Amino Acid Digestibility of a High Protein DDGS Product in Broilers

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Summary and Implications

Distiller's dried grains with solubles (DDGS) are a common feedstuff in poultry diets, however, digestibility estimates vary with production method and strain (broiler vs layer). The objective of this study was to determine the amino acid digestibility of 34.1% (as fed) high-protein DDGS in straight-run Cobb 500 broiler chickens. Calculated standardized ileal amino acid digestibility (SIAAD) of indispensable amino acids (AA) ranged from 81.20 to 90.41%. The SIAAD of dispensable AA ranged from 16.16 to 89.78%. The digestibility of limiting AA in HiP DDGS was greater than reported digestibility values of the same AA in DDGS. Additional research is needed to further illustrate the effect of DDGS production on the value of feeding high protein (HiP) DDGS in broiler chickens.

Introduction

Distillers dried grains with solubles (DDGS) are a co-product of the dry-milling process of ethanol production and have been used in poultry diets due to concentrated amounts of minerals, fiber, crude protein, amino acids, energy and other important nutrients as compared to whole grain corn. Intentional changes to the processing of DDGS can result in high protein DDGS (HiP DDGS) that contain ≥34% crude protein as fed compared to an average of 27% crude protein seen in conventional DDGS. To evaluate the availability of the increased crude protein content of HiP DDGS, standard apparent ileal amino acid digestibility (SIAAD) was analyzed in a broiler growth model and calculated based on previous research. The objective of this study was to determine the effects of HiP DDGS on amino acid digestibility in broiler chickens.

Materials and Methods

The protocol for this experiment was approved by the Iowa State University Institutional Animal Care and Use Committee. One hundred and twenty 6-week-old Cobb 500 broiler chickens were housed in 4ft x 4ft floor pens with 10 birds per pen and an equal representation of males and females. The pens were randomly assigned 1 of 2 amino acid digestibility test diets (Table 3). One diet was a semi-purified nitrogen-free diet to measure basal endogenous amino acid (AA) losses and the second diet contained HiP DDGS as the only source of crude protein. Both diets contained 0.50% titanium dioxide as an indigestible marker. Birds were given *ad libitum* access to food and water through a round feeder and nipple waterer for 7 consecutive days. At the end of 7 days, birds were euthanized by carbon dioxide to collect ileal digesta. All samples were pooled by pen and stored at -20°C until the conclusion of the experiment.

Prior to analysis, diet and digesta samples were dried in a 100°C forced air oven and ground through a 1mm screen in a Wiley mill (Arthur H. Thomas Company, Philadelphia, PA). All diets were analyzed for dry matter (DM), crude protein, crude fat, gross energy, and titanium dioxide concentration. The diet with HiP DDGS as the sole source of crude protein was analyzed for the AA profile. Digesta samples were analyzed for DM, crude protein (CP), AA profile, and titanium dioxide concentration. Amino acid profiles were analyzed by the University of Missouri Agriculture Experiment Station Chemical Laboratories in Columbia, Missouri.

Apparent ileal amino acid digestibility (AIAAD) was calculated using the following equation: AIAAD= $[(AA/TiO_2)_{diet} - (AA/TiO_2)_{digesta}] / (AA/TiO_2)_{diet}$. Ileal endogenous AA (IEAA) flow was calculated by using the following equation: IEAA, mg/kg of dry matter intake (DMI) = ileal AA x $([TiO_2]_{diet}/[TiO_2]_{digesta})$. The IEAA flows were then used to standardize the AIAAD coefficients to determine standardized ileal AA digestibility (SIAAD) using the following equation: SIAAD= AIAAD + [(IEAA flow g/kg of DMI)/ (dietary AA content, g/kg of DM)] x 100.The SIAAD method of analysis reduces errors in digestibility estimates because it takes into account endogenous nitrogen loss.

Results and Discussion

Typically, amino acids are concentrated in DDGS approximately 3-fold as compared to whole corn grain. Corn contains on average 0.23% lysine and 0.17% methionine, while DDGS contain 0.70% lysine and 0.50% methionine. The HiP DDGS contained 1.16% lysine and 0.74% methionine, as fed. The concentrations of lysine and methionine in HiP DDGS were 0.46% and 0.24% greater, respectively, than the concentrations of lysine and methionine in DDGS (Table 1).

Table 1: Comparison of Lysine and Methionine Concentrations in HiP DDGS, DDGS, and Corn

	HiP DDGS	DDGS	Corn
Lysine (%)	1.16	0.70	0.23
Methionine (%)	0.74	0.50	0.17

The SIAAD of the indispensable AA in HiP DDGS ranged from 81.20 to 90.41% and the SIAAD of dispensable AA ranged from 16.16 to 89.78% (Table 4). The SIAADs of lysine and methionine in HiP DDGS were highly digestible at 80.89 and 88.59%, respectively. Published values in a study by Lemme *et al*. (2004) listed the percent digestibility of lysine and methionine in corn as 92 and 94%, respectively; however, corn contains less lysine and methionine. The percent digestibility of the same amino acids in DDGS were 58.32% for lysine and 81.66% for methionine according to a study by Adedokun *et al*.(2015). Compared to these reported values, lysine in HiP DDGS was 11.11% less digestible than lysine in corn, but 22.57% more digestible than lysine in DDGS. Methionine in HiP DDGS was 5.41% less digestible than methionine in corn, but 6.93% more digestible than the methionine in DDGS (Table 2).

Table 2: Percent Standard Ileal Amino Acid Digestibility Comparison of HiP DDGS, DDGS, and Corn

Amino Acid	HiP DDGS	DDGS (Adedokun, 2015)	Corn (Lemme, 2004)
Lysine (% SIAAD)	80.89	58.32	92.00
Methionine (% SIAAD)	88.59	81.66	94.00

Based on these results, feeding HiP DDGS could reduce the need for supplemental AA in broiler diets due to the high digestibility of indispensable and limiting AA as well as increased concentration of lysine and methionine in the HiP DDGS vs DDGS and corn (Table 1). Additional research is needed to further illustrate the value of feeding HiP DDGS to broiler chickens based on altered production methods for DDGS.

Table 3. Composition of experimental diets fed to Cobb 500 broilers for 7 consecutive days to determine the amino acid digestibility of HiP[1] DDGS.

	Experimental Diets (%)	
Ingredient	**Nitrogen Free Control**	**HiP DDGS Test**
HiP DDGS	0.00	54.20
Sucrose	38.53	29.18
Soy Oil	5.00	5.00
Magnesium Oxide	0.15	0.15
Potassium Chloride	0.34	0.40
Potassium Sulfate	0.80	0.60
Sodium Bicarbonate	0.84	0.12
Limestone	0.90	0.50
Defluorinated Phosphate	1.85	1.85
Choline Chloride 60	0.25	0.25
Vitamin Premix[2]	0.75	0.75
Starch	45.09	1.50
Solka Floc	5.00	5.00
Titanium Dioxide	0.50	0.50
Analyzed Values		
Moisture (%)	5.28	8.61
Dry Matter (%)	94.72	91.39
Crude Fat (%)	1.52	5.50
Crude Protein (%)	0.00	20.80
Energy (cal/g)	3,674	4,349
Titanium (%)	0.50	0.59

[1]HiP DDGS = high protein DDGS; crude protein=34.1%.

[2] Vitamin and mineral premix provided per kg of diet: selenium 250 μg; vitamin A 8,250 IU; vitamin D_3 2,750 IU; vitamin E 17.9 IU; menadione 1.1 mg; vitamin B_{12} 12 μg; biotin 41 μg; choline 447 mg; folic acid 1.4 mg; niacin 41.3 mg; pantothenic acid 11 mg; pyridoxine 1.1 mg; riboflavin 5.5 mg; thiamine 1.4 mg; iron 282 mg; magnesium 125 mg; manganese 275 mg; zinc 275 mg; copper 27.5 mg; iodine 844 μg.

Table 4. Calculated standard ileal amino acid digestibility (SIAAD) of HiP DDGS.

Amino Acid	SIAAD (%)[1]
Indispensable amino acids	
Arginine	90.32 ± 2.830
Histidine	85.79 ± 4.996
Isoleucine	84.27 ± 3.719
Leucine	90.41 ± 1.787
Lysine	80.89 ± 2.002
Methionine	88.59 ± 3.616
Phenylalanine	88.26 ± 2.781
Threonine	81.20 ± 4.238
Valine	85.50 ± 4.212
Dispensable amino acids	
Aspartic Acid	82.13 ± 4.501
Serine	87.49 ± 2.431
Glutamic Acid	89.78 ± 1.570
Proline	81.99 ± 1.761
Glycine	16.16 ± 14.061
Alanine	86.48 ± 3.053
Cysteine	80.56 ± 3.575
Tyrosine	84.27 ± 3.355
Tryptophan	82.44 ± 3.457

[1]SIAAD presented as average SIAAD of 6 replicate cages ± standard error.