Final Report

Effects of DDGS Source on Metabolizable Energy and Amino Acid Digestibility in Broilers

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OBJECTIVES

Two experiments were conducted to determine metabolizable energy and amino acid digestibility values of a high protein DDGS compared with a conventional DDGS source fed to broiler chickens from 12 to 21 days of age.

MATERIALS AND METHODS

The Institutional Animal Care and Use Committee at Auburn University approved the experimental protocol involving live birds (PRN 2019-3519).

Husbandry

Two experiments were conducted to determine apparent metabolizable energy and amino acid digestibility values of two sources of DDGS. Four hundred sixty-eight broilers were placed in 52 battery cages (9 birds per cage; 514 cm^2 per bird) from 1 to 21 days of age. Cage dimensions are 68 × 68 × 32 cm, which provided ample space for natural movement and social behavior. Room temperature was set at 33^0C at placement and gradually decreased to 25^0 C at 19 days of age to ensure broiler comfort and optimal growth performance. Photoperiod provided 23 hours light and 1 hour dark throughout the experimental period. Cages were equipped with linear trough feeder and waterer. Feed and water were provided ad libitum. Birds and feed were weighed at 12 (both experiments), 20 (experiment 1), and 21 (experiment 2) days of age. The incidence of mortality was recoded daily.

Experimental Treatments

In experiment 1, three dietary treatments were provided from 12 to 20 days of age for metabolizable energy determination of DDGS (Table 1): 1) Basal diet: corn-soybean meal with 15% dextrose, 2) Basal diet + 15% DDGS at the expense of dextrose, and 3) Basal diet + 15% high protein DDGS at the expense of dextrose. Sources of DDGS were obtained from Marquis Procap Hennepin, IL.

In experiment 2, two semi-purified diets with DDGS being the only source of amino acids were fed from 12 to 21 days of age (Table 2). The only difference between the diets was DDGS or high protein DDGS. Diets were formulated to 20% crude protein and 0.5% titanium

dioxide as an indigestible marker to calculate amino acid digestibility from diets and ileal digesta.

Sample Collection

In experiment 1, three 24 hour total excreta collections and feed were conducted at 18, 19, and 20 days of age for an energy balance assay. Total amount of excreta at each collection period was weighed (wet basis) for each pen. Multiple sub-samples were collected from the total amount of excreta and homogenized, and then a 250 g representative sample was placed in a plastic bag and frozen for later analysis to determine AME_n. Representative samples of feed were collected and excreta subsamples from each pen were collected, pooled, and frozen until later analysis. Feed and excreta samples were dried at 55^{o}C, and dried samples were ground through a mill equipped with a 1 mm screen to ensure a homogeneous mixture. Gross energy contents of feed and excreta were determined on a 0.8 g sample using an adiabatic oxygen bomb calorimeter (Parr Instruments, Moline, IA) and analysis was performed in duplicate as described by manufacturer's manual. Nitrogen contents of feed and excreta were determined on a 0.25 g sample with a combustion analyzer (Elementar Americas, Inc., Mt. Laurel, NJ) in duplicate using a previously established method (AOAC International, 2006; 968.06). Apparent ME_n for each dietary treatment was calculated using the following equations: total AME_n intake = [gross energy intake – gross energy excretion] – [8.22 × (nitrogen intake – nitrogen excretion)]; basal AME_n intake = AME_n of control diet (85% basal + 15% dextrose) – 3,640 kcal ME/kg of dextrose (Hill and Anderson, 1958; Sell et al., 2001); DDGS AME_n = total AME_n intake – basal AME_n intake ÷ DDGS intake.

In experiment 2, 8 birds per pen were euthanized via CO_2 asphyxiation and digesta were collected by gently flushing out the contents of the lower 1/3 ileum using deionized water. Samples were pooled by pen and kept on ice before being frozen at -20°C for later analysis. Feed and digesta samples were lyophilized (Virtis Genesis Pilot Lyophilizer, SP Industries, Warminster, PA) and ground through a coffee grinder to ensure a homogeneous mixture. Complete amino acid content of the diets and digesta were analyzed by a commercial

laboratory (University of Missouri Agricultural Experiment Station Chemical Laboratory, Columbia, MO) duplicates for diets and digesta (method 982.30 E (a,b,c); AOAC International, 2006). Performic acid oxidation (method 985.28; AOAC International, 2006) was conducted before acid hydrolysis for the determination of Met and Cys, whereas all other amino acids were determined after acid hydrolysis. Titanium dioxide concentrations were determined in quadruplicates and duplicates for diets and digesta, respectively.

Apparent ileal amino acids (AA) digestibility was calculated using the following equation (Adedokun et al., 2008):

$$AIAAD = \left[1 - \left(\frac{TiO_{2\ diet}}{TiO_{2\ digesta}}\right) \times \left(\frac{AA_{digesta}}{AA_{diet}}\right)\right]$$

where $TiO_{2digesta}$ and TiO_{2diet} represent the analyzed concentrations of TiO_2 in the digesta and diets (%, respectively), and $AA_{digesta}$ and AA_{diets} denotes analyzed concentrations of amino acids in the digest and diets (%, respectively).

Statistical Analysis

Cage (9 birds per cage) was considered as the experimental unit. Data were evaluated as a randomized complete block design with cage location being the blocking factor. The number of replicate pens per treatment (12 per experiment 1; 8 per experiment 2) was used to detect significant differences among the dietary treatments. Analysis of variance was performed using PROC MIXED (SAS Institute, 2004). Means were separated using multiple range test (Tukey, 1953). Statistical significance was determined at $P \leq 0.05$.

RESULTS

Experiment 1

ProCap Gold and a conventional DDGS had AME_n values of 3,546 and 2,427 kcal/kg, respectively (Table 3). Apparent metabolizable value of ProCap Gold was 32% higher ($P < 0.0001$) than conventional DDGS source. One explanation for the increase AME_n with ProCap

Gold may be due to the removal of fiber and a higher content of crude protein/amino acids compared with the conventional source of DDGS.

Experiment 2

ProCap Gold had higher ($P < 0.001$) digestibility amino acid coefficients for both essential and non-essential amino acids (Table 4). When the digestibility coefficients were applied to the total amino acid values of both DDGS sources, digestible amino acid values were approximately 60-70% higher with ProCap Gold than the conventional DDGS source. Both digestibility coefficients and digestible amino acid values were consistently higher for ProCap Gold. It is important to note a branch chain amino acid imbalance may be a concern with the relatively high values with digestible Leu with ProCap Gold and could potentially limit the inclusion in broiler diets. Floor pen studies are warranted to determine the optimum inclusion levels of ProCap Gold throughout production based on growth performance and meat yield of broilers. In addition, diet formulation scenarios are warranted to determine the value of ProCap Gold based on AME_n and digestible amino acid values.

SUMMARY

1. ProCap Gold increased AME_n and digestible amino acid values over the conventional DDGS source. The higher crude protein/amino acid content and lower fiber may have led to the superior nutrient value of ProCap Gold.

2. The relatively high digestible Leu content of ProCap Gold could create branch chain amino acid imbalance with diet formulation. However, Val and Ile values are also higher with ProCap Gold, which will help alleviate a branch chain antagonism. The potential of a branch chain antagonism could potentially limit the inclusion of ProCap Gold in broiler diets.

3. The higher AME_n and digestible amino acid values have the potential to be very advantageous in diet formulations for broilers. Hence, research is needed to evaluate the effects of ProCap Gold on growth performance and meat yield of broilers to determine optimum inclusion levels during starter, grower, and finisher periods.

4. Mineral and fiber analysis of ProCap Gold should be considered. The fiber analysis would help explain the results with AME_n and amino acid digestibility. Phosphorus and sodium values would be useful for diet formulation.

Table 1. Ingredient and nutrient composition of the basal diet, experiment 1[1]

Ingredient (%)	**Diet**
Corn	43.19
Soybean Meal	34.75
Vegetable Oil	3.72
Defluorinated Phosphate	1.60
Calcium Carbonate	0.67
Sodium Chloride	0.39
Methionine	0.29
AU Vitamin Premix[2]	0.09
AU Mineral Premix[3]	0.09
Threonine	0.08
Lysine	0.07
Choline[4]	0.07
Test Ingredient[5]	15.00
Calculated Nutrient Content (% unless otherwise specified)	
Crude Protein	23.98
AME_n (kcal/kg)[6]	3053
Digestible Lys	1.25
Digestible Met	0.66
Digestible Thr	0.86
Digestible Trp	0.25
Digestible Arg	1.47
Digestible Ile	0.91
Digestible Val	0.96
Digestible Met + Cys	0.95
Calcium	1.01
Non-Phytate Phosphorus	0.48
Sodium	0.22
Choline (mg/kg)	400

[1]Basal mixture makes up 85% of diet inclusion, excluding test ingredients
[2]Mineral premix includes per kg of diet: Mn (manganese sulfate), 120 mg; Zn (zinc sulfate), 100mg; Fe (iron sulfate monohydrate), 30 mg; Cu (tri-basic copper chloride), 8 mg; I (ethylenediaminedihydroxide), 1.4mg; Se (sodium selenite), 0.3 mg.
[3]Vitamin premix includes per kg of diet: Vitamin A (Vitamin A acetate), 9,370 IU; Vitamin D (cholecalciferol), 3,300 IU; Vitamin E (DL-alpha tocopheryl acetate), 33 IU; menadione (menadione sodium bisulfate complex), 2 mg; Vitamin B12 (cyanocobalamin), 0.02 mg; folacin (folic acid), 1.3 mg: D-pantothenic acid (calcium pantothenate), 15 mg; riboflavin (riboflavin), 11 mg; niacin (niacinamide), 44 mg; thiamin (thiamin mononitrate), 2.7 mg; D-biotin (biotin), 0.09 mg; and pyridoxine (pyridoxine hydrochloride), 3.8 mg.
[4]Choline chloride-70 (Balchem Corporation, New Hamptopn, NY).
[5]Test ingredients included ProCap Gold, DDGS, and dextrose
[6]AME_n = nitrogen-corrected apparent metabolizable energy.

Table 2. Ingredient and nutrient composition of the experimental diets, experiment 2[1]

Ingredient (%)	**Treatment**	
	1	2
Dextrose	22.43	9.89
ProCap Gold	46.00	-
DDGS[1]	-	66.50
Corn Starch	20.39	13.82
Sodium Chloride	0.44	0.30
Poultry Oil	4.00	5.00
Sodium Bicarbinate	0.05	-
Dicalcium Phosphate	1.25	-
Potassium Sulfate	1.60	0.10
Potasium Chloride	0.14	0.35
Calcium Carbonate	2.10	2.60
Magnesium Oxide	0.10	0.10
Choline[2]	0.25	0.25
AU Vitamin Premix[3]	0.25	0.25
AU Mineral Premix[4]	0.50	0.30
Titanium Dioxide	0.50	0.50
Calculated Nutrient Content		
(% unless otherwise indicated)		
Crude Protien	20.02	20.03
AME_n (kcal/kg)[5]	3,236	3,236
Calcium	1.01	1.01
Non-Phytate Phosphorus	0.62	0.62
Sodium	0.22	0.22
Choline (mg/kg)	1,305	1,305

[1]Dried distillers grains with solubles

[2]Choline chloride-70 (Balchem Corporation, New Hamptopn, NY).

[3]Vitamin premix includes per kg of diet: Vitamin A (Vitamin A acetate), 9,370 IU; Vitamin D (cholecalciferol), 3,300 IU; Vitamin E (DL-alpha tocopheryl acetate), 33 IU; menadione (menadione sodium bisulfate complex), 2 mg; Vitamin B12 (cyanocobalamin), 0.02 mg; folacin (folic acid), 1.3 mg: D-pantothenic acid (calcium pantothenate), 15 mg; riboflavin (riboflavin), 11 mg; niacin (niacinamide), 44 mg; thiamin (thiamin mononitrate), 2.7 mg; D-biotin (biotin), 0.09 mg; and pyridoxine (pyridoxine hydrochloride), 3.8 mg.

[4]Mineral premix includes per kg of diet: Mn (manganese sulfate), 120 mg; Zn (zinc sulfate), 100mg; Fe (iron sulfate monohydrate), 30 mg; Cu (tri-basic copper chloride), 8 mg; I (ethylenediaminedihydroxide), 1.4mg; Se (sodium selenite), 0.3 mg.

[5]AME_n = nitrogen-corrected apparent metabolizable energy.

Table 3. Apparent metabolizable energy (N corrected) values for ProCap Gold and DDGS[1]

Product	**AME_n[2]** (kcal/kg)
ProCap Gold	3,546
DDGS[3]	2,427
P-value	< 0.0001
SEM[4]	76

[1]Values are the least square means of 12 replicate pens
[2]Apparent Metabolizable Energy (N corrected)
[3]Dried distillers grains with solubles
[4]Standard error of the mean

Table 4. Apparent amino acid digestibility of ProCap Gold and Conventional DDGS, experiment 2

	Digestibility Coefficient[1]				Digestible Amino Acids[4]	
Essential Amino Acids	ProCap Gold[2]	Diet 2[3]	*P*-value	SEM	ProCap Gold	DDGS
	%				%	
Methionine	83.94	58.95	< 0.001	3.999	0.858	0.293
Lysine	67.85	51.41	< 0.001	2.962	1.298	0.510
Threonine	66.96	48.49	< 0.001	4.161	1.252	0.503
Valine	77.54	47.59	< 0.001	4.135	2.158	0.644
Isoleucine	77.96	53.56	< 0.001	4.196	1.576	0.564
Tryptophan	85.62	76.69	< 0.001	1.735	0.428	0.173
Arginine	87.47	68.20	< 0.001	4.334	2.111	0.810
Histidine	78.82	59.65	< 0.001	3.571	1.097	0.440
Phenylalanine	83.05	66.01	< 0.001	3.286	2.203	1.052
Leucine	85.95	66.31	< 0.001	6.106	4.746	1.954
Nonessential Amino Acids						
Aspartic Acid	68.94	44.83	< 0.001	4.360	2.308	0.789
Serine	77.34	58.77	< 0.001	3.719	1.597	0.654
Glutamic Acid	82.76	60.53	< 0.001	3.824	6.135	2.194
Proline	79.45	65.56	< 0.001	3.962	2.763	1.291
Glycine	68.98	46.50	< 0.001	3.381	1.440	0.510
Alanine	81.64	58.87	< 0.001	2.737	2.822	1.045
Cystine	69.04	52.82	< 0.001	3.713	0.645	0.278
Tyrosine	84.01	65.09	< 0.001	3.476	1.534	0.607

[1]Data are least-square means of 8 replicate pens. Diets contained 0.5% titanium dioxide with a recovery of 97.5% in the digestibility assays.

[2]Contained ProCap Gold as sole source of dietary protein

[3]Contained DDGS as the sole source of dietary protien

[4]Digestible amino acids = analyzed total amino acid * digestibility coefficient