Alternative Ingredients for Poultry – Turkeys

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Alternative ingredients are usually defined as those ingredients other than corn and soybean meal, however, this is also dependent on the availability of those and other competing ingredients in the region. In some areas, what might be considered as alternative are ingredients that are already commonly used i.e., wheat products, meat and bone meal, milo, and so forth. For the purposes of this paper, the focus will be on distiller dried grains with solubles and their potential incorporation into diets with various types of alternative ingredients.

Distiller grains with solubles (DDGs) is not a new or novel feed ingredient. However, increased supplies of distiller's dried grains with solubles are anticipated throughout the US as a result of ethanol production and this has rekindled the interest in utilization of this corn co-product in animal feeds. DDGs as a feed ingredient has a moderate protein content. In the Midwest US, corn is the primary feed stock although other grains can be processed as well. 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 and dried to form DDGS as a dry ingredient. Some of the liquid solubles has been fed experimentally with acceptable results (Hunt et al., 1997) but usually the product is fed after drying. Newer production methods ("new generation plants") are thought to produce a higher quality ingredient.

An early use of DDGs in poultry diets was primarily as a source of unidentified factors that promoted 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 performance in reproduction have 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). 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).

Considerations for the use of this product or any alternative product is fairly similar to that of other ingredients. Information would be needed regarding its nutrient composition and variability, amino acid digestibility, amino acid balance, energy, mineral availability, maximum inclusion levels and cost relative to other ingredients. Unfortunately there is limited recent research for this ingredient with modern strains of poultry.

Nutrient composition and variability

To assess composition of material from "new generation" processing plants,
DDGs samples were collected from four ethanol processors in Minnesota over a period of time during spring, 2002.

Four representative samples were obtained from each ethanol processor. Each sample was analyzed chemically for proximate components (protein, fiber, fat, ash, moisture), amino acids, and minerals. In addition, the samples were submitted to Dr. Parson's laboratory at the University of Illinois for *in vivo* determination of amino acid digestibility using cecatomized roosters. Samples are also being assessed for energy in turkeys using the True Metabolizable Energy (TME) assay developed by Sibbald.

Preliminary results indicate that nutrient content of the DDGs varies among sources but is relatively consistent within processing source. Sources were found to vary in proximate composition especially protein and fat content. Mineral content also varied among sources. Magnesium, sodium, potassium and phosphorus accounted for most of the inorganic component of the feed ingredient.

Nutrient profile and range in analytical values among DDGs as compared to NRC

Content		NRC, 1994
	%	
Protein	25.5-30.7	27.4
Fat	8.9-11.4	9
Fiber	5.4-6.5	9.1
Calcium	.017-.45	.17
Phosphorus	.62-.78	.72
Sodium	.05-.17	.48
Chloride	.13-.19	.17
Potassium	.79-1.05	.65
Amino acids (selected EAA)	% total amino acid	
Methionine	.44-.56	.6
Cystine	.45-.60	.4
Lysine	.64-.83	.75
Arginine	1.02-1.23	.98
Tryptophan	.19-.23	.19
Threonine	.94-1.05	.92

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 previously literature citations indicates 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 82%. Other sources also assign a low digestibility to DDGs.

In the survey conducted, digestibility of several essential amino acids were affected, in particular that of lysine, threonine and cystine. Digestible lysine was in general much improved over previously published values in three of the four sources. The data indicate that while there are product differences among sources the product is relatively consistent for each source.

Digestible Amino Acid Content and range among DDGs

Amino acids (selected EAA)	% Digestible amino acid	Digestibility Coefficient (%)
Methionine	.35-.53	85.6-90
Cystine	.28-.57	66.3-85
Lysine	.37-.74	59.1-83
Arginine	.73-1.18	80.5-90
Tryptophan	.14-.21	76.4-87.4
Threonine	.61-.92	66.8-80.7

The higher digestibility of some sources of DDGs for lysine can definitely add value to the DDGs. An economic analysis of turkey grower diets containing DDGs with either lower or higher lysine digestibility (60% vs. 78%) resulted in an opportunity cost of 50 cents greater for the DDGs with higher digestibility. Different scenarios of corn and SBM prices were used.

Influence of digestible lysine content on value of DDGs ($/cwt)

Ingredient and price ($/cwt)	DDGs – Low digestible lysine	DDGs – High digestible lysine
Corn, 3.10	4.28	4.78
Corn, 3.50	4.54	5.00
Corn, 5.30	5.70	6.02
SBM, 8.25	4.54	5.00
SBM, 8.70	4.72	5.21

Amino Acid Content and Balance

As a sole source of protein in diet, Parsons and coworkers (1983) found DDGs to be limiting in tryptophan and arginine after lysine. 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. A comparison of amino acid content as percent of protein also indicates that tryptophan and arginine could become limiting as DDGs replaces SBM in the diet. Isoleucine also could be potentially limiting especially considering other ingredients such as blood meal and meat and bone meal.

In Midwestern diets, canola meal is often used in combination with meat and bone meal. 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. 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 . 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 the tables below 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.

Selected Diet Composition 5-8 Wks of Age
(Exp. TG002)[1]

Ingredient (%)	Control (C-S-MBM) Trt 1		DDGS Trt 2		Canola Trt 3		Canola & DDGS Trt 4	
Corn	59.95		54.09		54.81		48.95	
SBM 47%	26.78		20.49		18.68		12.39	
Poultry blend	8		8		8		8	
DDGs	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	
Vitamin/mineral mix	+		+		+		+	
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	
Crude fat (%)	6.4		7.4		7.9		8.9	
	Digest.	Total	Digest.	Total	Digest.	Total	Digest.	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
Threonine (%)	0.785	0.887	0.785	0.891	0.785	0.901	0.785	0.905
Isoleucine (%)	0.788	0.861	0.759	0.832	0.792	0.843	0.732	0.814

[1] For all diets, ME was set at 3070 kcal/kg, calcium at 1.18%, inorganic phosphorus at .6%, potassium at .8%, sodium at .19%, and chloride at .22%

Selected Diets for 17-19 Wks of Age
(Exp. TG002) [1]

Nutrient (%)	Control (C-S-MBM)		DDGS		Canola		Canola & DDGS	
	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	5.00		5.00		5.00		5.00	
DDGs	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	
Vitamin/mineral mix	+		+		+		+	
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	
Crude fat (%)	9.9		10.5		10.8		11.5	
	Digest.	Total	Digest.	Total	Digest.	Total	Digest.	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
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

[1] For all diets, ME was set at 3390 kcal/kg, calcium at .8%, inorganic phosphorus at .4%, potassium at .5%, sodium at .18%, and chloride at .22%

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 . 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 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.

Performance of Male Market Turkeys
(Exp. TG002) Main Effect of Diet

Diet#	Description	Body Weight		Feed Efficiency	Carcass Weight	Breast Weight	Breast Meat
		11 wks	19 wks	5-19 wks			
		------ lbs ------		feed/gain	lbs	lbs	%
1	Control (Corn-Soy-Animal Protein)	18.6	41.6	2.437	32.39	9.99	30.74
2	As 1 + DDGs	18.7	41.9	2.477	33.21	10.13	30.45
3	As 1 + Canola Meal	18.9	42.2	2.470	33.30	10.30	30.88
4	As 1 + DDGs & Canola	18.8	41.8	2.470	32.71	9.81	29.93
5	As 4 + Tryptophan to Trt #1	19.0	41.9	2.494	32.84	10.01	30.43
6	As 5 + Isoleucine to Trt #1	18.7	41.7	2.449	32.85	9.88	29.98
7	As 6 + Arginine to Trt #1	18.8	42.2	2.466	33.25	10.25	30.78
	Average	18.8	41.9	2.466	32.93	10.05	30.45
	P Value						
	Diet	NS	NS	0.2638	NS	NS	0.0206
	Environment	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	Diet x Env	NS	NS	0.1415	NS	NS	NS
	Least Significant Difference (P<.05)						
	Diet	0.3	0.7	0.046	0.86	0.39	0.65

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.

A second trial (Exp. TG013) was conducted to compare the performance of DDGs as protein level of the diet decreased. The experimental design was factorial (2x3) with 2 diet series comparisons (corn-soybean meal-poultry byproduct meal vs. inclusion of DDGs); and 3 protein levels (100,95 and 90% NRC dig thr. Diet protein level was established by using intact protein to provide the desired digestible thr target without supplemental thr. All diets were supplemented with lysine and methionine plus cystine to meet the estimated digestible amino acid requirement.

Diets were formulated using digestible amino acids as determined prior to the start of the trial. Thus corn, soybean meal, DDGs, and poultry byproduct meal would be assayed as described above. Diets were isocaloric and fed in mash form. Each diet was fed to 8 replicate pens of turkeys. The trial started at 8 weeks of age. At 7 weeks of age the birds were randomly distributed into 96 pens with 10 birds per pen. All diets contained 60 gm Coban and 50 gm (BMD) bacitracin from 0-8 wks and 50 gm BMD per ton alone from 8-17 wks of age. The trial was conducted during the approximate time period of February to April.

Weights and feed consumption were determined at 8, 11, 14, 17, and 19 wks of age. At 19 weeks of age, toms were processed, carcass and breast meat yield determined. Analyses of variance were conducted to determine the main effects of diet series, protein, and thr addition, and their interaction on gain, feed conversion, and breast meat yield for the main factorial design.

Diet protein as digestible thr (90, 95, 100% NRC) had the most consistent effect on body weight at the different ages and on breast meat yield at 19 wks of age. The response to diet protein was similar for both diet series. Body weights and breast meat yield per bird were reduced when diet protein was reduced to 90% NRC thr.

Effect of protein (as dig NRC thr), and diet series on market tom turkey performance (Exp. TG013)

			Diet Series	
Measurement	Diet % NRC thr	Corn/soy/meat		Corn/soy/ meat/DDGs
14 wk BW, lbs	100	27.1		27.5
	95	27.4		26.9
	90	26.8		27.2
19 wk BW, lbs	100	42.4		42.5
	95	42.4		42.3
	90	41.6		41.9
Breast meat, lb/bird	100	10.7		10.6
	95	10.5		10.5
	90	10.0		10.2

Information from the feeding trial indicates that when DDGs are incorporated into market turkey diets on a digestible amino acid basis, performance was equivalent to that of the control at all protein levels. Greater responses to threonine were observed in the diet series without DDGs at a lower protein level.

In summary, DDGs was found to be an acceptable source of protein in diets for heavy toms at moderate levels of inclusion. Diets should be formulated taking into consideration specifications for tryptophan and arginine. While isoleucine was not found to be limiting, combined use of DDGs with alternative ingredients may lead to shortages of isoleucine and/or arginine. More information regarding DDGs can be found at the following University of Minnesota website: http://www.ddgs.umn.edu/.

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