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Use of dried distiller’s grains with soluble for swine diets

Abstract

A large increase in the number of ethanol plants has lead to increased availability of dried distillerâ€™s grains with solubles (DDGS). New plants also have improved processing techniques, which makes DDGS more attractive to use in swine diets. Two experiments were conducted to determine the energy value of DDGS. In Experiment 1, 360 pigs (each initially 38.5 lb) were used in a 22 d growth assay. Treatments consisted of five corn-soybean meal-based diets with added wheat bran or soy oil to provide five different energy densities ranging from 1,390 to 1,604 Kcal/lb ME. The objective was to use responses to the wide range of energy densities to calculate an energy value for two sources of DDGS. Because it is speculated that newer ethanol plants produce a better quality DDGS than older plants, we selected one relatively new plant in Minnesota, and a second, older plant in Nebraska as separate sources of DDGS. Pigs were fed four additional diets, including either 15 or 30% DDGS from one of the two different sources. For the overall 22 d study, increasing energy increased ADG (linear; $P<0.01$), reduced ADFI (linear; $P< 0.01$), and improved F/G (linear; $P<0.01$). Because of the linear response to increasing energy in our five basal diets, the F/G of pigs fed the diets containing DDGS could be compared to the F/G of the control diets. Thus, we estimated the ME of 1,586 and 1,419 kcal ME/lb for the Minnesota and Nebraska DDGS sources, respectively. In Experiment 2, eight barrows (each initially 98.3 lb) were used in a Latin square design to determine the ME of the two DDGS sources used in Experiment 1. Diets were made up of 97% DDGS supplemented with crystalline amino acids, vitamins, and minerals to meet or exceed the pigsâ€™ nutrient requirements. There were no differences ($P>0.49$) for any growth traits; however, estimated digestible energy (DE) (1,756 vs. 1,691; $P<0.02$) and ME values (1,677 vs. 1,627; $P<0.05$) were greater than calculated in the growth trial. The results of these two studies with the same batches of DDGS suggest possible variation in the energy value of DDGS based on how it is measured. In a nutrient balance study where pigs are individually fed a limited amount of feed, ME values were estimated to be higher than predicted from extrapolating our results from a growth trial. This leads us to speculate that in the growth trial, the decrease in ADFI and improvement in F/G observed from increasing DDGS may not have been a result of its increased energy content, but rather a palatability problem. Therefore, while it appears that the ME content of DDGS produced from relatively new processing plants appears to be comparable to that of corn, palatability problems may affect performance of pigs fed diets containing DDGS. Therefore, producers should exercise caution and evaluate potential variation and palatability before incorporating DDGS into their nutrition programs.; Swine Day, 2003, Kansas State University, Manhattan, KS, 2003

Keywords

Swine day, 2003; Kansas Agricultural Experiment Station contribution; no. 04-120-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 920; Distiller's dried grains with solubles; Energy; Swine

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USE OF DRIED DISTILLER'S GRAINS WITH SOLUBLES FOR SWINE DIETS

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Summary

A large increase in the number of ethanol plants has lead to increased availability of dried distiller's grains with solubles (DDGS). New plants also have improved processing techniques, which makes DDGS more attractive to use in swine diets.

Two experiments were conducted to determine the energy value of DDGS. In Experiment 1, 360 pigs (each initially 38.5 lb) were used in a 22 d growth assay. Treatments consisted of five corn-soybean meal-based diets with added wheat bran or soy oil to provide five different energy densities ranging from 1,390 to 1,604 Kcal/lb ME. The objective was to use responses to the wide range of energy densities to calculate an energy value for two sources of DDGS.

Because it is speculated that newer ethanol plants produce a better quality DDGS than older plants, we selected one relatively new plant in Minnesota, and a second, older plant in Nebraska as separate sources of DDGS. Pigs were fed four additional diets, including either 15 or 30% DDGS from one of the two different sources. For the overall 22 d study, increasing energy increased ADG (linear; $P<0.01$), reduced ADFI (linear; $P< 0.01$), and improved F/G (linear; $P<0.01$). Because of the linear response to increasing energy in our five basal diets, the F/G of pigs fed the diets containing DDGS could be compared to the F/G of the control diets. Thus, we estimated the ME of 1,586 and 1,419 kcal ME/lb for the Minnesota and Nebraska DDGS sources, respectively.

In Experiment 2, eight barrows (each initially 98.3 lb) were used in a Latin square design to determine the ME of the two DDGS sources used in Experiment 1. Diets were made up of 97% DDGS supplemented with crystalline amino acids, vitamins, and minerals to meet or exceed the pigs' nutrient requirements. There were no differences ($P>0.49$) for any growth traits; however, estimated digestible energy (DE) (1,756 vs. 1,691; $P<0.02$) and ME values (1,677 vs. 1,627; $P<0.05$) were greater than calculated in the growth trial.

The results of these two studies with the same batches of DDGS suggest possible variation in the energy value of DDGS based on how it is measured. In a nutrient balance study where pigs are individually fed a limited amount of feed, ME values were estimated to be higher than predicted from extrapolating our results from a growth trial. This leads us to speculate that in the growth trial, the decrease in ADFI and improvement in F/G observed from increasing DDGS may not have been a result of its increased energy content,

[1]Food Animal Health and Management Center.

but rather a palatability problem. Therefore, while it appears that the ME content of DDGS produced from relatively new processing plants appears to be comparable to that of corn, palatability problems may affect performance of pigs fed diets containing DDGS. Therefore, producers should exercise caution and evaluate potential variation and palatability before incorporating DDGS into their nutrition programs.

(Key Words: Distiller's Dried Grains with Solubles, Pigs, Energy)

Introduction

A recent study by the University of Minnesota has shown that distiller's dried grains with solubles (DDGS) have higher nutrient values than previously reported by the NRC (1998). A large number of new ethanol plants, which produce DDGS as a by-product, has increased the availability and attractiveness for use in swine diets. Traditionally, DDGS has been widely fed to ruminants because of the low lysine and high fiber content compared to other ingredients typically fed to pigs. New processing techniques and better quality control may lead to a better and more consistent nutrient profile of DDGS. Therefore, the objective of these trials was to determine a relative energy value for two DDGS sources: one from a relatively new ethanol plant, and the second from an older plant.

Procedures

In Experiment 1, a total of 360 pigs (each initially 38.5 lb) were blocked by weight and allotted randomly to one of nine dietary treatments. Treatments consisted of five corn-soybean meal-based diets with either added wheat bran or soy oil to provide five different energy densities (1,390 to 1,604 kcal ME/lb). The energy levels were selected because in a previous pilot study we had observed a linear response in feed efficiency within this energy range. These diets served to provide a reference to which we could then calculate an energy value for DDGS. The additional four treatments included either 15 or 30% DDGS from one of two different sources (Table 2). There were five pigs/pen and eight pens per treatment. The trial was conducted in the KSU Segregated Weaning Facility.

Experiment 2 was conducted, in an environmentally controlled metabolism at the KSU Swine Teaching and Research Facility. Eight non-littermate barrows (each initially 98.3 lb) were used in a nutrient balance study to determine the actual ME values of the two different DDGS used in Experiment 1. Pigs were fed diets containing 97% of one of the two DDGS sources. Crystalline amino acids, vitamins, and minerals were added to the diet to meet or exceed the pig's requirement (Table 3). The diets were formulated to have approximately 0.84% true digestible lysine.

Total tract digestibility was determined using ferric oxide as a marker. Ferric oxide was added at 1% of the diet in the ninth and fourteenth meals to mark the beginning and end of the collection period. This provided pigs 4 days to acclimate to their diet, followed by 3 days of feces and urine collection. Pigs were fed approximately 2.5% of BW on an as-fed basis. Daily feed allowances were equally divided between meals fed at 6 a.m. and 6 p.m. Water was provided at the rate of 2:1 water:feed (wt/wt) and then offered free choice after feeding. Feces and urine were collected twice daily. Feces were freeze-dried, ground, mixed, and a representative sub-sample was used for laboratory analysis. Urine was collected into plastic bottles containing 25 mL of 6 *N* HCl. Ten percent of each day's output (volume basis) was stored, frozen, mixed with each day's output, centrifuged to remove trace amounts of particulate matter, and analyzed.

Results and Discussion

For the overall 21-d trial, increasing energy density of the diet increased ADG (quadratic, $P<0.03$) reduced ADFI (quadratic, $P<0.06$), and improved F/G (linear; $P<0.01$). There were no differences in ADG or F/G ($P>0.16$) among pigs fed either DDGS source; however, pigs fed Minnesota DDGS had lower ADFI ($P<0.01$) compared with those fed Nebraska DDGS.

Using the known energy content of the five basal treatments and the overall F/G, we calculated the ME of the DDGS diets by comparing F/G of pigs fed these diets to those of the five known energy densities (Figure 1). We could then estimate the energy content of the DDGS by subtracting the known energy values from the amounts of corn and soybean meal in the diet. Using this method, we calculated an ME value of 1,586 and 1,419 kcal for the Minnesota and Nebraska DDGS sources, respectively.

Using the same lots of DDGS from Experiment 1, we conducted a metabolism study to further determine the ME value for the two DDGS sources. In Experiment 2, there were no differences ($P>0.49$) for any growth traits. The Nebraska DDGS source had greater ($P<0.01$) gross energy (GE); however, the Minnesota DDGS had greater ($P<0.05$) DE (1,756 vs 1,691 kcal/lb) and ME (1,677 vs. 1,627 kcal/lb).

The results of our nutrient balance study show that the DDGS sources used have a higher ME value than estimated in the NRC (1998). However, these values are similar to those observed in trials conducted at the University of Minnesota. Furthermore, these results suggest that the ME from DDGS is 5% to 8% greater than that of corn.

In addition to determining DE and ME content of the two DDGS sources, we also calculated net energy. Net energy takes into account energy lost in feces, urine, and gas, as well as energy lost as heat during the process of digestion. By using equations developed to determine net energy from its chemical composition (starch, fat, ADF, and crude protein) we estimated the net energy value of our DDGS sources. Using this equation, the predicted NE value for these DDGS sources is 1,182 and 1,112 kcal/lb for Minnesota and Nebraska, respectively. Comparing the net energy of the two DDGS source to corn (NRC, 1998), we find the DDGS to contain only 90% to 96% of the Nebraska as corn. The discrepancy between ME and net energy values occurs because the ME system overestimates the energy from high-fiber and high crude protein ingredients and underestimates the energy from starch and oil-rich ingredients. The composition of corn (high starch and low fiber) and DDGS (high protein and high fiber) lead DDGS to have a higher ME relative to corn. This illustrates that evaluating feedstuffs on a net energy basis can be used to more precisely predict performance. Because a large portion of swine diets are corn based, replacing it with an energy source that is lower in net energy is likely to reduce performance.

A second possible explanation for the variation in the energy value of DDGS between our two studies may be related to feed intake. In the nutrient balance study, pigs were individually fed a limited amount of feed, ME values were estimated to be higher than predicted from extrapolating our results from a growth trial. This leads us to speculate that in the growth trial, the decrease in ADFI and improvement in F/G observed from increasing DDGS may not have been a result of its increased energy content, but rather the result of decreased palatability. If the DDGS were unpalatable enough to slightly reduce feed intake, this could also slightly improve F/G, which could be misinterpreted as a response to energy. Therefore, while it appears that the ME content of DDGS produced from relatively new processing plants appears to be comparable to that of corn, palatability problems may affect performance of pigs fed diets containing DDGS. Because of differences in the fiber content of DDGS, NE may be a more reliable method of estimating energy content rather than ME. Therefore, producers should exercise caution and evaluate potential variation and palatability before incorporating DDGS into their nutrition programs.

Table 1. Composition of DDGS Sources[a]

Item	Minnesota	Nebraska
Dry matter	92.79	92.99
GE, kcal/lb	2,372	2,395
Crude protein, %	26.67	30.95
Crude fat, %	10.78	9.03
Crude fiber, %	5.61	7.62
Ash, %	6.16	3.91
Ca, %	0.84	0.60
P, %	0.83	0.49
K, %	0.88	0.50
Mg, %	0.30	0.16
NDF, %	26.03	32.61
ADF, %	6.85	9.97
Amino acids,%		
Lysine	0.78	1.08
Isoleucine	1.03	1.23
Leucine	3.28	3.97
Methionine	0.55	0.71
Met & Cys	1.08	1.42
Threonine	1.07	1.25
Tryptophan	0.19	0.21
Valine	1.40	1.66
Tyrosine	1.12	1.28
Phenylalanine	1.36	1.68
Histidine	0.75	0.98
Arginine	1.15	1.43

[a]Values are shown on an as-fed-basis.

Table 2. Composition of Diets for Experiment 1 (As-fed Basis)

	Dietary ME, kcal					DDGS	
Item	1,390	1,444	1,497	1551	1,604	15%	30%
Corn	41.42	51.42	61.45	59.10	56.73	46.84	32.27
Wheat bran	20.00	10.00	0.00	0.00	0.00	0.00	0.00
DDGS[a]	0.00	0.00	0.00	0.00	0.00	15.00	30.00
Soybean oil	0.00	0.00	0.00	2.35	4.70	0.00	0.00
Soybean meal, (46.5%)	34.69	34.70	34.70	34.69	34.69	34.70	34.68
Monocalcium P, (21% P)	1.23	1.38	1.51	1.51	1.53	1.12	0.73
Limestone	1.45	1.24	1.02	1.00	0.99	1.13	1.23
Salt	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Vitamin premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Trace mineral premix	0.15	0.15	0.15	0.15	0.15	0.15	0.15
L-Threonine	0.12	0.13	0.14	0.15	0.15	0.11	0.07
L-Lysine HCl	0.23	0.26	0.29	0.30	0.31	0.26	0.23
DL-Methionine	0.12	0.13	0.15	0.16	0.16	0.10	0.06
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis							
Lysine, %	1.46	1.45	1.44	1.44	1.44	1.47	1.50
Isoleucine:lysine ratio, %	0.66	0.65	0.64	0.64	0.63	0.71	0.77
Leucine:lysine ratio, %	1.28	1.29	1.31	1.29	1.28	1.44	1.58
Methionine:lysine ratio, %	0.32	0.33	0.34	0.34	0.34	0.33	0.33
Met & Cys:lysine ratio, %	0.60	0.59	0.60	0.60	0.59	0.62	0.65
Threonine:lysine ratio, %	0.67	0.67	0.66	0.67	0.67	0.68	0.68
Tryptophan:lysine ratio, %	0.20	0.19	0.18	0.18	0.18	0.20	0.21
Valine:lysine ratio, %	0.75	0.73	0.71	0.71	0.70	0.79	0.87
ME, kcal/lb	1,390	1,444	1,497	1,551	1,604	1,483	1,551
Protein, %	22.79	22.08	21.36	21.15	20.95	24.27	27.18
Calcium, %	0.94	0.87	0.80	0.80	0.79	0.80	0.79
Phosphorus, %	0.85	0.79	0.73	0.72	0.72	0.72	0.71
Available P, %	0.40	0.40	0.40	0.40	0.40	0.40	0.40

[a]NRC (1998) values were used for ME values and amino acid digestibility coefficients.

Table 3. Composition of Diets for Experiment 2 (As-fed Basis)

	Source	
Ingredient, %	Minnesota	Nebraska
Distiller’s dried grains with solubles	96.92	96.92
Limestone	1.65	1.65
Salt	0.35	0.35
Vitamin premix	0.25	0.25
Trace mineral premix	0.15	0.15
L-Threonine	0.01	---
L-Lysine HCl	0.63	0.41
Tryptophan	0.06	0.04
Sand	---	0.24
Total	100.00	100.00
Calculated analysis		
Lysine, %	1.15	1.15
Isoleucine:lysine ratio, %	0.87	1.04
Leucine:lysine ratio, %	2.76	3.35
Methionine:lysine ratio, %	0.46	0.60
Met & Cys:lysine ratio, %	0.91	1.20
Threonine:lysine ratio, %	0.91	1.05
Tryptophan:lysine ratio, %	0.21	0.21
Valine:lysine ratio, %	1.18	1.40
ME, kcal/lb[a]	1,638	1,586
Protein, %	26.85	26.85
Ca, %	0.82	0.82
P, %	0.75	0.75
Available P, %	0.57	0.57
True digestible amino acids		
Lysine	0.94	0.94
Isoleucine:lysine ratio, %	78	93
Leucine:lysine ratio, %	268	324
Methionine:lysine ratio, %	43	55
Met & Cys:lysine ratio, %	67	88
Threonine:lysine ratio, %	72	84
Tryptophan:lysine ratio, %	20	20
Valine:lysine ratio, %	97	115

[a]Estimated values.

Table 4. Effects of 15 & 30% DDGS on Growth in Phase III Nursery Diets. Experiment 1[a]

	Dietary ME, kcal					Nebraska DDGS, %		Minnesota DDGS, %		Probability P<			
										Model[b]			
Item	1,390	1,444	1,497	1,551	1,604	15	30	15	30	Liner	Quad	Source	SE
D 0 to 22													
ADG, lb	1.48	1.60	1.59	1.59	1.61	1.60	1.57	1.59	1.52	0.01	0.03	0.19	0.038
ADFI, lb	2.49	2.49	2.53	2.42	2.37	2.52	2.50	2.45	2.38	0.01	0.06	0.01	0.072
F/G	1.67	1.56	1.58	1.53	1.48	1.58	1.59	1.55	1.56	0.01	0.48	0.16	0.022

[a]Values represent the means of 360 pigs (each initially 38.5 lb) with 5 pigs per pen and 8 replicate pens per treatment.
[b]Model includes all treatments except diets with DDGS.

Table 5. Growth Performance and Calculated Energy Values of Dried Distiller Grains & Solubles Experiment 2[a]

Item	Minnesota	Nebraska	SEM	Probability P<
Growth				
ADG, lb	0.91	0.90	0.160	0.90
ADFI, lb	2.05	2.02	0.119	0.49
F/G	2.29	2.52	0.352	0.50
Energy Values, kcal/lb				
GE	2,201	2,227	4.8	0.01
DE	1,756	1,691	43.0	0.02
ME	1,677	1,627	42.0	0.05
NE[b]	1,182	1,112	-	-

[a]Represents the means of eight pigs (each initially 98.3 lb) used in a Latin square design, metabolism study was conducted as four-day adaptation followed by a three-day collection.
[b]Calculated: NE = (ME × 0.726) + (13.3 × % Fat) + (3.9 × % Starch) – (6.7 × % Crude Protein) – (8.7 × % ADF) using Noblet et al. (1994).

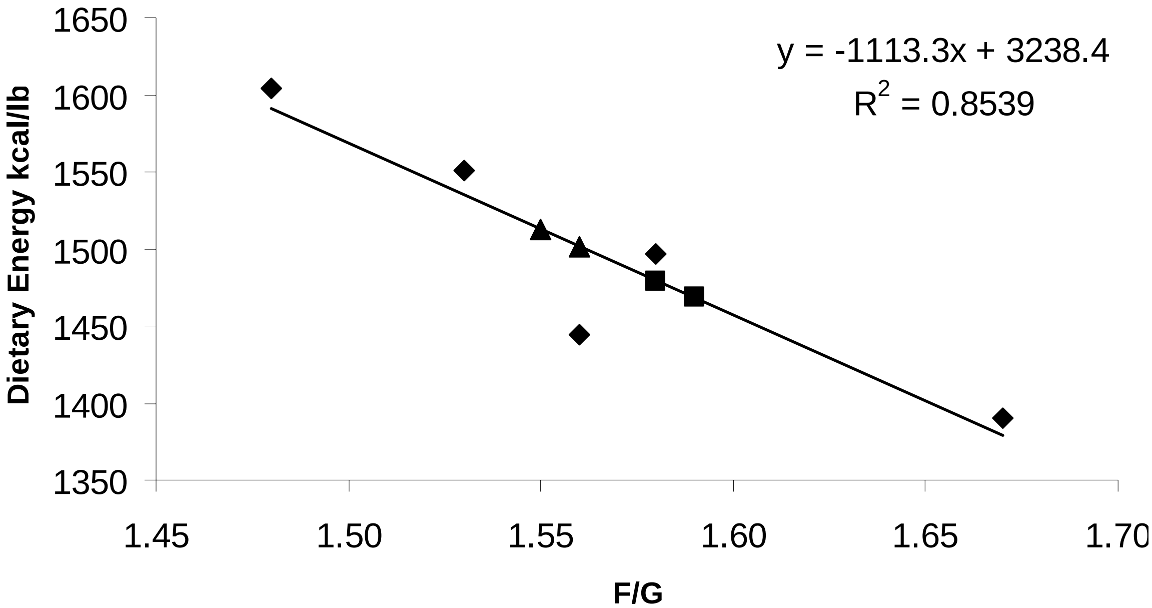

Figure 1. Relationship between Dietary Energy Density and Mean Feed Efficiency.

◆ Represents base diets with known dietary ME.

■ Represents calculated dietary ME for pigs fed Nebraska source DDGS. This value was used to calculated Nebraska DDGS ME value.

▲ Represents calculated dietary ME for pigs feed Minnesota source DDGS. This value was used to back calculated Minnesota DDGS ME value.