AMINO ACID DIGESTIBILITY AND ENERGY CONTENT OF CORN DISTILLERS MEAL FOR SWINE[1]

J. Y. Jacela[2], J. M. DeRouchey, S. S. Dritz[2], M. D. Tokach, R. D. Goodband, J. L. Nelssen, R. C. Sulabo, and R. C. Thaler[3]

Summary

An experiment was conducted to determine the apparent ileal digestibility and standardized ileal digestibility of amino acids and energy of corn distillers meal in pigs. Five growing barrows (initially 150 lb) were allotted to one of two diets in a crossover design. One diet contained corn distillers meal (66.7%) as the sole protein source. The second diet was nitrogen-free to determine basal endogenous AA losses. Ileal digesta and fecal samples were collected during each period and analyzed for amino acid and energy contents. Based on these analyses, apparent ileal digestibility (AID), standardized ileal digestibility (SID), gross energy (GE), digestible energy (DE), metabolizable energy (ME), and net energy (NE) were calculated. Apparent ileal digestibility values of lysine, methionine, and threonine in corn distillers meal were 47.2, 79.4, and 64.1%, respectively while SID values of the same amino acids were 50.4, 80.4, and 66.3%, respectively. The ME, DE, and estimated NE values of the corn distillers meal were 1,137; 1,233; and 813 kcal/lb, respectively.

(Key words: corn distillers meal, feed ingredients, digestibility.)

Introduction

With the increase in bio-fuel production, the availability of feed co-products like dried distillers grains with solubles (DDGS), especially from ethanol manufacturing, has greatly increased. Dried distillers grains with solubles (DDGS) is the product that remains after the ethanol is removed from the fermented corn mash and contains high levels of nutrients when compared to corn. While traditional DDGS have been evaluated for feeding value in swine, many other new products are being developed. One such product is corn distillers meal, in which the oil is removed and used in other industries. The remaining co-product has increased protein, fiber, and mineral concentrations. However, no data is available as to the actual digestibility of amino acids and energy of this coproduct. Thus, determination of nutrient digestibility is needed for accurately formulating and valuing corn distillers meal in diets for swine. The objective of this study was to determine the apparent ileal digestibility (AID) and standardized ileal digestibility (SID) of AA, DE, and ME, to estimate NE for corn distillers meal.

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[2]Food Animal Health and Management Center, College of Veterinary Medicine.

[3]Department of Animal and Range Science, South Dakota State University, Brookings, SD.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved protocols used in this experiment.

This experiment was done concurrently in a digestibility study with 2 different feed ingredients utilizing the same animals. Five growing barrows (initially 65 lb) were fitted with a T-cannula on their right flank approximately 15 cm anterior to the ileocecal valve. The pigs were housed individually in stainless steel metabolism crates in an environmentally controlled building after surgery and fed a standard corn-soybean meal-based diet for 10 d during the recovery period. After the recovery period, the pigs were utilized in a separate digestibility study for 5 weeks and then fed a common corn-soybean meal diet for 7 d. Pigs were then randomly allotted in a balanced crossover design with an initial starting weight of 150 lb. Two diets were utilized for this experiment with one diet formulated to contain the corn distillers meal while the second diet was formulated to be nitrogen-free to determine the basal AA endogenous losses (Table 1). Both diets contained 0.25% chromic oxide as an indigestible marker. Each feeding period consisted of 7 d with the first 4 d as adaptation period to the diet. On d 5 and 6, feces were collected in the morning and ileal digesta was collected on d 6 and 7 throughout a 10 h period (between 0600 and 1800 each day). Pigs were weighed at the beginning of each period to determine the amount of feed to be given each day. Feed was given at a daily level of 3 times the estimated maintenance requirement for energy. Feeding was done twice a day at 0600 and 1800 with the allocated daily amount divided into two equal meals. At the end of each period, all the pigs were taken off feed overnight before the next experimental diet was fed the following morning. The pigs were given free access to water through a nipple waterer throughout the duration of the experiment.

Table 1. Diet Composition (as-fed basis)

Ingredient, %	Corn Distillers meal	N-Free
Corn starch	27.05	81.15
Corn distillers meal	66.70	---
Soybean oil	1.00	3.00
Monocalcium P (21% P)	---	1.75
Limestone	1.25	0.40
Salt	0.35	0.45
Vitamin premix	0.25	0.25
Trace mineral premix	0.15	0.15
Potassium chloride	---	0.50
Magnessium oxide	---	0.10
Chromic oxide	0.25	0.25
Solka floc	---	3.00
Sucrose	3.00	9.00
Total	100.00	100.00
Calculated analysis, %		
Total lysine	0.58	0.00
CP	20.80	0.00
Ca	0.51	0.38
P	0.51	0.30
Available P	0.39	0.30

Ileal digesta were collected by attaching a latex balloon to the cannula. Balloons were removed periodically or as soon as they were filled with digesta and emptied in a collection container which was stored in a freezer. After the collection phase of the experiment, ileal samples from each period from each animal were thawed and homogenized. A subsample was taken from each homogenized sample, freeze-dried and ground for amino acid (AA) analysis. Grab-samples of feces collected on d 5 and d 6 were stored and frozen. Fecal samples were then thawed at the conclusion of the collection phase, homogenized within each pig and diet. A subsample was taken and dried in a forced air oven, and ground for analysis. Energy concentration in diets, corn distillers

meal, and fecal samples were determined using bomb calorimetry. Chromic oxide served as the indigestible marker for calculation of AA and energy digestibility values. Corn Distillers meal, diets, and digesta samples were also analyzed for DM and CP.

The AID for AA in the corn distillers meal diet was calculated as:

$$AID = [1 - (AAd/AAf) \times (Crf/Crd)] \times 100\%,$$

where AID is the apparent ileal digestibility of an AA (%), AAd is the concentration of that AA in the ileal digesta (g/kg of DM), AAf is the concentration of that AA in the diets (g/kg of DM), Crf is the chromium concentration in the diet (g/kg of DM), and Crd is the chromium concentration in the ileal digesta (g/kg of DM).

The basal endogenous loss of each amino acid at the ileum was determined based on the digesta samples obtained after feeding the N-free diet using the equation:

$$IAAend = [AAd \times (Crf/Crd)],$$

where IAAend is the basal ileal endogenous loss of an AA (g/kg of DMI).

SID value for each AA was calculated using the equation:

$$SID = [AID + (IAAend/AAf)],$$

where SID is the standardized ileal digestibility of an AA (%).

Digestible Energy value (DE) of corn distillers meal diet was calculated using the same equation for AID to determine the apparent total tract digestibility (ATTD) of energy. This value was then multiplied by the analyzed concentration of GE in the diets to get the DE of the diet. DE of the corn distillers meal was calculated by subtracting 33% of the N-free DE from the DE of the corn distillers meal diet. Metabolizable Energy (ME) and Net Energy (NE) were calculated using the following equations:

$$ME = 1 * DE – 0.68 * CP$$
$$NE = (0.87 * ME) – 442$$

Results and Discussion

The nutrient composition of the corn distillers meal used in the experiment is reported in Table 2. The CP of the corn distillers meal was 31.2%, which, as expected was higher than the CP content in traditional DDGS. Also, as expected, fat level was lower than traditional DDGS as a result of oil separation to produce the corn distillers meal. In addition, analyzed values of most amino acids and ADF and NDF were higher than in typical DDGS.

Lysine, methionine, and threonine in corn distillers meal had AID values of 47.2, 79.4, and 64.1%, respectively (Table 3). The AID value of lysine was lower than published values but most of the other AA AID values were higher than published values for DDGS. Standardized ileal digestibility values were 50.4% for lysine, 80.4% for methionine, and 66.3% for threonine. Just like AID, SID value of lysine was lower than most published values. It has been proposed that a lysine to CP ratio of greater then 2.8 indicates a DDGS co-product with higher amino acid digestibility. The ratio for the corn distillers meal tested in this study was 2.8.

The DE, ME, and estimated NE values of the corn distillers meal were 1,233; 1,137; and 813 kcal/lb, respectively. These values were lower than traditional DDGS energy values, which was expected, because the removal of the majority of the oil.

The AA and energy digestibility values have been established for corn distillers meal in this trial and can now be used as basis when formulating diets. This coproduct of ethanol and fat extraction industries has increased CP

and AA levels compared with traditional DDGS. However, it does contain lower energy and slightly lower lysine digestibility. Experiments to determine the effects of corn distillers meal on pig growth performance are necessary to further evaluate this ingredient and determine optimum use in the swine industry.

Table 2. Analyzed Nutrient Composition of Corn Distillers Meal

Nutrient, %	DM basis	As-is basis
DM	100.00	87.69
Crude protein	35.58	31.20
Crude fat	4.56	4.00
ADF	18.36	16.1
NDF	39.46	34.60
Ca	0.06	0.05
P	0.87	0.76
Ash	5.29	4.64
Amino acids, %		
Arginine	1.50	1.31
Histidine	0.93	0.82
Isoleucine	1.38	1.21
Leucine	4.15	3.64
Lysine	0.99	0.87
Methionine	0.67	0.58
Phenylalanine	1.92	1.69
Threonine	1.26	1.10
Tryptophan	0.22	0.19
Valine	1.75	1.54
Alanine	2.43	2.13
Aspartic acid	2.10	1.84
Cysteine	0.62	0.54
Glutamic acid	4.85	4.26
Glycine	1.35	1.18
Proline	2.41	2.11
Serine	1.48	1.30
Tyrosine	1.29	1.13

Table 3. Standardized and Apparent Ileal Digestibility of Amino Acids in Corn Distillers Meal [a]

Amino acid	SID, % [b]	AID, %[c]
Indispensable amino acids		
Arginine	82.70	79.65
Histidine	74.63	72.79
Isoleucine	74.52	72.46
Leucine	83.79	82.68
Lysine	50.38	47.20
Methionine	80.41	79.42
Phenylalanine	80.77	79.35
Threonine	66.31	64.09
Tryptophan	77.96	73.72
Valine	73.75	71.75
Dispensable amino acids		
Alanine	74.04	77.22
Aspartic acid	62.79	61.31
Cysteine	57.90	64.14
Glutamic acid	76.62	77.45
Glycine	57.26	52.69
Proline	83.45	73.44
Serine	71.08	73.20
Tyrosine	77.77	80.60

[a]Values are means of 5 pigs (initially 150 lb) used in a crossover design.
[b]Standardized ileal digestibility.
[c]Apparent ileal digestibility.

Table 4. Energy Analysis of Corn Distillers Meal [a]

Energy, kcal/lb	DM Basis	As-is Basis
Gross energy	2,116	1,855
Digestible energy	1,406	1,233
Metabolizable energy[b]	1,296	1,137
Net energy[c]	927	813

[a]Values are means of 5 observations per treatment.
[b]The ME value of corn distillers meal was calculated using the equation: ME = 1 * DE – 0.68 * CP (Noblet and Perez, 1993).
[c]The NE value of corn distillers meal was calculated by using the equation: NE = (0.87 * ME) – 442 (Noblet et al., 1994).