Effects of the Nutrient Variability of Distiller's Solubles and Grains within Ethanol Plants and the Amount of Distiller's Solubles Blended with Distiller's Grains on Fat, Protein and Phosphorus Content of DDGS.

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Background

One of the primary concerns and reasons for low acceptance of distiller's dried grains with solubles (DDGS) by swine and poultry nutritionists is due to nutrient content variability within and among ethanol plants, particularly protein (lysine), fat, fiber, and phosphorus. The three most expensive nutrients provided in livestock feeds are energy, protein (amino acids), and phosphorus. Selecting ingredient sources that provide relatively consistent levels of energy, protein, and phosphorus is a key factor when formulating economical livestock feeds. Previous research conducted at the University of Minnesota showed that the protein content of DDGS can range from 28.7 to 31.6% among Minnesota and South Dakota ethanol plants, and the lysine content ranges from 0.72 to 1.02%. Similarly, fat ranges from 10.2 to 11.7%, fiber ranges from 8.3 to 9.7%, and phosphorus ranges from 0.82 to 0.99% among plants. Of these key nutrients, lysine content is the most variable (CV = 17.3%) followed by phosphorus (CV = 11.7%) among ethanol plants.

Nutrient variation within plant can also be quite variable, and may largely be a function of the amount of solubles added to the grains to produce DDGS. The coefficient of variation for lysine can range from 2.9 to 25.7% within plants, and the same is true for phosphorus (CV ranges from 3.1 to 15.3%). Because of the economic significance of lysine and phosphorus in formulating least cost diets, methods that will reduce this variation need to be implemented within some ethanol plants.

Procedures

Six Minnesota ethanol plants participated in a study to determine the nutrient variability of distiller's grains and distiller's solubles over a 3-week period. Random samples of wet solubles and wet grains were collected at each plant over three consecutive weeks and sent to Iowa Testing Laboratories, Eagle Grove, IA for proximate analysis. The data were then summarized to determine minimum, maximum, and mean values of each nutrient within each participating plant, and a coefficient of variation was calculated. Once these data were analyzed, an Excel spreadsheet was developed to estimate DDGS composition based upon the level of solubles added to the grains before drying. The assumptions made in the calculations were:

32 gallons of syrup added/minute
79.63 lbs of dry syrup added/minute
40.63% of solubles in DDGS on a dry matter basis
59.37% of grains in DDGS on a dry matter basis

Results and Discussion

The average minimum, maximum, and mean nutrient values (dry matter basis), of grains and solubles fractions obtained from all six plants sampled are shown in the following table:

Grains Fraction	**Average**	**Minimum**	**Maximum**
Dry Matter, %	34.3	33.7	34.9
Crude Protein, %	33.8	31.3	36.0
Crude Fat, %	7.7	2.1	10.1
Crude Fiber, %	9.1	8.2	9.9
Ash, %	3.0	2.6	3.3
Calcium, %	0.04	0.03	0.05
Phosphorus, %	0.56	0.44	0.69
Solubles Fraction			
Dry Matter, %	27.7	23.7	30.5
Crude Protein, %	19.5	17.9	20.8
Crude Fat, %	17.4	14.4	20.1
Crude Fiber, %	1.4	1.1	1.8
Ash, %	8.4	7.8	9.1
Calcium, %	0.09	0.06	0.12
Phosphorus, %	1.3	1.2	1.4

The grains fraction is higher in dry matter, crude protein, and crude fiber than the solubles fraction. The solubles fraction contributes significant amounts of crude protein, crude fat, ash, and phosphorus to DDGS. Consequently, if the amount of solubles added to the grains is reduced, the fat and mineral content will also be significantly reduced.

In general, the grains fraction is less variable in nutrient content than the solubles fraction based upon the coefficients of variation among the six plants for all nutrients tested (CV's not shown). However, there is considerable variation in the dry matter content of the solubles fractions in the six participating plants that were sampled. Surprisingly, compared to other nutrients measured, crude fat levels varied the most in both grains and solubles fractions. This amount of variation can significantly affect the final energy content of DDGS. The protein content of the grains fraction is higher and less variable than the protein in the solubles fraction. However, for phosphorus, the solubles fraction is more concentrated and less variable than the grains fraction. If the amount of solubles added to the grains is reduced, the phosphorus content of DDGS will also be reduced.

The AAFCO definition for distiller's dried grains with solubles designates that at least 75% of the solubles produced by an ethanol plant must be added to the wet grains produced by that plant to officially be called DDGS. However, many plants blend 100% of the solubles with the grains. Due to the relatively high protein and phosphorus content of the solubles, the proportion of the solubles added to the grains can greatly influence the final nutrient content, especially accounting for the variability in nutrient content of each fraction within and among plants.

Effect of Nutrient Variability and Proportion of Solubles Added to Grains on Predicted Protein Content of DDGS for the Plant with the Least Variation and the Plant with the Most Variation in Protein Content.

Crude Protein	**Grains w/ 75% of the Solubles**		**Grains w/ 100% of the Solubles**	
Plant with the least variation in protein levels		**CV**		**CV**
Minimum	29.7		29.0	
Maximum	31.8		31.2	
Mean	***30.5***	3.49	***29.9***	3.57
Plant with the most variation in protein levels				
Minimum	20.0		***19.8***	
Maximum	30.4		***29.3***	
Mean	26.6	20.2	25.8	20.8

In the plant with the least variation in crude protein content of grains and solubles, protein levels in DDGS vary by only 2 percentage points regardless of the amount of solubles added to the grains. Because of the lower protein content of the solubles, the amount of crude protein in DDGS declines slightly as more solubles are blended with the grains to produce DDGS. However, in the plant with the highest variability in crude protein content of grains and solubles, the final crude protein content of DDGS can vary by 10 percentage points regardless of the amount of solubles added to the grains. There are serious implications of this extreme variation from a pricing and nutritional perspective.

First, the cost/lb of crude protein in DDGS is compared to the cost/lb of crude protein from other high protein ingredients (e.g. soybean meal) when purchasing DDGS for cattle feeding. Thus, this range in potential protein levels will affect whether or not it will fit in a least cost ration formula, and may influence whether DDGS is purchased in preference over another high protein ingredient. Secondly, crude protein is often viewed as a general indicator of the concentration of essential amino acids. In other words, the lysine content of DDGS is likely to be lower in the 20% protein DDGS than it is in the 30% DDGS. Finally, a 10 percentage unit variation may discourage feed ingredient purchasers from buying DDGS, or buying DDGS from this source, because of the relative unpredictability of the protein content from batch to batch or week to week from this plant.

Effect of Nutrient Variability and Proportion of Solubles Added to Grains on Predicted Crude Fat Content of DDGS for the Plant with the Least Variation and the Plant with the Most Variation in Fat Content.

Crude Fat	**Grains w/ 75% of the Solubles**		**Grains w/ 100% of the Solubles**	
Plant with the least variation in fat levels		**CV**		**CV**
Minimum	10.2		11.0	
Maximum	11.7		12.6	
Mean	***11.1***	7.56	***12.0***	7.00
Plant with the most variation in fat levels				
Minimum	8.2		***7.9***	
Maximum	10.9		***11.5***	
Mean	9.6	44.42	9.8	43.58

Because of the high fat content of the solubles, the amount of solubles added to the grains to produce DDGS will have a larger effect on energy content of DDGS than the effect of solubles on DDGS protein content. Increasing the amount of solubles added from 75% to 100% will increase the fat content of DDGS by about 1 percentage unit in plants with low variation in fat content. However, in plants with highly variable fat content, the average fat values may be similar depending on the amount of solubles added to the grains, but the variation in DDGS fat content can range from 7.9 to 11.5%.

Effect of Nutrient Variability and Proportion of Solubles Added to Grains on Predicted Phosphorus Content of DDGS for the Plant with the Least Variation and the Plant with the Most Variation in Phosphorus Content.

Phosphorus	**Grains w/ 75% of the Solubles**		**Grains w/ 100% of the Solubles**	
Plant with the least variation in phosphorus levels		CV		CV
Minimum	0.66		0.73	
Maximum	0.73		0.82	
Mean	***0.70***	8.61	***0.79***	7.64
Plant with the most variation in phosphorus levels				
Minimum	0.57		***0.63***	
Maximum	0.91		***0.96***	
Mean	0.70	24.23	0.76	22.44

Distiller's solubles has about 2.3 times more phosphorus (dry matter basis) than distiller's grains. Therefore, the phosphorus content of DDGS is highly influenced by the amount of solubles added to the grains to make DDGS. Increasing the amount of solubles added from 75% to 100% will increase the phosphorus content of DDGS by about 0.1 percentage unit in plants with the least variation in phosphorus content. However, in plants with highly variable phosphorus levels, phosphorus levels in DDGS can range from 0.63 to 0.96%, which greatly affects the amount of dicalcium phosphate supplementation needed in swine and poultry diets, as well as the cost competitiveness of DDGS in least cost formulations.

Conclusions:

Significant variability in distiller's grains and distiller's solubles exist within some ethanol plants. Plants that have high nutrient variability in grains and solubles fractions will also have high nutrient variability in DDGS. The amount of solubles added to the grains also has a significant effect on the final DDGS nutrient content, particularly for plants that have high variability in protein, fat and phosphorus in the grains and solubles fractions. It is unclear why some plants have very little variation in nutrient content of the solubles and grains fractions, whereas other ethanol plants have high variation in nutrient content of grains and solubles fractions. However, ethanol plants with high nutrient variation must make corrective measures to reduce this nutrient variation if they are interested in establishing a long-term market for their DDGS for use in swine and poultry feeds.