Non-Ruminant Session II

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Notes

Energy Content of Co-Products for Pigs and Poultry

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Take-Home Message

Co-products from the grain (e.g., wheat middlings), oilseed (e.g., soybean hulls), and biofuel (e.g., corn dried distillers grains with solubles) industries have been and will continue to be utilized in the livestock industry as sources of energy and nutrients. However, variability among and within each of these feedstuffs remain a challenge when assessing their relative feeding and economic value. Consequently, improving our ability to obtain accurate 'real time' chemical composition of feedstuffs is essential to increase energy and nutrient utilization efficiency. Because the accuracy and calibration of these measures are often related to wet-lab procedures, understanding lab-to-lab variability and bias becomes an equally important task.

Once analyzed, these feedstuffs undergo a biochemical process (digestion and metabolism), and because many of these co-products are now 'fiber rich', there must be a renewed effort to develop a better understanding of the impact of dietary fiber on energy and nutrient metabolism on a physiological basis (gi function, passage rate, gene expression, energy and nutrient digestion, microbial ecology, immunology, feed intake mechanisms, etc.). It is only through these processes that the real value of a feedstuff (ME or NE) can be assessed for its contributions to productive purposes (meat, milk, or egg production). Given that these co-products are rich in 'fiber', there must be a more complete understanding of the most appropriate analysis of dietary fiber (NSP vs. NDF vs. TDF) and whether a specific measure is appropriate for all monogastrics or is species specific. Lastly, the generation of prediction equations linking chemical and physical measurements to a feedstuffs' energy value must be developed and validated for their robustness within each species. Understanding all these factors will also improve the ability to understand and utilize feed processing and exogenous enzymes as a means to enhance energy utilization of fibrous feedstuffs.

In reviewing the data obtained from the poultry and swine experiments reported herein, lipid content is highly important relative to the gross energy of a corn dried distillers grains with solubles sample, but it is not initially important to its digestible or metabolizable energy content. In contrast, dietary fiber (as measured as total dietary fiber or neutral detergent fiber) is a primary variable in predictive equations for both poultry in swine because it plays a significant role in energy and nutrient digestive processes, with other variables (ash, crude protein, lipid, etc.) being included as equation modifiers.

Energy determination of corn co-products fed to broiler chicks from 15 to 24 days of age, and use of composition analysis to predict nitrogen-corrected apparent metabolizable energy[1]

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ABSTRACT An experiment (3 trials) was conducted to determine the AME_n of 15 corn co-products obtained from various wet and dry milling plants, and to develop prediction equations for AME_n based on chemical composition. Co-products included distillers dried grains with solubles (DDGS, $n = 6$), high-protein distillers dried grains ($n = 2$), corn germ ($n = 2$), corn germ meal, corn bran with solubles, corn gluten meal, corn gluten feed, and dehulled, degermed corn. Treatments (15) consisted of 85% inclusion of the corn-soybean meal basal diet combined with a 15% inclusion of each corn co-product, as well as a control diet containing glucose·H_2O (15%) at the expense of the co-product. In each trial, Ross × Ross 708 chicks (10 birds per pen) were randomly assigned to 16 dietary treatments (12 replicate pens; 4 replicate pens per trial). After a 7-d diet acclimation period from 15 to 22 d of age, a 48-h total excreta collection was conducted for the determination of AME_n. Co-products were analyzed for gross energy, CP, moisture, crude fat, starch, crude fiber, ash, total dietary fiber, neutral detergent fiber, and acid detergent fiber, and hemicellulose was determined by difference. Stepwise regression resulted in the following equation: AME_n, kcal/kg of DM = 3,517 + (46.02 × % crude fat, DM basis) − (82.47 × % ash, DM basis) − (33.27 × % hemicellulose, DM basis) ($R^2 = 0.89$; SEM = 191; $P \leq 0.01$). Removing hemicellulose from the model resulted in the following equation: AME_n, kcal/kg of DM = (−30.19 × % neutral detergent fiber, DM basis) + (0.81 × gross energy, kcal/kg of DM basis) − (12.26 × % CP, DM basis) ($R^2 = 0.87$; SEM = 196; $P \leq 0.01$). These results indicate that nutrient composition may be used to generate AME_n prediction equations for corn co-products fed to broiler chicks.

Key words: broiler, co-product, distillers dried grains with solubles, energy prediction

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Determination and prediction of digestible and metabolizable energy from chemical analysis of corn coproducts fed to finishing pigs[1]

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ABSTRACT: Twenty corn coproducts from various wet- and dry-grind ethanol plants were fed to finishing pigs to determine DE and ME and to generate equations predicting DE and ME based on chemical analysis. A basal diet comprised corn (97.05%), limestone, dicalcium phosphate, salt, vitamins, and trace minerals. Twenty test diets were formulated by mixing the basal diet with 30% of a coproduct, except for dried corn solubles and corn oil, which were included at 20 and 10%, respectively. There were 8 groups of 24 finishing gilts ($n = 192$; $BW = 112.7 \pm 7.9$ kg). Within each group, gilts were randomly assigned to 1 of 5 test diets or the basal diet for a total of 4 replications per diet per group. Two groups of gilts were used for each set of coproducts, resulting in 8 replications per coproduct and 32 replications of the basal diet. The experiment was conducted as a completely randomized design. Gilts were placed in metabolism crates and offered 3 kg daily of their assigned test diet for 13 d, with total collection of feces and urine during the last 4 d. Ingredients were analyzed for DM, GE, CP, ether extract, crude fiber, NDF, ADF, total dietary fiber (TDF), ash, AA, and minerals, and in vitro OM digestibility was calculated for each ingredient. The GE was determined in the diets, feces, and urine to calculate DE and ME for each ingredient. The DE and ME of the basal diet were used as covariates among groups of pigs. The DE of the coproducts ranged from 2,517 kcal/kg of DM (corn gluten feed) to 8,988 kcal/kg of DM (corn oil), and ME ranged from 2,334 kcal/kg of DM (corn gluten feed) to 8,755 kcal/kg of DM (corn oil). By excluding corn oil and corn starch from the stepwise regression analysis, a series of DE and ME prediction equations were generated. The best fit equations were as follows: DE, kcal/kg of DM $= -7{,}471 + (1.94 \times \text{GE}) - (50.91 \times \text{ether extract}) + (15.20 \times \text{total starch}) + (18.04 \times \text{OM digestibility})$, with $R^2 = 0.90$, $SE = 227$, and $P < 0.01$; ME, kcal/kg of DM $= (0.90 \times \text{GE}) - (29.95 \times \text{TDF})$, with $R^2 = 0.72$, $SE = 323$, and $P < 0.01$. Additional equations for DE and ME included NDF in the instance that TDF data were not available. These results indicate that DE and ME varied substantially among corn coproducts and that various nutritional components can be used to accurately predict DE and ME in corn coproducts for finishing pigs.

Key words: corn coproduct, digestible energy, ingredient analysis, metabolizable energy, pig, prediction equation

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Effects of reduced-oil corn distillers dried grains with solubles composition on digestible and metabolizable energy value and prediction in growing pigs[1]

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ABSTRACT: Two experiments were conducted to determine the DE and ME content of corn distillers dried grains with solubles (corn-DDGS) containing variable ether extract (EE) concentrations and to develop DE and ME prediction equations based on chemical composition. Ether extract content of corn-DDGS ranged from 4.88 to 10.88% (DM basis) among 4 corn-DDGS samples in Exp. 1 and from 8.56 to 13.23% (DM basis) among 11 corn-DDGS samples in Exp. 2. The difference in concentration of total dietary fiber (TDF) and NDF among the 4 corn-DDGS sources was 2.25 and 3.40 percentage units, respectively, in Exp. 1 but was greater among the 11 corn-DDGS sources evaluated in Exp. 2, where they differed by 6.46 and 15.18 percentage units, respectively. The range in CP and ash were from 28.97 to 31.19% and 5.37 to 6.14%, respectively, in Exp. 1 and from 27.69 to 32.93% and 4.32 to 5.31%, respectively, in Exp. 2. Gross energy content among corn-DDGS samples varied from 4,780 to 5,113 kcal/kg DM in Exp. 1 and from 4,897 to 5,167 kcal/kg DM in Exp. 2. In Exp. 1, the range in DE content was from 3,500 to 3,870 kcal/kg DM and ME content varied from 3,266 to 3,696 kcal/kg DM. There were no differences in ME:DE content among the 4 corn-DDGS sources in Exp. 1, but ME:GE content differed ($P = 0.04$) among sources (66.82 to 74.56%). In Exp. 2, the range in DE content among the 11 corn-DDGS sources was from 3,474 to 3,807 kcal/kg DM and ME content varied from 3,277 to 3,603 kcal/kg DM. However, there were no differences in DE:GE, ME:DE, or ME:GE among sources in Exp. 2. In Exp. 1, no ingredient physical or chemical measurement [bulk density (BD), particle size, GE, CP, starch, TDF, NDF, ADF, hemicellulose, EE, or ash)] was statistically significant at $P \leq 0.15$ to predict DE or ME content in corn-DDGS. In Exp. 2, the best fit DE equation was DE (kcal/kg DM) = 1,601 – (54.48 × % TDF) + (0.69 × % GE) + (731.5 × BD) [$R^2 = 0.91$, SE = 41.25]. The best fit ME equation was ME (kcal/kg DM) = 4,558 + (52.26 × % EE) – (50.08 × % TDF) [$R^2 = 0.85$, SE = 48.74]. Apparent total tract digestibility of several nutritional components such as ADF, EE, and N were quite variable among corn-DDGS sources in both experiments. These results indicate that although EE may be a good predictor of GE content in corn-DDGS, it is not a primary factor for predicting DE or ME content. Measures of dietary fiber, such as ADF or TDF, are more important than EE in determining the DE or ME content of corn-DDGS for growing pigs.

Key words: corn-distillers grains with solubles,
energy, energy prediction, ether extract, growing–finishing pigs

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37 Prediction equations for apparent metabolizable energy of corn distillers dried grains with solubles determined in broiler chicks from 10 to 18 days of age. K. J. Meloche*[1], B. J. Kerr[2], G. C. Shurson[3], and W. A. Dozier III[1], *[1]Auburn University, Auburn, Alabama, [2]USDA-ARS National Laboratory for Agriculture and the Environment, Ames, IA, [3]University of Minnesota, St. Paul.*

The ethanol industry has been extracting 2 to 6% corn oil from corn distillers dried grains with solubles (DDGS) as a strategy to generate additional revenue through the production of crude corn oil. As a result, the AME$_n$ value of reduced oil DDGS may be decreased by as much as 300 to 600 kcal/kg. An experiment was conducted to examine the nutrient composition of DDGS to develop prediction equations for AME$_n$ in broilers. Fifteen samples of DDGS ranging in ether extract (EE) from 3.15 to 13.23% (DM-basis) were collected from various dry milling plants and were subsequently fed to broiler chicks to determine AME$_n$. A corn-soybean meal control diet was formulated to contain 15% dextrose, and test diets were created by mixing the control diet with 15% DDGS at the expense of dextrose. A total of 1,344 male Ross × Ross 708 chicks housed in battery grower cages (7 birds/cage; 0.06 m^2/bird) was randomly assigned to 16 dietary treatments (12 replicate pens per treatment). Broilers were fed experimental diets from 10 to 16 d of age, followed by a 48 h total excreta collection period. On a DM-basis, AME$_n$ of the 15 DDGS samples ranged from 1,869 to 2,824 kcal/kg. Analyses were conducted to determine the gross energy (GE), CP, EE, moisture, starch, total dietary fiber (TDF), neutral detergent fiber (NDF), acid detergent fiber (ADF), and ash content of the DDGS. Stepwise regression resulted in the following best-fit equation for AME$_n$ (DM basis): AME$_n$, kcal/kg $= -12{,}282 + (2.60 \times \text{GE}) + (89.75 \times \text{CP}) + (125.80 \times \text{starch}) - (40.67 \times \text{TDF})$ ($R^2 = 0.90$; SE $= 98.76$; $P \leq 0.0001$). Ether extract did not enter the model as a significant predictor of AME$_n$. These results indicate that the composition of DDGS may be used to generate prediction equations for AME$_n$ in broiler chicks.

Key Words: broiler, distillers dried grains with solubles, metabolizable energy, prediction equations, fiber

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REVIEW **Open Access**

Strategies to improve fiber utilization in swine

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Abstract

Application of feed processing methods and use of exogenous feed additives in an effort to improve nutrient digestibility of plant-based feed ingredients for swine has been studied for decades. The following review will discuss several of these topics, including: fiber characterization, impact of dietary fiber on gastrointestinal physiology, energy, and nutrient digestibility, mechanical processing of feed on fiber and energy digestibility, and the use of exogenous enzymes in diets fed to growing pigs. Taken together, the diversity and concentration of chemical characteristics that exists among plant-based feed ingredients, as well as interactions among constituents within feed ingredients and diets, suggests that improvements in nutrient digestibility and pig performance from mechanical processing or adding exogenous enzymes to diets fed to swine depends on a better understanding of these characteristics, but also relating enzyme activity to targeted substrates. It may be that an enzyme must not only match a target substrate(s), but there may also need to be a 'cocktail' of enzymes to effectively breakdown the complex matrixes of fibrous carbohydrates, such that the negative impact of these compounds on nutrient digestibility or voluntary feed intake are alleviated. With the inverse relationship between fiber content and energy digestibility being well described for several feed ingredients, it is only logical that development of processing techniques or enzymes that degrade fiber, and thereby improve energy digestibility or voluntary feed intake, will be both metabolically and economically beneficial to pork production.

Keywords: Energy, Enzymes, Fiber, Growing-finishing pigs, Nutrient digestibility, Processing

Assessing the Energy Value of Corn Co-products

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Summary

Corn dried distillers grains with solubles (DDGS) have been used extensively in commercial swine diets as an economical energy source. Variability in energy and nutrient content among DDGS sources continues to be a significant challenge when assessing relative feeding value among sources and determining accurate nutrient loading values for use in feed formulation. Implementation of partial oil extraction technology by the majority of U.S. ethanol plants has further increased energy and nutrient content variability. To manage this variability, nutritionists need accurate, inexpensive, and rapid methods to assess energy value among DDGS sources. Prediction equations using chemical and physical measurements that are most predictive of metabolizable or net energy content offer a reasonable approach to estimate DDGS energy content, but understanding their limitations is essential. Fiber content and composition in DDGS plays a significant role in estimation of energy content. Minimizing the impact of dietary fiber on fatty acid digestibility, as well as increasing digestibility of dietary fiber, represent two of the most significant opportunities for improving energy utilization in DDGS. Dietary fiber may reduce energy utilization of DDGS through several mechanisms. Using the most appropriate measure to characterize dietary fiber and its physiologic and nutritional impact in swine diets is essential. A better understanding fiber digestion and fermentation is needed in order to improve the efficacy of exogenous enzymes as a means to enhance energy utilization in DDGS.

2013 Midwest Swine Nutrition Conference

CURRENT RESEARCH UPDATE

SWINE

Validation of Digestible and Metabolizable Energy Prediction Equations, and Determination of Net Energy of Corn DDGS Sources Varying in Fat and Fiber Content in Growing Pigs

1. **Objective 1-Refine DE and ME values for 6 DDGS products ranging in fat content from 5 to 14%.**

Methodology: Three separate groups of pigs were utilized in for the metabolism experiment to determine DE and ME of 6 corn-DDGS products, Table 1. Based upon past experience, this study utilized each pig as its own control, and thus the experiment consisted of two feeding periods within each group. To accomplish this, a switch-back design was used. For example, during Period-1, pigs 1 through 12 were first fed the basal diet while pigs 13 through 24 were first fed the 60% basal plus 40% C-DDGS treatments. In contrast, during Period-2, pigs 1 through 12 were fed the 60% basal plus 40% C-DDGS treatments while pigs 13 through 24 were fed the basal diet. Each collection period consisted of a 9 day adaptation and a 4 day collection. The inclusion rate for all C-DDGS products was 40%, the remainder being the C-SBM basal diet. Within a specific assay diet, the DE and ME of each test ingredient was calculated by subtracting the DE or ME contributed by the basal diet from the DE or ME of the diet containing a particular C-DDGS source. Dry matter digestibility (DMD), was calculated in a likewise manner, being reported on a percentage of intake basis. Using Proc REG, stepwise regression was used to determine the effect of nutrient composition among C-DDGS sources on apparent GE, DE, ME, and DE:GE, ME:GE, and ME:DE; variables with P-values ≤ 0.15 being retained in the model.

Table 1. Composition of the basal and corn-DDGS, DM basis

		DDGS Source					
Item	Basal	A	B	C	D	E	F
Particle size, μm[1]	NA	*Large*	*Large*	*Large*	*Small*	*Small*	*Small*
Dry matter, %[2]	88.54	88.66	88.88	89.34	89.80	90.52	91.28
GE, kcal/kg[1]	4,267	5,227	5,094	5,052	4,981	4,918	5,155
CP, %[2]	17.04	29.65	32.00	31.59	30.58	32.21	29.83
Lysine, %[2]	1.02	1.07	1.14	1.13	1.18	1.15	1.10
Total starch, %[2]	50.44	2.50	2.33	3.82	4.93	4.40	4.68
TDF, %[3]	10.84	31.47	31.62	31.12	32.41	32.81	32.10
NDF, %[2]	9.32	38.27	38.49	39.58	30.95	31.05	27.84
ADF, %[2]	3.35	11.48	12.14	11.60	8.90	8.55	8.55
Hemicellulose, %[4]	5.96	26.79	26.35	27.98	22.05	22.50	19.29
Ash, %[2]	4.86	4.79	4.71	5.38	5.63	5.51	5.53
Chloride, %[2]	0.34	0.16	0.16	0.17	0.21	0.21	0.19
Phosphorus, %[2]	0.50	0.83	0.87	0.92	0.90	0.94	0.85
Potassium, %[2]	0.72	1.16	1.14	1.18	1.29	1.27	1.30
Sodium, %[2]	0.16	0.19	0.14	0.18	0.26	0.18	0.19
Sulfur, %[2]	0.23	0.56	0.54	0.73	1.10	1.05	0.11
EE, %[2]	3.14	13.34	10.41	9.11	8.01	6.99	11.38
Free fatty acids, %[2]	1.32	1.88	1.10	1.25	0.99	0.72	1.21
Thiobarbituric acid, absorbance[2]	45.65	11.73	8.19	14.04	8.15	10.85	5.90
Peroxide value, mEq/kg[2]	22.53	10.21	13.27	3.46	6.73	4.23	2.77

[1] Analyzed by USDA-ARS, Ames, IA. [2] Analyzed by University of Missouri, Columbia, MO. [3] Analyzed by Eurofins, Des Moines, IA. [4] Calculated as NDF – ADF. [5] Fatty acid composition is expressed as a percentage of total fat.

Results: Averaged across all treatments (including pigs fed the C-SBM basal diet; 79.35% corn and 17.90% SBM), pig BW (87.0, 103.9, and 98.3 kg) and ADFI (2,432, 2,560, and 2,334 g/d) were different ($P < 0.01$) among Groups 1, 2, and 3, respectively. In a similar manner, pigs in Period 1 were heavier than pigs in Period 2 (91.0 vs 101.0 kg), but no difference was noted for ADFI (2,433 vs 2,465 g/d, $P = 0.33$) between Periods 1 and 2, respectively. For the 68 pigs fed the C-SBM basal diet, BW, ADFI, DE, ME, and DMD averaged 96.1 kg (SD = 10.0), 2,462 g/d (SD = 191), 3,750 kcal/kg DM (SD = 70), 3,681 kcal/kg DM (SD = 73), and 87.94% (SD = 1.63), respectively, with no differences in BW or ADFI noted between pigs fed the basal diet or pigs fed the various C-DDSS treatments, Table 2.

Table 2. Energy content of the basal and corn-DDGS, DM basis

		C-DDGS source						Statistics[2]	
Item	Basal[1]	A	B	C	D	E	F	SD	P
Observations	68	12	8	12	12	12	12	-	-
BW, kg	96.1	97.3	95.5	97.2	96.2	94.8	97.2	10.7	0.99
ADFI, g	2,462	2,379	2,493	2,459	2,473	2,376	2,434	211	0.71
DMD, %	87.94	74.33	72.05	75.74	72.52	74.77	74.10	5.70	0.68
GE, kcal/kg	4,267	5,227	5,094	5,052	4,981	4,918	5,155	-	-
DE, kcal/kg	3,750	4,006	3,830	3,965	3,836	3,874	4,050	246	0.18
ME, kcal/kg	3,681	3,880	3,693	3,855	3,716	3,739	3,906	252	0.21
DE:GE	87.87	76.64	75.18	78.48	77.02	78.77	78.57	4.88	0.53
ME:DE	98.17	96.87	96.46	97.20	96.85	96.50	96.45	1.90	0.92
ME:GE	86.26	74.22	72.50	76.31	74.60	76.03	75.77	5.00	0.56

[1] The DM digestibility and DE and ME of the C-SBM basal diet for each pig was used as a covariate in subsequent determination of the digestibility and energy values for each C-DDGS. [2] Statistical analysis are relative to the C-DDGS sources only and do not include pigs fed the basal diet.

Results: The "BEST-FIT" equations utilizing this data were:

$GE = 4{,}594 + (48.36 \times EE)$; $R^2 = 0.99$ $P = 0.01$

$DE = -1{,}583 + (0.92 \times GE) + (0.63 \times ash)$; $R^2 = 0.79$ $P = 0.10$

$ME = 5{,}530 - (55.9 \times CP)$; $R^2 = 0.45$ $P = 0.14$

$DE{:}GE = 63.0 + (2.75 \times ash)$; $R^2 = 0.61$ $P = 0.07$

$ME{:}GE = 60.5 + (2.73 \times ash)$; $R^2 = 0.59$ $P = 0.08$

ME:DE = none

2. **Objective 2-Validate DE and ME prediction equations determined for DDGS of varying fat content that were determined from ongoing research projects.**

Status: Utilize the DE and ME equations obtained from this experiment (Objective 1) to predict the DE or ME obtained from other experiments (Pedersen et al., 2007; Anderson et al., 2012; Kerr et al., 2013) is currently underway. Likewise, utilizing prediction equations published by others (Pedersen et al., 2007; Anderson et al., 2012; Kerr et al., 2013) to predict the *in vivo* values obtained in this Objective 1 and in each other experiment are underway.

3. Objective 3-Determine the net energy (NE) content in these same DDGS sources.

Methodology: For the NE experiment, a separate group of 77 pigs was utilized. Body lean, fat, and bone were predicted by DXA (dual energy X-ray absorptiometry). Net energy for maintenance was estimated at 179 kcal/kg $BW^{0.60}$ (Kil et al., 2011), with protein assumed to contain 5.54 kcal/g and lipid assumed to contain 9.34 kcal/g (Birkett and DeLange, 2001). The conversion of DXA lean to whole body protein was calculated as 3.25 grams lean = 1 g whole body protein (Kerr, BioKyowa Technical Review-6, 1993). Pigs had an initial BW of 45.6 kg (SD = 4.3 kg), consisting of 1.30% bone (SD = 0.14), 17.18% fat (SD = 1.09%), and 81.52% lean (SD 1.16%). Pigs were fed their respective diet (similar composition as the metabolism experiment) for 35 d, after which they were scanned by DXA. Protein, fat, and bone deposition was calculated subtracting the initial body composition values form the final body composition values. The NE of each diets were calculated, with the NE of each DDGS source determined for each test ingredient was calculated by subtracting the NE contributed by the basal diet from the NE of the diet containing a particular DDGS source. Using Proc REG, stepwise regression was used to determine the effect of nutrient composition among DDGS sources on apparent NE, NE:GE, NE:DE, NE:ME; variables with P-values ≤ 0.15 were retained in the model.

Results: No "BEST-FIT" equations for NE, NE:GE, NE:DE, or NE:ME could be determined, Table 3.

Table 3. Energy content of basal and corn-DDGS

		C-DDGS source						Statistics[2]	
Item	Basal	A	B	C	D	E	F	SD	P
Observations	13	14	7	8	11	12	12	-	-
DDGS, %	0	40	30	40	40	40	40	-	-
ADG, g	918	845	884	831	801	827	870	89	0.40
ADFI, g	2,067	2,021	2,056	2,022	1,990	1,990	2,012	132	0.92
G:F, g/kg	445	419	430	411	402	415	432	33	0.34
Bone gain, g/d	9.4	6.2	7.8	6.3	4.8	4.5	5.2	1.2	0.01
Fat gain, g/d	137.2	133.0	139.4	126.7	118.8	130.6	138.7	17.9	0.12
Lean gain, g/d	663.9	584.4	606.9	582.9	564.2	584.0	602.8	52.8	0.54
E intake, kcal/d	7,810	8,415	8,270	8,279	8,120	8,047	8,373	543	0.52
E retained, kcal/d	4,537	4,318	4,417	4,290	4,160	4,298	4,411	261	0.28
NE, kcal/kg DM	2,478	2,262	2,249	2,219	2,129	2,326	2,381	214	0.11
NE:GE	58.1	43.3	44.1	43.9	42.7	47.3	46.2	4.2	0.08
NE:DE	66.1	56.5	58.7	56.0	55.5	60.0	58.8	5.4	0.30
NE:ME	67.3	58.3	60.9	57.6	57.3	62.2	60.9	5.6	0.22

[1] Average initial BW averaged 45.6 kg (SD = 4.3 kg), with pigs averaging 1.30% bone (SD = 0.14), 17.18% fat (SD = 1.09%), and 81.52% lean (SD 1.16%) based on DXA analysis. The trial lasted 35 d. On average, the DXA estimated initial and final BW to be 4.2% greater and 2.7% less than that of the farm scales, respectively. Fat = 9.34 cal/g, lean = 1.705 cal/g (5.54 cal/g protein; 1 g protein = 3.25 gram lean), bone = 0 kcal/g. Maintenance determined as 179 kcal × $BW^{0.60}$/day. [2] Statistical analysis are relative to the C-DDGS sources only and do not include pigs fed the basal diet.

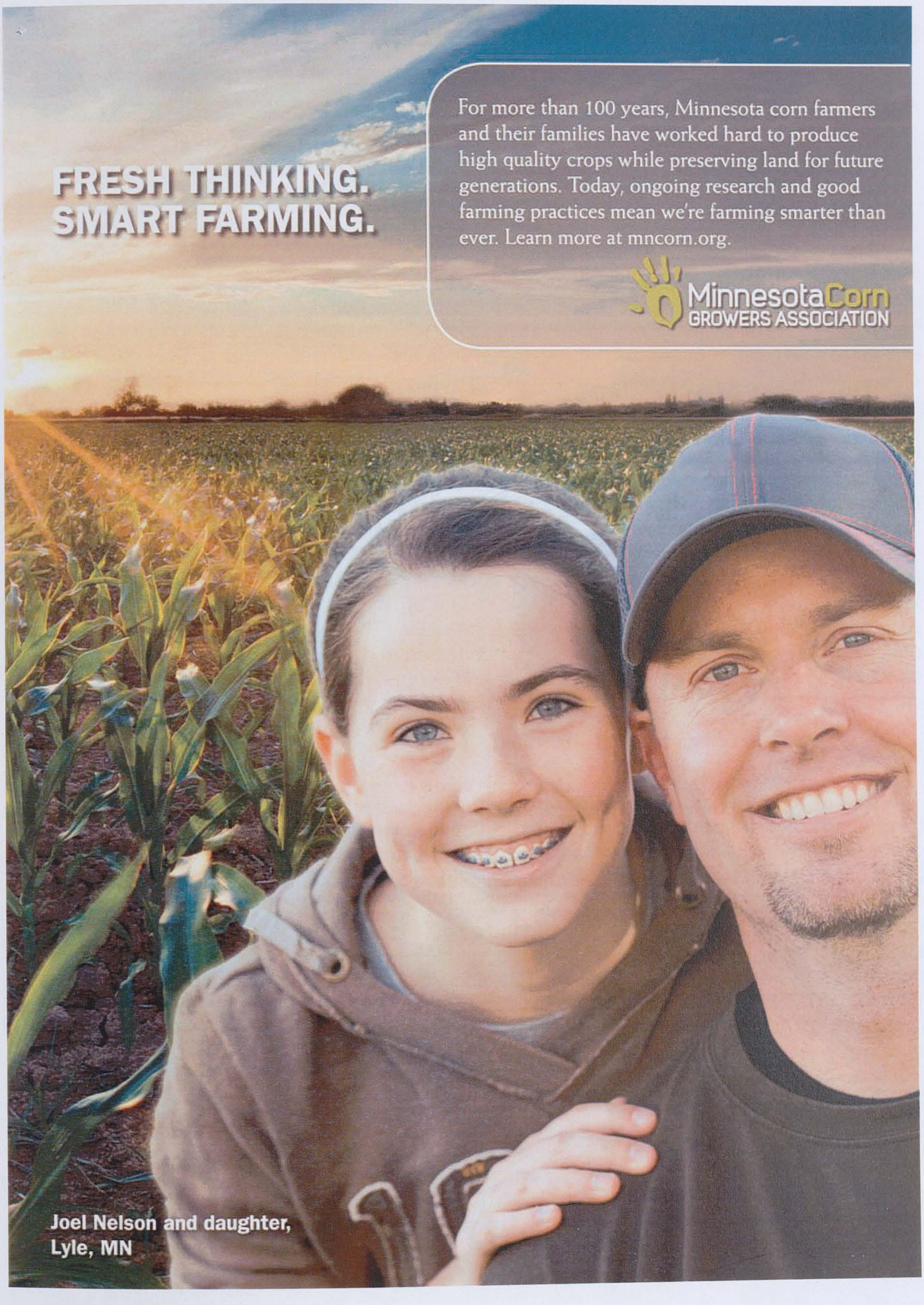
4. Objective 4-Validate the DE and NE content of a corn-DDGS in a field study.

Methodology: *Field study-Performance*—A single source of DDGS was obtained (32.85% CP, 6.30% EE, 31.42% NDF, 33.94% TDF, DM basis) after which 4 diets containing 0, 10, 20, and 30% DDGS were formulated to be equal in NE (corn 1473 ME-1160 NE, sbm 1403 ME-889 NE, soy oil 3889 ME-3422 NE, 6%eeDDGS 1478 ME-1036 NE; as-is basis). Diets were fed to 3 bans of pigs with each barn containing 48 pens of 22 pigs/pen resulting in 12 reps/trt/barn. Pigs were fed for 28 days after which ADG, ADFI, and GF were determined. Any change in GF would relate to an over/under-estimation of the NE in the DDGS. *Field study-Digestibility*—One batch of diets fed to one barn contained an indigestible marker (TiO_2) and after 10 days of feeding, a grab sample from 2 pigs/pen was obtained (12 reps/trt) for subsequent determination of energy, lipid, phosphorus, and fiber digestibility. Likewise, an adequate amount of each was obtained at the same time and was fed to 40 pigs in metabolism crates (10 reps/trt) for subsequent determination of energy, lipid, phosphorus, and fiber digestibility. In addition, an adequate amount of DDGS was obtained at the same time of obtaining DDGS for the field performance study for possible DE and ME determination in metabolism crates.

Results: Field study-Performance is completed but no data available at this time. Field study-Digestibility samples have been collected but not analyzed at this time. Likewise feeding the field study diets to metabolism pigs has also been completed, but not data available. Feeding the original DDGS to determine DE and ME (validation) has not begun.

POULTRY

These same 6 DDGS sources are being evaluated for AME_n in turkeys (University of Minnesota-Dr. Sally Noll) and broilers (Auburn University-Dr. William Dozier). No data is available at this time.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