The Value of High-Protein Distillers Coproducts in Swine Feeds

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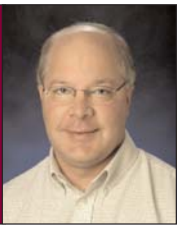
Several ethanol production companies and other research groups have been developing a variety of modified processes to enhance ethanol yield and change the resulting coproducts produced by dry-grind ethanol plants. Some of these modified processes involve using new enzyme technologies to increase the crude protein content of distillers grains. Others involve removing the germ and/or bran from corn prior to fermentation. Although these modified processes may enhance ethanol yield and produce a coproduct that is well suited for ruminant diets, they may not necessarily enhance the nutritional and economic value of distillers grains produced specifically for swine.



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Protein (amino acids) is the second most expensive component of swine diets, behind energy. Therefore, a common initial reaction to the value of high-protein ingredients is that they are worth more or have higher economic value. In fact, that's true to an extent. High-protein DDGS is worth much more than typical DDGS in ruminant diets and minimizes some of the concerns of feeding high levels of DDGS to beef and dairy cattle. Cattle can take advantage of the high protein in these ingredients, and the lower phosphorus is an advantage in minimizing manure phosphorus excretion. Furthermore, the lower fat content of high-protein DDGS allows more of these ingredients to be used in diets for lactating dairy cattle without negatively affecting milk fat concentration.

Table 1

Common nutrient specifications for DDGS compared to the nutrient content of a branded DDGS, a high-protein, branded DDGS; and Corn Protein Concentrate (CPC; 100 percent dry matter basis)

Nutrient	DDGS Specification 1	Branded DDGS Specification 2	High-protein, branded DDGS	CPC
Dry matter, %	88.0	90.0	90.0	90.0
Crude protein, %	30.7	29.2	39.2	50.0
Crude fat, %	10.9	11.6	4.8	3.6
ME (swine), kcal/kg	3,759	3,749	3,749	No data
ADF, %	16.2	11.6	9.7	10.3
NDF, %	-	29.9	15.8	17.0
Ash, %	5.5	4.2	2.7	4.4
Calcium, %	0.06	0.04	0.04	0.20
Phosphorus, %	0.89	0.83	0.48	1.07
Lysine, %	0.83	1.06	1.06	0.90
Tryptophan, %	0.24	0.21	0.24	0.29
Methionine, %	0.55	0.49	0.77	0.97
Cystine, %	0.58	0.41	0.70	0.88
Threonine, %	1.13	0.77	1.20	1.76

However, when it comes to swine diets, we have determined that the story is a little different. First, the quality of the protein (amino acid balance) in feed ingredients is probably equally if not more important than the concentration of protein. Remember, corn and corn byproducts have low protein quality for swine. Feeding a high-protein DDGS may initially appear to have improved feeding and economic value for swine. However, as crude protein increases, other nutrients must decrease in concentration.

As shown in Table 1, one particular high-protein DDGS on the market today, the product we analyzed, has 34 percent more crude protein than typical forms of distillers grains. Despite increases in other essential amino acids, the lysine content is not increased in this product. Much of the increase in crude protein content is at the expense of fat (reduced by 59 percent) and phosphorus (reduced by 42 percent). Neutral detergent fiber (NDF) in this high-protein DDGS is reduced, and it would be expected that the reduction in fat content would substantially reduce the metabolizable energy (ME) value of the coproduct for swine and poultry. However, the ME estimates provided in nutrient specification sheets suggest that the energy value is the same as typical DDGS. Furthermore, since about 50 percent of the diet cost savings of using DDGS in swine diets is due to the reduced need for inorganic phosphorus supplementation in the diet, the large reduction in phosphorus content in high-protein DDGS would make it more difficult to provide the same degree of diet cost savings as provided by the typical coproduct.

Corn protein concentrate (CPC) is another example of a corn-based byproduct resulting from a modified wet milling production process. This product is produced post-fermentation after the germ and primary fiber components are physically removed prior to fermentation. It is substantially higher in protein than typical DDGS, but lysine and other amino acids are not increased proportionately (Table 1). In fact, the high-crude protein:lysine ratio may be detrimental to energy utilization because of the additional energy that would be expended by the pig to remove excess nitrogen.

In order to understand the feeding and relative economic value of typical corn DDGS to high-protein DDGS, we formulated typical swine grower diets on an "as-fed" basis using the following assumptions. For each of the coproducts, it was assumed that digestibility coefficients for lysine, tryptophan, threonine and methionine plus cystine were 53 percent, 64 percent, 55 percent and 52 percent, respectively. We also assumed that phosphorus availability in each of the coproducts was 85 percent. Although the calculated ME values for high-protein DDGS and CPC suggest that energy value is relatively high, these values were lowered because the fat content of these products is substantially lower than the fat level in DDGS. The ME values used in this analysis were 1,300 and 1,258 kilocalories (kcal) ME per pound for high-protein DDGS and CPC, respectively.

All diets contained 1,553 kcal ME per pound, 1.0 percent lysine, 0.84 percent digestible lysine, a minimum of 0.48 percent digestible threonine and 0.14 percent digestible tryptophan, 0.58 percent calcium and 0.26 percent available phosphorus. The minimum ratios of digestible methionine plus cystine digestible threonine, and digestible tryptophan to digestible lysine were 55 percent, 58 percent and 16.6 percent. In addition, all diets were formulated to contain equivalent amounts of salt, vitamins and minerals. Synthetic L-lysine HCl (78.8 percent), DL-methionine (99 percent), and L-threonine (98.5 percent) were used to meet minimum digestible amino acid requirements as needed. The feed ingredient prices used in the diet formulation comparisons are shown in Table 2.

Table 2

Feed ingredient prices used in diet formulation comparisons

Ingredient	$/cwt
Corn	3.50
Soybean meal (47)	10.50
DDGS	4.00
Choice white grease	17.00
Dicalcium phosphate	13.00
Limestone	2.00
Salt	6.00
L-lysine HCl	80.00
L-threonine	145.00
DL-methionine	120.00
VTM premix	100.00

As a reference point, a standard corn-soybean meal grower diet (Diet 1) containing 3 pounds of synthetic lysine was formulated to represent a diet commonly used in the swine industry (Table 3). Diet 2 was formulated to contain 10 percent DDGS using the nutrient specifications shown for DDGS Specification 1 in Table 1. The only amino acid offered during the formulation of Diet 2 was L-lysine HCl, which was used at a level of 4.13 pounds per ton. Knowing that threonine is second limiting in corn-soybean meal-DDGS diets, we offered both L-lysine HCl and L-threonine for the formulation of DDGS Diet 3. In this case, 5.78 pounds of L-lysine HCl and 0.65 pounds of L-threonine were added. Currently, there is limited data to indicate that acceptable growth performance can be achieved by using these high amounts of synthetic amino acids in swine diets. In order to demonstrate how important it is to know the source of DDGS being used, the need for accurate DDGS nutrient specifications and how nutrient specifications can affect the opportunity cost of DDGS, an additional diet (Diet 4) containing 10 percent DDGS was formulated using the nutrient profile for DDGS Specification 2 (Table 1).

Adding 10 percent DDGS and a non-fixed amount of L-lysine HCl to a swine grower diet using DDGS nutrient Specification 1 replaced 146 pounds of corn, 55 pounds of soybean meal, and 6 pounds of dicalcium phosphate, and increased the amount of choice white grease by 2 pounds, limestone by 3 pounds, and L-lysine HCl by about 1 pound in order to provide equivalent dietary ME, digestible lysine, calcium, and available phosphorus levels in the standard corn-soybean meal diet containing 3 pounds of L-lysine HCl (Diet 1) per ton (Table 3). As a result, using the feed ingredient prices shown in Table 2, adding 10 percent DDGS to a swine grower diet will reduce diet cost by $2.34 per ton. When 10 percent DDGS (Specification 1) and a non-fixed amount of L-lysine HCl and L-threonine were added (Diet 3), diet cost was reduced by an additional $1.55 per ton. However, adding high amounts of synthetic amino acids may be risky until we have data that show that satisfactory growth performance can be achieved using this formulation approach. If DDGS nutrient Specification 2 is used (Diet 4) at the same price as DDGS nutrient Specification 1, diet cost actually increases 20 cents per ton compared to Diet 3, which used DDGS nutrient Specification 1. This demonstrates that the DDGS nutrient specifications affect opportunity cost since DDGS Specification 2 is worth $78 per ton, whereas DDGS Specification 1 is worth $80 per ton because of differences in lysine, sulfur amino acids and threonine levels.

Table 3

Effect on ingredient use and diet cost of adding synthetic amino acids and DDGS with two different nutrient specifications to a practical swine grower diet

Ingredient	Diet 1	Diet 2	Diet 3	Diet 4
	Corn + SBM + 3 lbs.	10 % DDGS (Spec. 1)	10% DDGS (Spec. 1) + Lys	DDGS (Spec. 2) + Lys,
	%	%	%	%
Corn	72.57	65.29	67.84	67.70
Soybean meal (47)	23.04	20.30	17.61	17.89
DDGS	0.00	10.00	10.00	10.00
Choice white grease	2.00	2.11	2.11	1.96
Dicalcium phosphate	1.07	0.76	0.78	0.79
Limestone	0.72	0.89	0.90	0.90
Salt	0.30	0.30	0.30	0.30
L-lysine HCl	0.15	0.21	0.29	0.27
L-threonine	0.00	0.00	0.03	0.05
DL-methionine	0.00	0.00	0.00	0.007
VTM premix	0.15	0.15	0.15	0.15
Total	100.00	100.00	100.00	100.00
Cost, $/ton	111.85	109.51	107.96	107.96
Opportunity cost of DDGS, $/ton	---	80.00	80.00	78.00
Nutrient Analysis	Corn + SBM + 3 lbs.	10 % DDGS (Spec. 1)	10% DDGS (Spec. 1) + Lys	DDGS (Spec. 2) + Lys,
ME, kcal/lb.	1,553	15,53	1,553	1,553
Crude fat, %	4.73	5.52	5.60	5.53
Crude protein, %	17.5	18.3	17.4	17.4
Lysine, %	1.00	1.01	1.01	1.02
Dig. lysine, %	0.84	0.84	0.84	0.84
Met + cys, %	0.59	0.63	0.60	0.59
Dig. met + cys, %	0.49	0.49	0.46	0.46
Threonine, %	0.65	0.68	0.67	0.65
Dig. threonine, %	0.48	0.48	0.48	0.48
Tryptophan, %	0.21	0.21	0.19	0.19
Dig. tryptophan, %	0.16	0.15	0.14	0.14
Calcium, %	0.58	0.58	0.58	0.58
Phosphorus, %	0.53	0.51	0.51	0.51
Avail. P, %	0.26	0.26	0.26	0.26

As shown in Table 4, the addition of 10 percent high-protein DDGS to a swine grower diet slightly reduces the amount of corn (20 pounds less), soybean meal (5 pounds less), L-threonine (0.4 pounds less), DL-methionine (0.14 pounds less), while the amount of choice white grease (24 pounds more) and dicalcium phosphate (3 pounds more) per ton of complete feed increases compared to the Diet 4 DDGS shown in Table 3. The increase in the amount of additional choice white grease that was added is based upon the assumption that the actual ME value of high-protein DDGS is lower than estimated on the nutrient specification sheet due to the lower fat content compared to typical DDGS. This clearly shows the importance of knowing the actual energy value of various forms of distillers grains because it has a substantial impact on the feeding and economic value in swine diets. Processes that reduce the fat content of distillers grains will significantly reduce the product's energy value for swine which makes it more difficult to economically fit into least-cost diet formulations. Since phosphorus is the third most expensive nutrient added to swine diets, the lower phosphorus content of high protein DDGS also adversely affects its economic value in swine diets because more dicalcium phosphate must be added to the diet to achieve the desired level of available phosphorous. In fact, using a price of $80 per ton for DDGS, and the nutrient content assumptions used for the product in this comparison, one could afford to pay only $51 per ton for the high-protein product if it were being used in swine diets.

Similarly, even though CPC is even higher in crude protein content compared to high-protein DDGS, our estimated energy value and the poor protein quality (low lysine content) results in minimal reductions in corn and soybean meal use in swine diets compared to adding the same level of DDGS to the diet. In fact, an additional 0.7 to 0.8 pounds of L-lysine HCl

Table 4

Effect on ingredient use of adding high-protein DDGS or corn protein concentrate (CPC) to growing swine diets

Ingredient	High-protein, branded DDGS	CPC
	%	%
Corn	66.69	67.34
Soybean meal (47)	17.66	17.06
HP DDGS	10.00	0.00
CPC	0.00	10.00
Glutenol	0.00	0.00
Choice white grease	3.14	3.23
Dicalcium phosphate	0.94	0.70
Limestone	0.82	0.91
Salt	0.30	0.30
L-lysine HCl	0.27	0.30
L-threonine	0.03	0.009
DL-methionine	0.00	0.00
VTM premix	0.15	0.15
Total	100.00	100.00
Cost, $/ton	107.95	107.95
Opportunity cost of by product, $/ton	51.00	63.40
Nutrient Analysis	**High-protein, brandedDDGS**	**CPC**
ME, kcal/lb.	1,553	1,553
Crude fat, %	6.06	6.06
Crude protein, %	18.1	18.9
Lysine, %	1.01	1.01
Dig. lysine, %	0.84	0.84
Met + cys, %	0.63	0.66
Dig. met + cys, %	0.48	0.49
Threonine, %	0.67	0.69
Dig. threonine, %	0.48	0.48
Tryptophan, %	0.19	0.19
Dig. tryptophan, %	0.14	0.14
Calcium, %	0.58	0.58
Phosphorus, %	0.50	0.50
Avail. P, %	0.26	0.26

needs to be added to the diets containing this product in order to achieve the desired, equivalent level of digestible lysine. The slightly higher phosphorus content of CPC compared to DDGS is an economic advantage. As shown in Table 4, the economic value of CPC in swine diets is $63.40 per ton, which is substantially less than the value of typical DDGS.

In summary, ME content, amino acid level and digestibility, and available phosphorus levels of feed ingredients are the primary factors that influence the suitability and value of distillers grains for use in swine diets. Based upon the assumption that high-protein distillers grains have a lower metabolizable energy value, these product will have less value than regular DDGS in swine diets compared to ruminant diets because of the higher levels of nitrogen (crude protein), and lower levels of fat and phosphorus. Notably, high-protein DDGS is worth much more than DDGS in ruminant diets and minimizes some of the concerns of feeding high levels of DDGS to beef and dairy cattle. It does not appear that the benefits of these new product carry over to swine diets. DGQ

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