Increasing the usage level of corn and distillers grains in market turkey diets through the use of supplemental amino acids

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By:
Sandy Noll
University of Minnesota

Contents

Executive Summary

The amount of corn and distillers grains (DDGS) in poultry diets is primarily determined by assessing the cost of providing essential nutrients and energy relative to other ingredients. With the de-oiling process in the production of distillers grains being common-place, use of DDGS will more likely depend on the provision of protein (amino acids) and less as a source of energy. The amino acid content of corn-derived protein is not well balanced for animal feeding. In a poultry diet, the main amino acid deficiencies in corn are corrected through the use of other protein sources (soybean meal, canola meal, etc.) and supplemental amino acids (lysine, methionine and threonine). Other supplemental amino acids (tryptophan and valine) are available commercially and could be used to balance amino acids in poultry diets containing a high amount of corn coproducts if such a need can be demonstrated. However, arginine is often limiting for growth as well and is not commercially available for use in poultry diets.

The overall objective was to determine if supplemental tryptophan and valine can be utilized in market turkey diets with a significant amount of corn protein present. Specific objectives included:

1) Establish a negative control diet by feeding diets with lowered dietary protein and increased supplemental threonine in comparison to feeding a positive control to market turkeys during two age periods (0 to 4 weeks and 10 to 14 weeks of age).
2) Using information from Objective 1, determine if performance of the negative control diet can be improved with supplementation with tryptophan, valine, arginine, or a combination of amino acids.
3) Conduct an economic analysis utilizing the performance data achieved in Objectives 1 and 2.

Four feeding trials were conducted examining the performance response of market turkey hens to reduced dietary protein and amino acid supplementation during 0 to 4 and 10 to 14 weeks of age. In the first objective, dietary reductions in crude protein were achieved by utilizing increasing amounts of supplemental threonine and level of corn in the diets, however, a reduced gain was observed in turkeys. In the second objective, supplements of valine, tryptophan, and arginine were added in various combinations to reduced protein diets containing 20% DDGS to examine the potential restoration of performance. The amino acids, arginine and tryptophan, were found to be co-limiting in poult starter diets with 20% DDGS. In grower type diets with 20% DDGS, valine appears to be limiting along with arginine and tryptophan. In both phases, performance was not completely restored with amino acid supplementation. Also, utilization of supplemental valine and tryptophan in diets high in corn protein will be limited by a lack of a commercially available arginine and potentially isoleucine. Dried distillers grains with solubles were found to decrease diet cost per ton of feed and to decrease cost per unit of gain in grower hen turkeys. However, reduced dietary protein with the resulting decreased rate of gain would affect market weight at a specific age.

Introduction

The amount of corn and distillers grains (DDGS) in poultry diets is primarily determined by assessing the cost of providing essential nutrients and energy relative to other ingredients. With the de-oiling process in the production of distillers grains being common-place, use of DDGS will more likely depend on the provision of protein (amino acids) and less as a source of energy. The amino acid content of corn-derived protein is not well balanced for animal feeding. In a poultry diet, the main amino acid deficiencies in corn are corrected through the use of other protein sources (soybean meal, canola meal, etc.) and supplemental amino acids (lysine, methionine and threonine). An evolution in formulation of poultry diets has allowed for formulating diets to meet amino acid need based on digestibility, determination of amino acid requirements and use of amino acid ratios. Hence, the emphasis by the poultry nutritionist is on meeting amino acid need and not a specific dietary protein level. Research has indicated that for reasons of minimizing environment impact and optimizing bird health, excess protein/amino acids should be avoided. Excess dietary protein results in wasteful excretion of nitrogen, diverts dietary energy for metabolism of the excess protein instead of growth, and can challenge gut health with excess protein in the small intestine.

Typically, diets will have some excess protein present as the desired amino acids levels can only be balanced to the extent that other ingredients and feed additives can provide specific amino acids relative to the most limiting amino acids. Corn is considered limiting in lysine, threonine, tryptophan, and perhaps co-limiting in arginine/isoleucine/valine. In diets containing DDGS, tryptophan and arginine are expected to be more limiting. In corn-soybean meal based diets, the amino acids that will be limiting bird performance were identified to be methionine, threonine, lysine, valine, arginine and tryptophan (Fernandez et al, 1994; Parsons et al., 1983). Commercially available supplements have been available for methionine, lysine and threonine and are commonly used. More recently commercially available supplements of tryptophan and now valine are available but are still expensive to use due to limited supply.

Results of a grow-finish trial with market tom turkeys indicated that the use of supplemental threonine needed to be restricted to less than the 6% of the targeted threonine level (Noll and Brannon, 2007) in diets with high levels of byproducts (20% DDGS and 10 % poultry byproduct meal) during 8-19 weeks of age. Body weights were reduced by 3.3% at 19 weeks of age when turkeys were fed diets containing 94% of the targeted threonine from intact protein and the remaining 6% from supplemental threonine most likely due to other amino acid limitations.

Depending on availability and cost, these co- or by-products can be incorporated into poultry diets. However, their use will be restricted to the extent that other amino acids become limiting as diet protein decreases such as tryptophan, valine, isoleucine and arginine. At this time, commercially available and priced supplements for two of these amino acids (arginine and isoleucine) are not available.

In order to effectively use tryptophan and valine, feeding trials are needed to identify that as crude protein content of the diet is decreased, performance is not sacrificed due to shortages of other essential amino acids such as arginine, isoleucine, glycine + serine, or nitrogen from non-essential amino acids or excess of leucine which is involved in a branch chain antagonism with valine and isoleucine (Baker, 2009; Corzo et al. 2007, 2008, 2009).

If successful, the proportion of corn protein from corn and/or DDGS should increase in turkey diets. Increasing the level of corn in the diet also has the advantage of using an ingredient that is high energy and is readily digested by poultry. Demand for corn by Minnesota's turkey industry should at least be maintained and should increase if the project is successful.

Objectives:

The overall objective was to determine if supplemental tryptophan and valine can be utilized in market turkey diets with a significant amount of corn protein present without causing a decline in performance. The hypothesis is that diets with increased corn protein and supplemental tryptophan, arginine, and/or valine will maintain performance comparable to the positive control.

Specific objectives included:

4) Establish a negative control diet by feeding diets with lowered dietary protein and increased supplemental threonine in comparison to feeding a positive control to market turkeys during two age periods (0-4 weeks and 10-14 weeks of age).
5) Using information from Objective 1, determine if performance of the negative control diet can be improved with supplementation with tryptophan, valine, arginine, or a combination of amino acids.
6) Conduct an economic analysis utilizing the performance data achieved in Objectives 1 and 2.

Description of work performed – Objective 1 (Experiments 1A and 1B).

For the first objective, it was important to establish the degree of crude protein reduction possible while using the supplemental amino acids of lysine, methionine, and threonine. Two basal diets were studied, one with DDGs inclusion and one without. The base dietary components included corn, soybean meal and animal byproduct meal. Two age periods (0 to 4 and 10 to 14 weeks) were chosen for examination as the portion of corn would be increased during the 10 to 14 week period and more likely to place more pressure on the amino acid balance as compared to the 0 to 4 diet.

Turkey poults (Large White Hybrid strain, hens) were obtained from a Minnesota hatchery, weighed and randomly allocated to 48 pens at the UMore Park Turkey Research Unit, Rosemount, MN after wing banding for identification purposes. Standard operating procedures were used to rear the turkeys. There were two experimental phases of 0 to 4 and 10 to 14 weeks of age. Between 4 and 10 weeks of age, turkeys were fed a common feed appropriate for their age. At 10 weeks of age the turkeys were weighed and re-randomized to 48 pens on the basis of body weight such that the average body weight per pen of turkeys was similar.

During the experimental phases, turkeys were weighed individually at the start and finish of each phase. Feed intake was measured for each 4-week period. Records of removals (culls and mortality) and other bird observations were kept during each phase. From the collected data, treatment performance was assessed based on body weight, average daily gain, average daily feed intake, feed efficiency, and removals (culls plus mortality).

Diets were formulated on a digestible amino acid basis. The positive control diet was formulated to meet the digestible threonine (dthr) requirement with intact diet protein. The level of dthr from intact protein was reduced from the positive control by increasing supplemental thr at 0, .05, .10 and .15%. The dietary content of dthr was the same for all diets. Potassium carbonate was added to the 10-14 week diets to meet the estimated potassium requirement. Diets were formulated for each of the two basal diet series – a corn-soybean meal based diet and the same diet with 20% DDGS included. Diets were analyzed for nutrient content. Example diets are provided in Table 1 for the 0-4 and 10-14 week experimental feeding periods. On a calculated basis, arginine and valine appeared more limiting in the DDGS diets with .1 and .15% supplemental threonine. Tryptophan only appeared limiting in diets with .15% supplemental thr. All diets were fed as mash and were supplemented with phytase (500 FTU/kg), coccidiostat and growth promoting antibiotic.

The experimental diets were:

1. Positive control, corn-soy diet series, no supplemental thr
2. Reduced protein, corn-soy diet series, .05% supplemental thr
3. Reduced protein, corn-soy diet series, .10% supplemental thr
4. Reduced protein, corn-soy diet series, .15% supplemental thr
5. Positive control, corn-soy-DDGS diet series, no supplemental thr
6. Reduced protein, corn-soy-DDGS diet series, .05% supplemental thr
7. Reduced protein, corn-soy-DDGS diet series, .10% supplemental thr
8. Reduced protein, corn-soy-DDGS diet series, .15% supplemental thr

Table 1. Composition of selected diet series for Experiments 1A and 1B with reduced protein									
Age Period (wks)	0 to 4 wks					10 to 14 wks			
Diet Series	Corn/soy		Corn/soy/DDGS			Corn/soy		Corn/soy/DDGS	
Protein Level	Control	Reduced	Control	Reduced		Control	Reduced	Control	Reduced
Treatment ID	Trt 1	Trt 4	Trt 5	Trt 8		Trt 1	Trt 4	Trt 5	Trt 8
	------%------								
Ingredients									
Corn	37.41	50.12	23.97	36.68		59.99	71.88	46.69	58.73
Soybean meal, 46%	49.87	38.52	42.37	31.02		28.78	17.63	21.17	10.00
Poultry Byproduct Meal	5.0	5.0	5.0	5.0		3.0	3.0	3.0	3.0
Distillers Dried Grains w/sol	0.0	0.0	20.0	20.0		0.0	0.0	20.0	20.0
Dicalcium phosphate	1.723	1.802	1.353	1.431		0.504	0.584	0.134	0.213
Calcium carbonate	1.354	1.398	1.618	1.661		1.014	1.055	1.278	1.320
Salt	0.242	0.127	0.160	0.044		0.259	0.143	0.178	0.062
Sodium Sesquicarbonate	0.180	0.336	0.252	0.407		0.139	0.295	0.209	0.365
Potassium Carbonate	0.000	0.000	0.000	0.000		0.004	0.349	0.000	0.265
L-Lysine · HCL	0.173	0.514	0.289	0.630		0.172	0.516	0.282	0.627
DL-Methionine	0.315	0.407	0.280	0.372		0.220	0.318	0.179	0.278
Threonine	0.000	0.150	0.000	0.150		0.0	0.150	0.0	0.150
Choice White Grease	3.15	1.05	4.14	2.03		5.59	3.76	6.55	4.66
Vitamins/minerals	+++	+++	+++	+++		+++	+++	+++	+++
Phytase, coccidostat, AGP	+++	+++	+++	+++		+++	+++	+++	+++
Calculated composition									
Protein (%)	29.0	25.1	29.9	26.0		19.7	15.8	20.5	16.7
Metabolizable energy (kcal/kg)	2900	2900	2900	2900		3275	3275	3275	3275
Digestible									
Met + Cys (%)	1.050	1.050	1.050	1.050		0.730	0.730	0.730	0.730
Lysine (%)	1.640	1.640	1.640	1.640		1.060	1.060	1.060	1.060
Arginine (%)	1.878	1.563	1.801	1.486		1.186	0.867	1.114	0.795
Tryptophan (%)	0.317	0.260	0.304	0.247		0.203	0.146	0.189	0.133
Valine (%)	1.191	1.011	1.222	1.043		0.798	0.616	0.832	0.650
Threonine (%)	0.950	0.950	0.950	0.950		0.636	0.636	0.636	0.636
Isoleucine (%)	1.114	0.933	1.114	0.932		0.717	0.532	0.720	0.535

The experimental design was a completely randomized block design. There were 8 dietary treatments per phase and each treatment was fed to 8 replicate pens. For purposes of the statistical model, factors of dietary crude protein (dthr) (4 levels) and two diet series (with and without DDGS) along with their interaction were included. Treatment effect was assessed by statistical analyses (analyses of variance) and where significant, treatment means were separated by Least Significant Difference (LSD). The probability of significance was $P<.05$. Trends were indicated if P was less than $P<.10$.

A summary of the results is presented in Table 2 for the 0-4 week study (Experiment 1A). Gain, feed intake and feed efficiency of hen poults as affected by diet series was modified by level of dthr from intact diet protein, that is, a significant interaction existed for diet series and supplemental threonine level. Treatment 1, while included in the statistical analyses, is not considered in the discussion because a low level of dietary sodium was found by diet analyses and is probably responsible for the poorer growth. Overall, turkeys fed diets with 20% DDGS had better gain and similar feed efficiency as compared to turkeys fed the diets without DDGS. The increase in supplemental threonine reduced the amount of digestible threonine from intact protein resulting in diets with decreased protein level. The reduced dietary protein content in the corn-soy series only affected feed conversion and not gains. The poorer feed conversion with reduced protein was due to the increase in feed intake without an increase in gain. In the diets with DDGS, gain decreased with reduced dietary protein as the level of supplemental threonine increased. In contrast to the corn-soy diet series, feed intake also decreased with the decrease in dietary protein for the DDGS diets. This response resulted in no detectable difference in feed efficiency as gain and feed intake decreased together.

The difference in response for the two diet series may be indicative of either the level or type of amino acid(s) that are becoming limiting as dietary protein is decreased. A slight deficiency of an amino acid may cause an increase in feed intake as occurred with the corn-soy diet series with dietary protein reduction. In the DDGs diets, the severity of deficiency may be greater causing the turkeys to decrease feed intake. Regardless, performance of turkey poults fed diets with DDGS were more sensitive to the reduction in dietary protein caused by the substitution of supplemental threonine for dthr from intact protein sources as compared to the corn-soy diet series.

Results for the 10 to 14 week experimental period are presented in Table 2 (Experiment 1B). In contrast to the 0-4 week period, turkeys fed the diet series with and without 20% overall were similar in performance. Only dthr reduction from intact protein (reduced dietary protein) affected turkey performance. Performance in terms of reduced gain and poorer feed efficiency was observed with .1 and .15% supplemental threonine.

Table 2. Turkey hen performance and reduction of diet protein with different diet series (Experiments 1A and 1B)

Trt #	Treatment Description	Age period (wks)	0-4 wks Gain	0-4 wks Feed Intake	0-4 wks Feed Efficiency	10-14 wks Gain	10-14 wks Feed Intake	10-14 wks Feed Efficiency
			--- g/day ---	--- g/day ---	F/G	--- g/day ---	--- g/day ---	F/G
	Diet Series	**Supp. threonine (%)**						
1	Corn-Soy	0	---[1]	---	---	143.6	418.1	2.92
2	Corn-Soy	0.05	28.5[d]	41.9[de]	1.48[c]	143.8	410.1	2.86
3	Corn-Soy	0.1	28.7[d]	43.1[cd]	1.50[bc]	137.8	404.7	2.94
4	Corn-Soy	0.15	28.8[cd]	44.7[bc]	1.55[ab]	139.3	410.4	2.95
5	Corn-Soy-DDGs	0	32.5[a]	48.6[a]	1.49[c]	144.9	419.6	2.86
6	Corn-Soy-DDGs	0.05	30.3[bc]	45.2[b]	1.50[c]	142.0	418.2	2.95
7	Corn-Soy-DDGs	0.1	30.9[b]	45.5[b]	1.48[c]	140.1	414.5	2.94
8	Corn-Soy-DDGs	0.15	30.0[bcd]	44.5[bc]	1.49[c]	133.8	407.2	3.05
Main effect means								
	Diet Series [2]							
	Corn-Soy		28.7[b]	43.2[b]	1.51	141.1	410.8	2.92
	Corn-Soy-DDGs		30.4[a]	45.1[a]	1.49	140.2	414.9	2.95
	Supp. threonine Level (%) [2]							
	0		---	---	---	144.2[a]	418.8	2.89[b]
	0.05		29.4	43.6	1.49	142.9[a]	414.1	2.90[b]
	0.1		29.8	44.3	1.49	139.0[b]	409.6	2.94[ab]
	0.15		29.4	44.6	1.52	136.6[b]	408.8	3.00[a]
Probability								
	--- Diet		0.0001	0.0001	0.0045	NS	NS	NS
	--- Level		NS	NS	0.0254	0.0011	NS	0.0373
	--- Diet x Level		0.0001	0.0001	0.0326	NS	NS	NS

[1] Treatment 1 diet composition did not meet expected nutrient content; data omitted

[2] For Experiment 1A, Treatments 1 and 5 were deleted and contrast testing completed to determine the main effect of diet series and threonine level

[a, b, c, d, e] Means with different superscripts for treatment or main effects are significantly different (P<.05)

<u>Description of work performed – Objective 2 (Experiments 2A and 2B).</u>

Results from Objective 1 were used to design the positive and negative control diets for Objective 2 diets containing 20% DDGS. The positive control (PC) was selected as a diet with some excess of crude protein and amino acids such that growth is not limited. The two negative control diets would represent a slight (NC1) and moderate (NC2) decrease in crude protein and amino acids that would limit growth and/or feed conversion of market turkeys. Supplemental amino acids were added in various combinations to the moderate negative control diet to test their ability to achieve performance similar to the PC and/or NC1 diets.

Similar to Objective 1, two age periods (0 to 4 and 10 to 14 weeks) were chosen for examination as the portion of corn would be increased during the 10 to 14 week period and more likely to place more pressure on the amino acid balance as compared to the 0 to 4 diet.

Turkey poults (Large White Hybrid strain, hens) were obtained from a Minnesota hatchery, weighed and randomly allocated to 48 pens at the UMore Park Turkey Research Unit, Rosemount, MN after wing banding for identification purposes. Standard operating procedures were used to rear the turkeys. There were two experimental phases of 0 to 4 and 10 to 14 weeks of age. Between 4 and 10 weeks of age, turkeys were fed a common feed appropriate for their age. At 10 weeks of age the turkeys were weighed and re-randomized to 48 pens on the basis of body weight such that the average body weight per pen of turkeys was similar.

During the experimental phases, turkeys were weighed individually at the start and finish of each phase. Feed intake was measured for each 4-week period. Records of removals (culls and mortality) and other bird observations were kept during each phase. From the collected data, treatment performance was assessed based on body weight, average daily gain, average daily feed intake, feed efficiency, and removals (culls plus mortality).

Diets were formulated on a digestible amino acid basis and contained 20% DDGS. Similar to Objective 1 trials, diets were formulated to meet specific levels of digestible lys, met + cys, thr with a reduction in protein level. Potassium carbonate was added to the 10 to 14 week diets to meet the estimated potassium requirement. Valine, tryptophan, and arginine were supplemented to increase those levels in NC2 diets to the recommended requirement for those amino acids. Diets were analyzed for nutrient content.   Example diets are provided in Table 3. During the 0 to 4 week period, the NC1 and NC2 diets contained .06 and .12% supplemental thr. For the 10 to 14 week experimental period, the NC1 and NC2 diets contained .075 and .15% supplemental thr. All diets contained the same overall level of dthr. All diets were fed as mash and were supplemented with phytase (500 FTU/kg), a coccidiostat and a growth promoting antibiotic.

The dietary treatments were:

1. Positive Control (PC)
2. Negative Control #1 (NC1)
3. Negative Control #2 (NC2)
4. As Treatment 3 plus valine (V)
5. As Treatment 3 plus tryptophan (T)
6. As Treatment 3 plus arginine (A)
7. As Treatment 3 plus V, T
8. As Treatment 3 plus V, A
9. As Treatment 3 plus A, T
10. As Treatment 3 plus V, T, A

Table 3. Composition of selected diets containing DDGS for Experiments 2A and 2B with reduced protein

Age Period (wks)	0 to 4 wks				10 to 14 wks			
Protein Level	Control	Reduced	Reduced		Control	Reduced	Reduced	
Treatment ID	PC	NC1	NC2		PC	NC1	NC2	
	--%-------------------------------------							
Ingredients								
Corn	23.79	28.87	33.96		46.62	52.72	58.66	
Soybean meal, 46%	43.67	39.13	34.59		21.17	15.57	10.00	
Poultry Byproduct Meal	5.00	5.00	5.00		3.00	3.00	3.00	
Distillers Dried Grains w/sol	20.00	20.00	20.00		20.00	20.00	20.00	
Dicalcium phosphate	0.910	0.941	0.973		0.134	0.173	0.213	
Calcium carbonate	1.311	1.328	1.346		1.278	1.299	1.320	
Salt	0.169	0.123	0.077		0.178	0.120	0.062	
Sodium Sesquicarbonate	0.180	0.242	0.304		0.209	0.287	0.365	
Potassium Carbonate	0.000	0.000	0.000		0.000	0.093	0.265	
L-Lysine · HCL	0.259	0.395	0.532		0.282	0.455	0.627	
DL-Methionine	0.286	0.323	0.360		0.179	0.228	0.278	
Threonine	0.000	0.060	0.120		0.0	0.075	0.150	
Choice White Grease	3.83	2.99	2.15		6.55	5.58	4.66	
Vitamin/Mineral	+++	+++	+++		+++	+++	+++	
Phytase, coccidostat, AGP	+++	+++	+++		+++	+++	+++	
Calculated Composition								
Protein (%)	30.5	28.9	27.4		20.5	18.60	16.7	
Metabolizable energy (kcal/kg)	2900	2900	2900		3275	3275	3275	
Digestible								
Met + Cys (%)	1.070	1.070	1.070		0.730	0.730	0.730	
Lysine (%)	1.650	1.650	1.650		1.060	1.060	1.060	
Arginine (%)	1.842	1.716	1.590		1.114	0.954	0.795	
Tryptophan (%)	0.312	0.289	0.266		0.189	0.161	0.133	
Valine (%)	1.247	1.175	1.103		0.832	0.741	0.650	
Threonine (%)	0.970	0.970	0.970		0.636	0.636	0.636	
Isoleucine (%)	1.138	1.065	0.992		0.720	0.627	0.535	

The experimental design was a completely randomized block design. There were 10 dietary treatments per phase and each treatment was fed to 8 replicate pens. For purposes of the statistical model, the main factor was dietary treatment. Treatment effect was assessed by statistical analyses (analyses of variance) and where significant, treatment means were separated by Least Significant Difference (LSD). The probability of significance was $P<.05$. Trends were indicated if P was less than $P<.10$.

A summary of the results is presented in Table 4 for the 0 to 4 week experimental period (Experiment 2A). Only gain was affected by dietary treatment ($P<.06$). As expected gain was reduced for turkeys fed the NC1 diet as compared to PC but no difference existed between NC1 and NC2. Supplementation of NC2 with arginine and tryptophan produced gain that was intermediate to the PC and NC1 diets. As gain was not improved with supplementation of arginine or tryptophan alone, the response would indicate that both arginine and tryptophan are co-limiting in turkey poult starter diets with 20% DDGS. For the 10-14 week feeding period (Table 4, Experiment 2B), dietary treatment affected gain, feed intake and feed efficiency. Gain was decreased for turkeys fed the NC1 and NC2 diets in comparison to the PC with no difference between NC1 and NC2. Feed efficiency increased or became poorer with the reduction in dietary protein. Supplementation with all three amino acids (valine, tryptophan, arginine) was needed to show some improvement in gain that was intermediate to NC1 and PC. Feed conversion tended to be improved to a level intermediate to NC1 and NC2 for the amino acid supplemented diets (Treatments 4 through 10) with the exception of valine alone.

Table 4. Turkey hen performance and amino supplementation of a reduced protein diet containing 20% DDGS (Experiments 2A and 2B)												
	Age Period (wks)	0-4 wks					10 to 14 wks					
		Gain		ca Intake		Feed Efficiency	Gain		Feed Intake		Feed Efficiency	
		--- g/day ---		--- g/day ---		-- F/G --	--- g/day ---		--- g/day ---		-- F/G --	
Trt #	**Dietary Treatment**											
1	Positive Control (PC)	34.8	a	52.8		1.52	132.1	a	378.6	ab	2.87	c
2	Negative Control (NC1)	33.8	b	51.6		1.53	127.3	bc	378.1	ab	2.97	b
3	Negative Control (NC2)	33.4	b	51.5		1.54	125.0	bcd	382.7	ab	3.06	a
4	NC2 + Valine (V)	33.5	b	51.8		1.55	123.7	cd	377.5	ab	3.05	a
5	NC2 + Tryptophan (T)	33.4	b	51.7		1.55	125.3	bcd	376.0	b	3.00	ab
6	NC2 + Arginine (A)	33.6	b	52.0		1.55	124.0	bcd	377.7	ab	3.05	ab
7	NC2 + V,T	33.4	b	51.7		1.55	122.5	bcd	368.0	c	3.01	ab
8	NC2 + V,A	33.3	b	51.7		1.55	126.4	bcd	379.9	ab	3.01	ab
9	NC2 + A.T	34.1	ab	53.3		1.56	125.0	bcd	375.6	bc	3.01	ab
10	NC2 + V,T,A	33.4	b	51.2		1.53	128.2	ab	385.2	a	3.00	ab
Probabiity												
	Treatment	0.0571		NS		NS	0.0052		0.0086		0.0005	

[a, b, c, d] Column means with different superscripts for treatment are significantly different (P<.05)

The results indicated that in diets with 20% DDGS, arginine and tryptophan were co-limiting in poult starter diets while in grower diets, valine may have been limiting as well, along with tryptophan and arginine. Unfortunately, the results were not clearly definitive in that turkey performance was not completely restored to the level of the PC. With arginine appearing to be limiting, this will hinder the use of supplemental valine and tryptophan as arginine is not commercially available and its cost would be prohibitive.

Description of work performed – Objective 3.

To evaluate the diet cost with protein reduction and diet series, feed costs were calculated using National Weekly Feedstuff Wholesale prices (USDA Market News, www.ams.usda.gov/mnreports/ms_gr852.txt) for July 15, 2014 and July 16, 2013 to represent low and higher feed cost of the major feed ingredients, respectively. As turkeys were only fed diets for a portion of the production cycle, diet costs were compared on a per ton basis as well as per unit of gain based on feed efficiency (i.e., feed cost per lb of gain) for each experiment. Respective low (2014) and high (2013) costs ($) per lb of corn was .0654 and .1161; for soybean meal, .211 and .27; and, for DDGs, .0563 and .1113. All other ingredients had the same cost for both 2013 and 2014 analyses. In comparing costs, the most valid comparison will be where performance (gain) was equivalent to the positive control diet.

In Experiment 1A and 1B (Table 5), reductions in dietary protein and/or use of DDGS decreased feed cost per ton of diet. For the 0-4 week feeding period, gain was optimal for the positive control diet with DDGS (Treatment 5) and greater than the corn-soy diets (Treatments 2, 3, and 4). All of these treatments had a similar feed cost per unit of gain (32 to 33 cents/lb). During the 10-14 week period, where gain was equivalent (i.e. Treatment 1 vs Treatment 5), cost savings were realized with the use of DDGS ranging from 2 to 4 cents per lb of gain during that feeding period during 2014 or 1 to 5 cents per lb of gain during 2013.

Table 5. Comparison of feed cost and cost per unit of gain as affected by diet series and dietary protein reduction (Experiments 1A and 1B)

	Experiment 1A 0 to 4 wks								Experiment 1B 10 to 14 wks								
2013 Ingredient Pricing									2013 Ingredient Pricing								
Diet Series	Corn/soy				Corn/Soy/DDGS				Diet Series	Corn/soy				Corn/Soy/DDGS			
Treatment ID	Trt 1	Trt 2	Trt 3	Trt 4	Trt 5	Trt 6	Trt 7	Trt 8	Treatment ID	Trt 1	Trt 2	Trt 3	Trt 4	Trt 5	Trt 6	Trt 7	Trt 8
Feed cost ($/ton)	450.6	439.5	428.3	417.1	427.6	416.5	405.3	394.1	Feed cost ($/ton)	374.4	363.7	352.9	342.2	350.8	339.9	329.2	318.4
	---------- Feed Cost per Unit Gain ----------								---------- Feed Cost per Unit Gain ----------								
Feed efficiency	1.58	1.48	1.50	1.55	1.49	1.47	1.48	1.49	Feed efficiency	2.92	2.86	2.94	2.95	2.86	2.91	2.94	3.05
Feed Cost ($/lb gain)	0.36	0.33	0.32	0.32	0.32	0.31	0.30	0.29	Feed Cost ($/lb gain)	0.55	0.52	0.52	0.50	0.50	0.49	0.48	0.49
2014 Ingredient Pricing									2014 Ingredient Pricing								
Diet Series	Corn/soy				Corn/Soy/DDGS				Diet Series	Corn/soy				Corn/Soy/DDGS			
Treatment ID	Trt 1	Trt 2	Trt 3	Trt 4	Trt 5	Trt 6	Trt 7	Trt 8	Treatment ID	Trt 1	Trt 2	Trt 3	Trt 4	Trt 5	Trt 6	Trt 7	Trt 8
Feed cost ($/ton)	354.8	343.8	332.8	321.7	332.2	321.2	310.2	299.2	Feed cost ($/ton)	280.3	269.9	259.5	249.1	257.1	246.4	236.0	225.6
	---------- Feed Cost per Unit Gain ----------								---------- Feed Cost per Unit Gain ----------								
Feed efficiency	1.58	1.48	1.50	1.55	1.49	1.47	1.48	1.49	Feed efficiency	2.92	2.86	2.94	2.95	2.86	2.91	2.94	3.05
Feed Cost ($/lb gain)	0.28	0.25	0.25	0.25	0.25	0.24	0.23	0.22	Feed Cost ($/lb gain)	0.41	0.39	0.38	0.37	0.37	0.36	0.35	0.34

In Experiment 2A and 2B (Table 6), reducing dietary protein (PC vs NC1, and NC2), also reduced feed cost per ton of feed. Reductions were also noted per unit of gain for NC1 and NC2 diets relative to PC.

However, here, gain was not equivalent to the PC. Depending on the production system, especially where a targeted weight is desired at a certain age, feeding the lowered protein diet would not be desirable. However, if the lower rate of gain is not a constraint, lowered protein diets maybe economical.

Table 6. Comparison of feed cost and cost per unit of gain as affected by dietary protein reduction in diets with DDGS (Experiments 2A and 2B)

	Experiment 2A 0 to 4 wks				Experiment 2B 10 to 14 wks		
2013 Ingredient Pricing				2013 Ingredient Pricing			
Treatment ID	PC	NC1	NC2	Treatment ID	PC	NC1	NC2
Feed cost ($/ton)	429.0	415.6	402.1	Feed cost ($/ton)	350.7	334.4	318.2
	--- Feed Cost per Unit Gain -------------------- --			--- Feed Cost per Unit Gain ------------------------- -------------------------------------			
Feed efficiency	1.52	1.53	1.54	Feed efficiency	2.87	2.97	3.06
Feed Cost ($/lb gain)	0.33	0.32	0.31	Feed Cost ($/lb gain)	0.50	0.50	0.49
2014 Ingredient Pricing				2014 Ingredient Pricing			
Treatment ID	PC	NC1	NC2	Treatment ID	PC	NC1	NC2
Feed cost ($/ton)	332.2	319.0	305.8	Feed cost ($/ton)	256.7	240.7	224.1
	------------ Feed Cost per Unit Gain -------- --			--- Feed Cost per Unit Gain ------------------------- -------------------------------------			
Feed efficiency	1.52	1.53	1.54	Feed efficiency	2.87	2.97	3.06
Feed Cost ($/lb gain)	0.25	0.24	0.24	Feed Cost ($/lb gain)	0.37	0.36	0.34

Conclusions

The amino acids arginine and tryptophan were found to be co-limiting in poult starter diets with 20% DDGS. In grower type diets with 20% DDGS, valine appears to be limiting along with arginine and tryptophan. Utilization of commercially available supplemental valine and tryptophan in diets high in corn protein is limited by a lack of a commercially available arginine and potentially isoleucine. Dried distillers grains with solubles was found to decrease diet cost per ton of feed and to decrease cost per unit of gain in grower hen turkeys under the different cost scenarios explored in this report.

Future Research Needs

While the research was not able to restore turkey performance to the level of the positive control with supplementation of tryptophan, valine and arginine to turkey diets containing high levels of DDGS, there is sufficient information to indicate that more research is needed to tease out some of the finer points of the inter-relationships of these amino acids with that of the requirement for the turkey. While this study emphasized valine and tryptophan supplementation, isoleucine could also be potentially limiting in reduced protein diets. This research may take the form of looking at different levels of amino acids (the reported studies here only looked at one level) and different levels of corn protein. This would be valuable information in the future, if and when, a commercial source of arginine can be produced that could be economically used for supplementation.