DISTILLERS GRAINS IN POULTRY DIETS

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Anticipation of increased supplies of distiller's dried grains with solubles (DDGS) in the Midwest has rekindled the interest in utilization of this by-product in animal feeds. In the Midwest US, corn is the primary feed stock although other grains can be processed as well. With increasing numbers of chicken layers and a large turkey industry in the Midwest, use of DDGS in poultry diets appears to have potential. Unfortunately, there is limited recent research for this ingredient with modern strains of poultry.

In the dry mill production of ethanol two products are produced – liquid solubles and grain residue. Each could be dried separately but are mixed together to form DDGS as a dry ingredient. Some of the liquid solubles have been fed experimentally with acceptable results (Hunt et al., 1997) but usually the product is fed after drying. DDGS as a feed ingredient has a moderate protein content and energy level similar to soybean meal. As a sole source of protein in diet, Parsons and coworkers (1983) found DDGS to be limiting in tryptophan and arginine after lysine.

An early use of DDGS in poultry diests was primarily as a source of unidentified factors that promote growth and hatchability. Distillers dried solubles (DDS) or DDGS were used in diets at low levels of inclusion usually less than 10%. Couch et al. (1957) found 5% inclusion of DDS variably improved turkey growth rates with the response ranging from 17-32%. Day et al (1972) reported broiler body weight improvements to DDS and DDGS in broiler diets at 2.5 and 5% in one of 3 trials. Improved reproductive performance has also been indicated for turkey breeder hens. Couch et al (1957) found improvements in turkey breeder hatchability during the second half of lay with inclusion of dried alfalfa meal, condensed fish solubles, and DDS. Manley et al (1978) found 3% DDGS improved egg production in hens late in lay and experiencing a low rate of egg production. In diets low in phosphorus DDGS was particularly valuable in improving egg production. However, in a subsequent report, no benefits were observed without low dietary phosphorus (Grizzle et al., 1982). Some have hypothesized that the UGF response may partially be due to alteration of feed palatability. Alenier and Combs (1981) noted chicken layer hens preferred rations containing 10% DDGS or 15% DDS over a corn-soy diet without DDGS. Cantor and Johnson (1983) were unable to document an effect with distillers in corn soy diets for young chicks. With identification of essential nutrients and availability of commercial supplements, UGF sources are often looked upon with skepticism (Leeson and Summers).

Use of DDGS has also been examined at high levels of inclusion. When lysine levels were adjusted in turkey diets, similar body weights were obtained with DDGS inclusion up to 20% of the diet to 8 wks of age; but feed conversion worsened (Potter, 1966). Parsons et al. (1983) found that DDGS could replace up to 40% of soybean meal protein when lysine content was adjusted without an effect on body weight. When energy is also adjusted body weights and feed conversions are not affected by inclusion of distillers to high levels. Waldroup et al (1981) included DDGS to 25% of diet for broilers. When adjusted for lysine and energy level,

performance was not affected. Without adjustment for energy, growth was maintained but feed conversion decreased. Caloric intake per gain was similar across all treatments.

Despite the above research results, nutritionists are hesitant to use high inclusion levels in the diet. The lower energy (less starch) and higher fiber content is a concern and high dietary levels may limit intake of high performance meat poultry. Variability in product nutrient content and quality is often cited. Indeed, variability exists in nutrient content and performance response. In the report presented by Cromwell and coworkers (1993), 9 different samples of DDGS were analyzed and tested in chick diets. A large range of lysine contents were noted (.43 to .89%). Chick responses to inclusion of these same samples (20%) in isonitrogenous and isocaloric diets ranged from 63 to 84% of the corn-soy-starch control. Samples higher in lysine tended to perform better but some samples did not follow this pattern.

As distiller grains undergo heating to produce the dried product, concern exists over amino acid digestibility especially for heating of lysine in the presence of sugars. Indeed the limited literature citations indicate poorer availability of lysine. Combs and Bossard (1969) found lysine availability to range from 71-93% by chick growth assay. Parsons et al (1983) found slightly lower availability of 66% by chick growth assay. Lysine digestibility with roosters was found to be 82%. Other sources also assign a low digestibility to DDGS.

With the paucity of research and new developments in production of DDGS, inclusion levels and digestibility should be reconsidered. In the Midwest, a variety of ingredients are available and may be cost effective when considering both ingredient cost and effects on performance. Besides soybean meal, meat and bone meal and canola meal is often available. Along with corn and SBM, these ingredients are often used in market poultry diets. Meat and bone meal is a good source of protein and offers other nutrients such as calcium and phosphorus and contributes energy (fat) to the diet. Canola meal has benefits for pellet quality and mill throughput. Utilization of other ingredients such as DDGS needs to be evaluated in such diets with an emphasis on protein quality or amino acid balance as performance and breast meat yield is greatly impacted by intake of specific amino acids.

Thus a study was designed to examine if significant levels of canola meal and DDGS can be used in market turkey diets and to determine which amino acids (tryptophan, isoleucine, arginine) may limit performance with diets containing canola and DDGS.

Nicholas male poults were placed in starting pens at one day of age and reared to 5 weeks of age. Poults were fed a pre-experimental diet designed for best rate of gain. At 5 weeks of age the birds were randomly distributed into 98 pens with 10 birds per pen. Room temperature at 5 wks was targeted at 70 F. In the other room temperature was gradually decreased to 60 F at 14 wks of age and a minimum of 55 F held for the remaining experimental period.

Starting at 5 wks of age, the toms in each environment (cool and warm temperature environments) were fed one of seven dietary treatments with 7 replicates per treatment.

Treatments

1. Control - Corn/soy/animal protein
2. As 1 plus corn DDGS
3. As 1 plus Canola meal
4. As 1 plus DDGS and Canola meal
5. As 4 plus Tryptophan to Trt 1
6. As 4 plus Tryptophan and Isoleucine to Trt 1
7. As 4 plus Tryptophan, Arginine, and Isoleucine to Trt 1

All major diet ingredients were analyzed for nutrient content and digestible amino acids (Table 1). Ingredients were chemically analyzed for protein, minerals and amino acids. Samples of each ingredient were submitted to Dr. Parson at the University of Illinois for determination of digestible amino acids using cecatomized chickens.

Sample diets are shown in Tables 2 and 3 for the respective 5-8 and 17-19 wk periods for Treatments 1 through 4. The control diet (Treatment 1) includes animal protein because of its obvious economic advantage and widespread use. Valine content (as a percent of protein) is similar across ingredients; therefore diet protein in these sample diets was fixed by setting a valine specification. Supplemental lysine, methionine, and threonine were used so that all diets contained adequate amounts of these amino acids. For Treatments 5, 6, and 7 supplements of tryptophan, arginine and isoleucine were used to achieve amino acid levels similar to that of Treatment 1. All diets contained 60 gm Coban and 20gm Stafac from 5-8 wks and 20 gm Stafac per ton alone from 8-19 wks of age. Weights and feed consumption were determined at 8, 11, 14, 17 and 19 wks of age. At 19 weeks, toms were processed and carcass and breast meat yield determined. At this time samples of breast meat representing each treatment and environment were measured for meat quality by obtaining color, pH, and purge loss.

The experimental design was factorial with diet and environment as the main effects. Analyses of variance were conducted to determine the effects of diet, environment and their interaction on gain, feed conversion, and breast meat yield.

Body weight and feed efficiency (feed/gain) were affected primarily by environment temperature. Turkeys grown in the warm temperature environment had less body weight especially at 19 wks of age with somewhat better feed efficiency (Table 4). Inclusion of moderate levels of canola meal and DDGS had no adverse effects on performance in comparison to the control diet in either environment. Both environment and diet (Table 5) affected breast meat yield (amount and percentage). Warm temperatures depressed yield by 1.2 lbs. or 2% of the carcass. Inclusion of either DDGS or canola meal alone had little effect on breast meat yield. However, the inclusion of both into the diet depressed percentage meat yield significantly. Supplementation of the diet with tryptophan restored some of the lost yield in comparison. Isoleucine was without effect, while supplementation with arginine (in combination with tryptophan and isoleucine) restored breast meat yield completely.

In summary, digestible amino acid content of the DDGS used in this project was much better than reported elsewhere. Warm environmental temperatures depressed body weights by 1.8 lbs.

at 19 wks of age and breast meat amount by 1.2 lbs. Inclusion of significant levels of either canola and/or DDGS had no effect on growth performance. Breast meat yield (as a proportion of carcass weight) was sensitive to amino acid quality as reflected by the depression in yield when the combined diet of canola and distiller grains were fed. The amino acids tryptophan and arginine appeared to play a role in restoring yield.

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Table 1. Ingredient Analyses for Turkey Feeding Trial.

	Corn, Ground yellow		Soybean meal, 47%		Distillers Grains Solubles		Canola Meal		Meat & Bone Meal Poultry Blend	
Nutrient (%)	Total	Digestible	Total	Digestible	Total	Digestible	Total	Digestible	Total	Digestible
PROTEIN, CRUDE	8.44		46.77		26.39		37.12		58.11	
DRY MATTER	87.13		88.27		90.23		89.32		95.19	
FAT, CRUDE	4.67		2.31		11.51		3.45		11.37	
FIBER, CRUDE	1.7		2.47		6.17		10.15		0.51	
CALCIUM	0.0079		0.24		0.08		0.78		7.77	
PHOSPHORUS, TOTAL	0.24		0.65		0.82		1.18		3.86	
POTASSIUM	0.29		2.11		1.1		1.29		0.61	
SODIUM	0.0008		0.0215		0.17		0.11		0.65	
CHLORIDE	0.04		0.01		0.08		0.05		0.58	
METHIONINE	0.15	0.14	0.66	0.61	0.49	0.43	0.72	0.65	1.07	0.99
CYSTINE	0.17	0.16	0.77	0.65	0.53	0.42	0.97	0.77	0.63	0.53
LYSINE	0.25	0.2	2.94	2.66	0.81	0.64	2.04	1.71	3.32	2.99
ARGININE	0.37	0.33	3.38	3.14	1.11	1.02	2.22	2.05	3.95	3.71
TRYPTOPHAN	0.06	0.05	0.66	0.58	0.24	0.192	0.5	0.45	0.52	0.468
VALINE	0.37	0.32	2.19	1.99	1.36	1.2	1.77	1.48	2.43	2.19
GLYCINE	0.3		1.93		1		1.75		6.41	
HISTIDINE	0.23	0.2	1.29	1.15	0.7	0.61	1.01	0.89	1.16	1.06
PHENYLALANINE	0.41	0.37	2.37	2.19	1.26	1.16	1.44	1.3	2.02	1.87
TYROSINE	0.26		1.63		0.99	0.95	0.99	0.88	1.47	1.36
THREONINE	0.29	0.24	1.78	1.57	1	0.83	1.51	1.23	2.01	1.81
LEUCINE	1.02	0.96	3.59	3.31	3	2.82	2.53	2.28	3.63	3.37
ISOLEUCINE	0.27	0.24	2.05	1.89	0.96	0.86	1.35	1.16	1.88	1.73
SERINE	0.37	0.37	2.09	2.09	1.12	1.01	1.33	1.15	2.22	1.98

Table 2. Selected Diet Composition 5-8 Wks of Age

	Control (C-S-MBM)		DDGS		Canola		Canola & DDGS	
Ingredient (%)	Trt 1		Trt 2		Trt 3		Trt 4	
Corn	59.95		54.09		54.81		48.95	
SBM 47%	26.78		20.49		18.68		12.39	
Poultry blend (meat&bone)	8		8		8		8	
Distillers grains w/sol	0		12		0		12	
Canola meal	0		0		12		12	
Dicalcium phosphate	1.094		1.005		0.954		0.865	
Calcium carbonate	0.683		0.748		0.567		0.632	
Scarb	0.381		0.366		0.338		0.324	
Salt	0.040		0.004		0.044		0.008	
Potassium carbonate	0.004		0.036		0.060		0.093	
DL-Methionine	0.184		0.179		0.131		0.125	
L-Lysine	0.275		0.405		0.301		0.432	
Threonine	0.077		0.091		0.069		0.082	
MNVIT99	0.22		0.22		0.22		0.22	
MNTM96	0.12		0.12		0.12		0.12	
Choline Chloride 60%	0.125		0.125		0.125		0.125	
Choice White Grease	2.06		2.12		3.57		3.63	
Total	100.0		100.0		100.0		100.0	
Calculated Nutrient Content								
Crude Protein (%)	22.7		22.5		22.9		22.7	
Metabolizable Energy (kcal/kg)	3070		3070		3070		3070	
Crude fat (%)	6.4		7.4		7.9		8.9	
Calcium (%)	1.18		1.18		1.18		1.18	
Phosphorus, total (%)	0.83		0.86		0.88		0.91	
Phosphorus, Inorganic (%)	0.59		0.59		0.59		0.59	
Potassium (%)	0.79		0.79		0.79		0.79	
Sodium (%)	0.19		0.19		0.19		0.19	
Chloride (%)	0.22		0.22		0.22		0.22	
	Digestible	Total	Digestible	Total	Digestible	Total	Digestible	Total
Met plus cys (%)	0.819	0.905	0.819	0.912	0.819	0.922	0.819	0.929
Lysine (%)	1.287	1.418	1.287	1.418	1.287	1.433	1.287	1.433
Arginine (%)	1.336	1.443	1.241	1.342	1.310	1.417	1.216	1.315
Tryptophan (%)	0.225	0.254	0.208	0.238	0.229	0.258	0.213	0.242
Valine (%)	0.900	1.003	0.900	1.006	0.900	1.019	0.900	1.022
Glycine (%)	1.210	1.21	1.190	1.19	1.248	1.248	1.229	1.229
Histidine (%)	0.513	0.576	0.502	0.566	0.516	0.581	0.505	0.57
Phenylalanine (%)	0.958	1.042	0.938	1.02	0.918	1.002	0.897	0.98
Tyrosine (%)	0.701	0.71	0.697	0.711	0.661	0.683	0.658	0.681
Threonine (%)	0.785	0.887	0.785	0.891	0.785	0.901	0.785	0.905
Leucine (%)	1.732	1.863	1.805	1.938	1.688	1.824	1.762	1.898
Isoleucine (%)	0.788	0.861	0.759	0.832	0.792	0.843	0.732	0.814
Serine (%)	0.940	0.959	0.908	0.94	0.890	0.93	0.858	0.912

Table 3. Selected Diets for 17-19 Wks of Age

	Control (C-S-MBM)		DDGS		Canola		Canola & DDGS	
Nutrient (%)	Trt 1		Trt 2		Trt 3		Trt 4	
Corn	74.46		70.55		71.04		67.13	
SBM 47%	12.67		8.48		7.28		3.08	
Poultry blend (meat&bone)	5.00		5.00		5.00		5.00	
Distillers grains w/solubles	0		8		0		8	
Canola meal	0		0		8		8	
Dicalcium phosphate	0.768		0.709		0.674		0.615	
Calcium carbonate	0.563		0.606		0.485		0.529	
Scarb	0.333		0.322		0.304		0.294	
Salt	0.110		0.085		0.112		0.088	
Potassium carbonate	0.011		0.033		0.049		0.070	
DL-Methionine	0.042		0.039		0.006		0.003	
L-Lysine	0.154		0.241		0.171		0.258	
Threonine	0.022		0.031		0.017		0.026	
MNVIT99	0.17		0.17		0.17		0.17	
MNTM96	0.08		0.08		0.08		0.08	
Choline Chloride 60%	0.1		0.1		0.1		0.1	
Choice White Grease	5.51		5.55		6.52		6.56	
Total	100.0		100.0		100.0		100.0	
Nutrient								
Crude Protein (%)	14.6		14.6		14.8		14.7	
Metabolizable Energy (kcal/kg)	3390		3390		3390		3390	
Crude fat (%)	9.9		10.5		10.8		11.5	
Calcium (%)	0.80		0.80		0.80		0.80	
Phosphorus, total (%)	0.60		0.61		0.63		0.65	
Phosphorus, inorganic (%)	0.40		0.40		0.40		0.40	
Potassium (%)	0.52		0.52		0.52		0.52	
Sodium (%)	0.18		0.18		0.18		0.18	
Chloride (%)	0.22		0.22		0.22		0.22	
	Digestible	Total	Digestible	Total	Digestible	Total	Digestible	Total
Met + Cys (%)	0.495	0.546	0.495	0.552	0.495	0.558	0.495	0.563
Lysine (%)	0.756	0.845	0.756	0.845	0.756	0.855	0.756	0.855
Arginine (%)	0.829	0.901	0.766	0.834	0.812	0.884	0.749	0.816
Tryptophan (%)	0.134	0.154	0.123	0.143	0.137	0.157	0.126	0.146
Valine (%)	0.600	0.675	0.600	0.677	0.600	0.685	0.600	0.688
Glycine (%)	0.789	0.789	0.776	0.776	0.814	0.814	0.801	0.801
Histidine (%)	0.348	0.393	0.340	0.386	0.350	0.396	0.343	0.389
Phenylalanine (%)	0.647	0.707	0.633	0.692	0.620	0.68	0.606	0.665
Tyrosine (%)	0.468	0.474	0.466	0.474	0.442	0.456	0.439	0.457
Threonine (%)	0.490	0.564	0.490	0.567	0.490	0.573	0.490	0.576
Leucine (%)	1.303	1.396	1.352	1.446	1.274	1.37	1.323	1.419
Isoleucine (%)	0.505	0.555	0.485	0.535	0.487	0.543	0.467	0.523
Serine (%)	0.639	0.651	0.618	0.639	0.606	0.632	0.585	0.62

Table 4. Performance of Male Market Turkeys

Diet Number	Description	Body Weight 11 wks	Body Weight 19 wks	Feed Efficiency 5-19 wks
		--- lbs ---		feed/gain
1	Control (Corn-Soybean-Animal Protein)	18.9	42.7	2.517
2	As 1 + Distillers Dried Grains	19.0	42.6	2.635
3	As 1 + Canola Meal	19.1	43.1	2.679
4	As 1 + Distillers Dried Grains & Canola Meal	19.1	42.8	2.650
5	As 4 + Tryptophan to Trt #1	19.1	42.6	2.860
6	As 5 + Isoleucine to Trt #1	19.0	43.2	2.592
7	As 6 + Arginine to Trt #1	18.9	42.9	2.619
	Cool Environment	**19.0**	**42.8**	**2.650**
1	Control (Corn-Soybean-Animal Protein)	18.4	40.6	2.515
2	As 1 + Distillers Dried Grains	18.5	41.2	2.536
3	As 1 + Canola Meal	18.7	41.3	2.543
4	As 1 + Distillers Dried Grains & Canola Meal	18.6	40.9	2.522
5	As 4 + Tryptophan to Trt #1	18.9	41.2	2.581
6	As 5 + Isoleucine to Trt #1	18.4	40.2	2.511
7	As 6 + Arginine to Trt #1	18.6	41.5	2.529
	Warm Environment	**18.6**	**41.0**	**2.534**
1	Control (Corn-Soybean-Animal Protein)	18.6	41.6	2.516
2	As 1 + Distillers Dried Grains	18.7	41.9	2.586
3	As 1 + Canola Meal	18.9	42.2	2.611
4	As 1 + Distillers Dried Grains & Canola Meal	18.8	41.8	2.586
5	As 4 + Tryptophan to Trt #1	19.0	41.9	2.721
6	As 5 + Isoleucine to Trt #1	18.7	41.7	2.551
7	As 6 + Arginine to Trt #1	18.8	42.2	2.574
	Average	18.8	41.9	2.592
	P Value			
	Diet	NS	NS	0.0183
	Room	0.0001	0.0001	0.0002
	Diet x Room	NS	NS	NS
	Least Significant Difference (P<.05)			
	Diet	0.3	0.7	0.109
	Room	0.2	0.4	0.059

Table 5. Carcass yield of market tom turkeys

Diet Number	Description	Body Wt 19 wks	Carcass	Breast	% of Carcass Breast
		---------- lbs ----------			---- % ---
1	Control (Corn-Soybean-Animal Protein)	42.51	33.41	10.65	31.83
2	As 1 + Distillers Dried Grains	43.14	34.28	10.84	31.59
3	As 1 + Canola Meal	42.93	34.10	10.90	31.90
4	As 1 + Distillers Dried Grains & Canola Meal	42.75	33.65	10.48	31.08
5	As 4 + Tryptophan to Trt #1	42.24	33.25	10.45	31.37
6	As 5 + Isoleucine to Trt #1	42.87	34.05	10.59	31.02
7	As 6 + Arginine to Trt #1	42.92	33.93	10.73	31.54
	Cool Environment	**42.76**	**33.81**	**10.66**	**31.48**
1	Control (Corn-Soybean-Animal Protein)	39.96	31.36	9.32	29.65
2	As 1 + Distillers Dried Grains	40.94	32.14	9.42	29.30
3	As 1 + Canola Meal	41.32	32.50	9.71	29.86
4	As 1 + Distillers Dried Grains & Canola Meal	40.68	31.76	9.15	28.78
5	As 4 + Tryptophan to Trt #1	41.25	32.44	9.57	29.48
6	As 5 + Isoleucine to Trt #1	40.52	31.65	9.17	28.93
7	As 6 + Arginine to Trt #1	41.42	32.57	9.78	30.01
	Warm Environment	**40.87**	**32.06**	**9.45**	**29.43**
1	Control (Corn-Soybean-Animal Protein)	41.23	32.39	9.99	30.74
2	As 1 + Distillers Dried Grains	42.04	33.21	10.13	30.45
3	As 1 + Canola Meal	42.13	33.30	10.30	30.88
4	As 1 + Distillers Dried Grains & Canola Meal	41.72	32.71	9.81	29.93
5	As 4 + Tryptophan to Trt #1	41.74	32.84	10.01	30.43
6	As 5 + Isoleucine to Trt #1	41.69	32.85	9.88	29.98
7	As 6 + Arginine to Trt #1	42.17	33.25	10.25	30.78
	Average	41.82	32.93	10.05	30.45
	P Value				
	Diet	NS	NS	NS	0.0206
	Room	0.0001	0.0001	0.0001	0.0001
	Diet x Room	NS	NS	NS	NS
	Least Significant Difference (P<.05)				
	Diet	0.94	0.86	0.39	0.65
	Room	0.50	0.46	0.21	0.35