor growth and feed efficiency. Choct and Hughes (1997) also found that AME values improved after 4 months of storage, but the magnitude of improvement differed amongst the samples and ranged from 0 to 3 MJ/kg. These changes were closely reflected in the feed conversion ratios of the birds. Apart from the storage factor, the variability in the digestibility of a particular chemical component such as fat also contributes significantly to the variation in AME of complete poultry diet. Steenfeldt (2001) found that the fat digestibility varied from 62.9 to 78.2% with a fat content of 5.5-6.1% in the wheat based diets. Thus it is not surprising that variation in AME of starter diets was not significant between the two commercial companies although the fat content in diet was 10.9% for company B and 4.9% for company A.

Variation in the AME and FCR between batches of commercial feed has a significant effect on the uniformity and profitability of batches of meat birds. A 0.18 unit difference for starter diets and 0.35 unit for finisher diets in FCR detected from the current study indicate a saving of AUS $0.07-$0.12 in producing 1 kg liveweight of chicken. When applying this value to a medium size broiler farm, it is clear that extra profit could be achieved if the diets were more consistent in quality.

There are a number of strategies to reduce the variability in nutritive value of complete poultry diets. This includes the assessment of AME in feed grains produced from different cultivars, regions and under different management systems prior to including in a diet. However, no rapid assay is currently available for the industry and most nutritionists are still formulating diets based on book values for AME, assuming that nutritive values of feed ingredients are additive. This assumption is not always true in commercial practice (Hughes and Choct, 1999) due to the interactions between ingredients that cannot be predicted in the complete diet. Thus it is more practical to establish a rapid assay of nutritive value which could assist poultry growers to purchase the feed based on quality and also assist feed companies to further enhance their quality control systems to deliver feed with more accurate specifications and greater consistency.

The correlations between AME, FCR and chemical composition may enable the indirect estimation of feeding value of commercial broiler diet. Of the chemical components, dietary fibre is particularly interesting. Each unit increase of crude fibre or ADF resulted in a decrease of 0.49 and 0.31 MJ AME/kg from the current experiment, although the fibre content of the commercial diet is within the industry specification. A large body of evidence also shows that the small increment in the dietary fibre, especially non-starch polysaccharides, in the poultry diet can result in non linear increases in viscosity of digesta, resulting in a loss of performance by interference with digestion and absorption of nutrients (Annison, 1993). However, current fibre analysis and AME bioassay are very expensive, labour-intensive and time-consuming and cannot rapidly supply specific information on the nutritive value of feed ingredients the animal nutritionists are about to use in the feedmill and the feeding value of the commercial diets the poultry farmers are going to purchase. This points to a need to develop rapid, low cost assays for assessing the nutritive value of commercial diets.

NIR has been widely used for feed evaluation at a rapid turnover and low costs. The current study with a small number of samples showed that NIR has the potential to predict AME and FCR for commercial broiler diets, with an error of 0.2 MJ/kg for AME and 0.06 unit for FCR, but the calibrations require further development and validation before being commercially available. If the calibrations can be successfully developed, the application of this technology in the poultry industry will result in significant benefit for the poultry producers and feed manufacturers. It should be noted that FCR in the current experiment was measured in the environmentally-controlled poultry shed and may not match the values obtained in the commercial environment. However, it is expected that FCR measured under research conditions would be strongly and positively related to the values in the commercial shed. If this has been approved, the development of NIR calibration for FCR will be of significance to the industry.

Predicting AME of feed ingredients for poultry using NIR has been successful in some studies. Windham et al. (1994) successfully developed NIR calibrations for AME estimation of cereals with a standard error of 0.38 MJ/kg DM. The global calibration for cereals and protein meals has a larger standard error (1.15 MJ/kg DM), suggesting that calibrations should be developed for each type of feed ingredient. Valdes and Leeson (1992a) reported that the best equation to predict AME using NIR was obtained using log 1/R (R^2=0.93). The SEE (standard error of estimate) of 0.41 MJ/kg is an acceptable value (3.3% of mean) for prediction of AME in poultry ingredients (Valdes and Leeson, 1992a). The application of the first or second derivatives for calibrations did not improve the accuracy of the calibrations. However, Wiseman and McNab (1995) and Choct (1995)

were not successful in predicting AME of wheat using NIR, probably due to complicated interactions between properties of feed ingredients and gut function of the animal (Choct, 1995). This was supported by research conducted by Garnsworthy et al. (2000), where the true metabolisable energy (TME) in broilers was predicted more accurately than AME, and the calibration for TME was better in young birds than in adult birds because of the wider range of TME values observed with the young birds. Edney et al. (1994) also reported a standard error of prediction of 0.21 MJ/kg DM and a R^2 of 0.90 for calibration of TME in barley. However, most researchers have focused on predicting AME of individual ingredients which will not fully reflect their value in a complete diet due to the interactions involving chemical and physical properties of ingredients.

Valdes and Lesson (1992b) found NIR has the potential for measuring AME in complete poultry diets. AME was best predicted in poultry feeds using four different wavelengths (1,500, 1,720, 2,216 and 2,192 nm) that were obtained with the log 1/R as the mathematical treatment. The lowest SEE was obtained when spectra were treated as log 1/R. The prediction of AME of ingredients using a calibration developed with complete diets was also successful for some ingredients (corn, barley, bakery by-product), but overestimated AME value for oats, flour mill screenings, whole soybeans, soybean meal and canola meal. The high SEE (0.73) was due to differences in chemical composition of diets for calibration and ingredients for prediction (Valdes and Lesson, 1992a). Moreover, two diets containing high levels of added fat (corn oil and tallow mix at a 6% level of basic diet) were outliers in their calibration. While Valdes and Leeson (1992b) suggested that selection of the proper wavelengths was one of the most difficult tasks of multiple linear regression (MLR) calibrations, principal component analysis (PCA) does not require wavelength selection because all wavelengths are used in the analysis. The outcomes of this earlier work and our current study warrant further development of NIR calibrations for predicting feeding value of commercial poultry feed.

In conclusion, there is significant variation in nutritive value of commercial broiler diets between batches within company or between companies, which could result in a huge difference in profit for the chicken meat industry. A rapid, low-cost assay is required to assess the quality of commercial broiler feed to ensure that poultry farmers purchase feed based on quality and to be used by feed manufacturers as a tool for quality control. The previous and current research show that NIR has potential for predicting nutritive value of commercial broiler diets with a short turnover time, simple operation and low running costs. However, more samples from different companies need to be assessed for further development and validation of NIR calibrations.

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