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RECOMMENDATIONS ON FEEDING DDGS TO SWINE

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The concentration of gross energy in distillers dried grain with solubles (DDGS) is greater than in corn, but because of a lower digestibility of energy in DDGS than in corn, there is no difference in the concentration of digestible and metabolizable energy between DDGS and corn. The apparent and standardized ileal digestibility of amino acids in DDGS does vary among sources, but, with the exception of lysine, the variability is no greater than what has been reported for other feed ingredients. Lysine in DDGS may be damaged if excessive heating is used during the drying process, which in turn leads to a low digestibility of lysine. To exclude badly heat-damaged products from swine feeding, it is recommended that producers calculate the lysine-to-crude-protein ratio and only use DDGS if the ratio is greater than 2.80 percent. The digestibility of phosphorus in DDGS is approximately 59 percent. This value is greater than in corn. Therefore, if DDGS is included in the diet, less inorganic phosphorus is needed.

Diets formulated to contain DDGS should be formulated on the basis of digestible amino acids and digestible phosphorus. In general, 10 percent DDGS can replace approximately 4.25 percent soybean meal and 5.8 percent corn, if 0.10 percent crystalline lysine is included in the diet. DDGS can be included in diets fed to nursery pigs, growing finishing pigs, and sows in amounts of 20 percent and in diets for gestating sows at 40 percent. Greater inclusion levels are possible, but may not always maximize pig performance.

Concentration and digestibility of energy, phosphorus, amino acids

DDGS is increasingly being included in diets fed to swine. Barley, wheat, sorghum, or corn may be used in the production of ethanol, and the resulting DDGS is characterized by the grain that was used. However, even when the same grain is used, variability in the chemical composition of DDGS may be observed. Analyzed concentrations of energy, phosphorus, and amino acids in a large number of DDGS samples are presented in Tables 1, 2, and 3, along with measured contents of digestible energy, digestible phosphorus, and digestible amino acids.

The average concentration of gross energy (GE) in DDGS is approximately 5,530 kcal GE per kg dry matter (DM). This value is greater than in corn. However, the digestibility of energy in DDGS is lower than in corn, and the measured concentration of digestible energy (DE) and metabolizable energy (ME) in DDGS is 4,140 and 3,897 kcal per kg DM, respectively. These values are not different from the DE and ME in corn (Table 1).

The phosphorus concentration in DDGS is approximately 0.80 percent (DM basis). The apparent total tract digestibility of phosphorus in DDGS is approximately 59 percent (Table 2). The corresponding value for corn is 21.5 percent, which is significantly lower than in DDGS. The reason for the greater digestibility of phosphorus in DDGS than in corn may be that some of the bonds that bind phosphorus to the phytate complex in corn have been hydrolyzed during the fermentation process in the ethanol plants, which in turn would make more phosphorus available for absorption. As a consequence, if DDGS is included in diets fed to swine, the utilization of organic phosphorus will increase and the need for supplemental inorganic phosphorus (i.e., dicalcium phosphate or monocalcium phosphate) will be reduced. This will not only reduce diet costs but also reduce the quantities of phosphorus that are excreted into the manure from the animals.

The concentration and standardized ileal digestibility of amino acids were determined in 37 samples of DDGS originating from 36 different ethanol plants in the Midwest (Table 3). The results showed that some variation exists for amino acid digestibility among different samples of DDGS. This is true in particular for lysine that is more variable than all other indispensable amino acids in terms of digestibility. The reason for this variation is believed to be that lysine may have been heat-damaged in some of the samples of DDGS, which in turn has lowered the calculated digestibility of lysine in these samples. Nonetheless, the amino acids in DDGS have a medium digestibility and, except for lysine, the variability among different samples is within the normal range of variation found in other feed ingredients. To reduce the risk of utilizing sources of DDGS that have a low digestibility of Lysine because of heat damage, the lysine to crude protein ratio can be calculated (Table 4). Because the low digestibility of lysine is often associated with a low analyzed concentration of lysine in the sample, this ratio gives an estimate of the quality of the lysine in the sample. If the ratio is 2.80 percent or greater, then the product will have an average or above average quality, but if the ratio is lower than 2.80, then the product has a reduced quality. Because lysine is usually the first limiting amino acid in diets fed to swine, DDGS samples with a lysine-to-crude-protein ratio that is less than 2.80 should not be used.

Formulating diets using DDGS

When formulating diets for growing pigs or lactating sows using DDGS, it is recommended that energy values that are similar to corn are being used for DDGS. Diets should be formulated based on standardized ileal digestible amino acids and digestible phosphorus. Because the protein in DDGS is relatively low in lysine, additional crystalline lysine needs to be included in the diet when DDGS is used. As a rule of thumb, for each 10 percent DDGS that is used, the inclusion of crystalline lysine should be increased by 0.10 percent (Table 5). By doing so, approximately 4.25 percent soybean meal and 5.66 percent corn can also be removed. Because of the greater concentration and digestibility of phosphorus in DDGS than in corn and soybean meal, approximately 0.22 percent monocalcium phosphate can be removed from the diet for each 10 percent DDGS that is used, but additional limestone is needed to maintain a proper concentration of calcium.

If diets for gestating sows are formulated with DDGS, less soybean meal can be removed from the diet because gestating sows have a relatively greater requirement for digestible tryptophan than lactating sows and growing pigs. Because DDGS has a low concentration of tryptophan, it is possible to maintain a proper tryptophan concentration in gestation diets only if the reduction in soybean meal is limited to 2.40 percent for each 10 percent DDGS that is included in the diet. As a consequence, if 10 percent DDGS is included in gestating diets, the concentration of corn in the diet can be reduced by 7.43 percent.

Inclusion rates of DDGS in diets fed to swine

Recent research has shown variable results in pig responses to the inclusion of DDGS in the diets. Excellent performance has been reported from many experiments, but in other cases, pig performance has been reduced when DDGS was included in the diets. However, diets fed to lactating sows, to nursery pigs after two weeks postweaning, and to growing finishing pigs may contain at least 20 percent DDGS and diets fed to gestating sows may contain at least 40 percent DDGS without negatively affecting pig performance—if the diets are carefully formulated using the principles outlined above and if a source of DDGS that has a lysine-to-crude-protein ratio that is greater than 2.80 percent is used (Table 6). In such circumstances, the inclusion of DDGS in the diets will not affect pig performance. It is also possible that greater inclusion rates can be used if a good source of DDGS is available. Many producers are successfully using up to 35 percent DDGS in diets fed to growing pigs, but the research to support such inclusion rates has not yet been conducted.

Other consequences of using DDG

The relatively high concentration of fat in DDGS may increase problems with feed bridging in bins and feeders. In some cases, therefore, it may be necessary to modify storage and delivery systems if DDGS is used in the diets. The fat in DDGS has a relatively high concentration of unsaturated fatty acids, which may cause increased belly softness of pigs fed diets containing DDGS. In general, this may become a problem if the finishing diet contains more than 20 percent DDGS, but not all packers discount pigs with softer bellies. Presently, research is being conducted to investigate possibilities for preventing pork bellies from becoming softer if high concentrations of DDGS are used in the diets.

The inclusion of DDGS in diets fed to nursery and growing pigs may improve intestinal health and reduce problems with ileitis. Many producers, therefore, prefer to have 20 percent DDGS in all diets fed to these categories of pigs, but research to demonstrate the health benefits of using DDGS has been inconclusive. Increased litter sizes of sows fed diets containing DDGS have also been reported from one experiment, but more research in this area is needed to verify the positive effects of DDGS on litter size.

Economics of using DDGS in diets fed to swine

Because DDGS replaces both corn and soybean meal in diets fed to pigs, the economic value of DDGS depends on the price of corn and soybean meal. The maximum price that can be paid for DDGS without increasing diet costs with different costs of corn and soybean meal are presented in Table 7. With constant costs of soybean meal, the maximum price that can be paid for DDGS increases approximately $9 to $10 for each $0.50 per bushel the cost of corn is increased. Likewise, if the price of soybean meal is increased by $25 per ton, then the price of DDGS can be increased by $11 to $12 without increasing diet costs. Before including DDGS in diets fed to swine, producers are advised to make their own calculations based on local prices for corn, soybean meal, and DDGS.

Conclusions

The usage of DDGS in diets fed to swine is rapidly increasing. Many producers are successfully including 20 percent DDGS in diets fed to all categories of swine. While this level of inclusion is generally recommended, some producers are successfully using greater inclusion rates, and it is possible that up to 35 percent DDGS can be included in diets fed to nursery pigs and growing finishing pigs. However, because of the risk of producing pork with soft bellies, the inclusion of DDGS in finishing diets should be limited to 20 percent. Likewise, it is generally not recommended that DDGS be included in diets fed to nursery pigs during the initial 2 weeks postweaning, but some producers have successfully included up to 20 percent DDGS in these diets as well. Regardless of the category of pigs being fed and the inclusion level, it is very important that diets be carefully formulated based on concentrations of digestible amino acids and digestible phosphorus. DDGS sources that have a lysine-to-crude-protein ratio that is lower than 2.80 should not be used in diets fed to swine.

Table 1. Concentration of energy in corn and 10 samples of dried distillers grain with solubles (DDGS) fed to growing pigs

Item Ingredient:	Corn	DDGS			
		Average	Standar deviation	Lowest value	Highest value
Gross energy, kcal/kg DM	4,496	5,434	292	5,272	5,592
Apparent total tract digestibility, %	90.4	76.8	2.73	73.9	82.8
Digestible energy, kcal/kg DM	4,088	4,140	205	3,947	4,593
Metabolizable energy, kcal/kg DM	3,989	3,897	210	3,674	4,336

Table 2. Phosphorus concentration and digestibility

Item	Average	Low	High	SD
Total P, %	0.61	0.51	0.74	0.09
Total P, % DM	0.70	0.57	0.85	0.10
ATTD, %	59	50	68	5.17
Digestible P, %	0.36	0.28	0.47	0.06

Table 3. Crude protein and amino acid concentration and digestibility

Item	Concentration in DDGS, %					Standardized ileal digestibility, %			
	Average	Low	High	SD		Average	Low	High	SD
CP	27.5	24.1	30.9	1.8		72.8	63.5	84.3	5.33
Indispensable AA									
Arg	1.16	0.95	1.41	0.10		81.1	74.1	92.0	5.18
His	0.72	0.56	0.84	0.07		77.4	70.0	85.0	4.58
Ile	1.01	0.87	1.31	0.09		75.2	66.5	82.6	4.77
Leu	3.17	2.76	4.02	0.32		83.4	75.1	90.5	3.85
Lys	0.78	0.54	0.99	0.09		62.3	43.9	77.9	7.61
Met	0.55	0.46	0.71	0.08		81.9	73.7	89.2	4.12
Phe	1.34	1.19	1.62	0.11		80.9	73.5	87.5	3.94
Thr	1.06	0.89	1.71	0.20		70.7	61.9	82.5	5.26
Trp	0.21	0.12	0.34	0.04		69.9	54.2	80.1	6.98
Val	1.35	1.15	1.59	0.11		74.5	65.8	81.9	4.72
Dispensable AA									
Ala	1.94	1.58	2.79	0.21		77.9	59.7	85.0	4.46
Asp	1.83	1.56	2.13	0.14		68.6	59.4	75.9	4.75
Cys	0.53	0.37	0.75	0.11		73.6	65.6	80.7	4.64
Glu	4.37	3.05	6.08	0.68		80.4	67.4	88.3	5.48
Gly	1.02	0.88	1.20	0.06		63.5	46.8	87.0	10.97
Pro	2.09	1.74	2.50	0.16		74.4	32.0	125.9	22.12
Ser	1.18	0.94	1.45	0.13		75.6	59.6	82.8	5.14
Tyr	1.01	0.83	1.31	0.16		80.9	74.6	88.9	3.79

Table 4. Lysine to CP ratio

Item	Average	Low	High
CP, %	27.5	24.1	30.9
Lys, %	0.78	0.54	0.99
SID Lys, %	62.3	43.9	77.9
SID Lys, g/kg	0.50	0.27	0.70
Lys:CP, %	2.86	2.18	3.54

Table 5. Replacement value of 10% DDGS

Item Diet:	Gestation diets	All other diets
Corn	↓ 7.43	↓ 5.66
Soybean meal, 48%	↓ 2.40	↓ 4.25
MCP, %	↓ 0.22	↓ 0.20
Fat	↓ 0.05	↓ 0.05
L-Lysine HCL	↑ 0.03	↑ 0.10
Limestone	↑ 0.07	↑ 0.08

Table 6. Recommended and maximum inclusion levels in diets fed to different categories of swine

Category	Recommended	Maximum
Gestation	30	40
Lactation	20	?
Nursery, week 0-2	0	20
Nursery, after wk 2	20	30
Grower	20	35
Early finisher	20	35
Late finisher	20	20

Table 7. Maximum price ($/ton) that can be paid for DDGS at different costs of corn and soybean meal (SBM) without increasing cost of complete diet[a]

SBM, $/ton Corn, $/Bu:	2.5	3.0	3.5	4.0
175	109	119	128	138
200	120	130	140	150
225	131	141	151	161

[a] *Calculations based on soybean meal containing 47.5% crude protein.*

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