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Ideal Protein Based Diets for Turkeys

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Abstract: Ideal protein as a concept has been around for a number of years. The data necessary to formulate an ideal protein based diet include amino acid digestibility of major feedstuffs, a working estimate of an ideal protein for turkeys, a workable low protein diet for determining amino acid requirements via titration and requirement data for the limiting amino acids. Previous research in our lab has collected data on all of these areas leading to an estimate of the ideal protein for turkeys (Missouri Ideal Turkey Protein). The objective of this work is to test the collected data in turkeys to market age and determine if the estimated ideal protein is accurate and if cost savings would result. An experiment was conducted with 800 Nicholas toms in a floor pen setting. Birds were placed in a curtain-sided building with circulating fans on used litter. Toms were moved from brooder to finisher at 8 weeks of age and processed at the conclusion of the trial for parts yield. Eight replicate pens of 25 toms per pen were used for a total of 32 pens. Birds were weighed at 3 week intervals. All diets were computer formulated using an industry provided premix and readily available feedstuffs that are commonly used throughout the industry. The control diets were industry average diets based on Agristats information. These diets were formulated on a total amino acid basis as per their data. The other diets were formulated on a digestible amino acid basis using constraints based on our research. All digestibility values were obtained using cecectomized hens with gavage feeding and total fecal collection. Treatments consisted of the following: 1) Control, 2) Exact requirements on a digestible Amino Acid (AA) basis with no safety factor (Ideal), 3) Ideal + 5% AA safety factor (recommended diet), 4) Ideal + 10%. Performance of the ideal protein diet was slightly reduced at 3 wks of age. The addition of 5 or 10% amino acids brought growth back to even with the industry diet at that time. No differences in performance were noted through 15 weeks. At 18 weeks the ideal protein diet was significantly lighter in weight (4.8%) than the industry diet while the diets with 5 or 10% AA additions did not differ from the control. Small differences in feed efficiency occurred through different phases of the trial, but there were no differences at the conclusion of the trial. No differences in mortality or parts yield were noted. Significant cost reductions were found in diets formulated based on the Missouri Ideal Turkey Protein.

Key words: Turkey, ideal protein, amino acids, cost savings

INTRODUCTION

Cost reduction is an imperative for the poultry industry. Feed costs are a significant portion of the total cost structure. Most of the cost containment measures such as use of alternative ingredients and computer diet formulation are already in use. Maximum growth is relatively easy to achieve through overfeeding of nutrients. It is not, however, a cost effective strategy and somewhat negates all of the research on nutrient requirements. Nutrients that are of significant cost to the poultry industry include energy, phosphorus and protein/amino acids and the provision of these can cost over 90% of total diet costs. This is not to say that other nutrients lack significance, but merely to look at areas of concentration. Previous work in our lab has looked at digestibility of amino acids in a variety of feedstuffs for turkeys, development of low protein and ideal protein diets for the starter period, digestible requirements for lysine, Total Sulfur Amino Acid (TSAA), threonine and valine in the starter period and digestible lysine, TSAA, and threonine throughout the growth cycle (Firman, 1992; Firman and Remus, 1993; 1994; Firman, 1994a; 1994b; Rivas and Firman, 1994; Boling and Firman, 1997a; 1997b; 1997c; Firman and Boling, 1998; Boling and Firman, 1998; Kamyab and Firman,1999; 2000; Lamberson and Firman, 2002; Baker *et al*., 2003a; 2003b; Moore *et al*., 2003; 2004; Brown *et al*., 2005; Robbins and Firman, 2005; Thompson *et al*., 2005).

These accumulated data have been used to develop the diets used in this study. This experiment was undertaken to determine if diets formulated based on the Missouri Ideal Turkey Protein would provide similar growth at lower cost than the industry standard diets.

MATERIALS AND METHODS

An experiment was conducted with 800 Nicholas toms in a floor pen setting. Birds were placed in a curtain-sided building with circulating fans on used litter. Toms

were moved from brooder to finisher at 8 weeks of age and processed at the conclusion of the trial for parts yield. Eight replicate pens of 25 toms per pen were used for a total of 32 pens. Birds were weighed at 3 week intervals which may affect growth rate somewhat. All husbandry would be considered standard and followed our Standard Operating Procedures and was approved by our institutional Animal Care and Use Committee.

All diets were computer formulated using an industry provided premix and readily available feedstuffs that are commonly used throughout the industry. The control diets were industry average diets based on Agristats information. These diets were formulated on a total amino acid basis as per their data. The other diets were formulated on a digestible amino acid basis using constraints based on our research with the Missouri Ideal Protein. All digestibility values used for diet formulation were obtained using cecectomized hens with gavage feeding and total fecal collection.

Treatments consisted of the following:

Control: Total amino acids (AA) basis

Exact requirements based on digestible AA with no safety factor (Ideal)

Ideal + 5% AA safety factor (recommended diet)

Ideal +10% AA safety factor

Formulation of the control diet was done on a total AA basis. The constraints placed on nutrients were minimums (Table 1) and in some cases the actual levels were slightly higher (Tables 2-7). Please also note that crude protein was constrained in the control diets based on industry use levels. In the ideal based diets, protein was constrained based on the valine requirement. Energy values were allowed to float somewhat as restricting energy would result in higher costs. Overall the diets were formulated with the intention of providing maximal performance at the best cost.

RESULTS AND DISCUSSION

Performance of the turkeys is shown in Tables 8 and 9. Performance of the ideal protein diet was slightly reduced at 3 wks of age. The addition of 5 or 10% amino acids brought growth back to even with the industry diet at that time. No differences in performance were noted through 15 weeks. At 18 weeks the ideal protein diet was significantly lighter in weight (4.8%) than the

Table 1: Amino acid constraints on control and ideal protein based diets

0-3 weeks	Control (total*)	Ideal (digest)	Ideal + 5%	Ideal + 10%
Lysine	1.76	1.45	1.53	1.60
Meth + Cys	1.20	0.84	0.88	0.92
Threonine	1.00	0.80	0.84	0.88
Valine	CP constrained**	1.08	1.13	1.19
3-6 weeks	Control (total)	Ideal (digest)	Ideal + 5%	Ideal + 10%
Lysine	1.68	1.28	1.35	1.41
Meth + Cys	1.17	0.77	0.81	0.84
Threonine	CP constrained	0.71	0.75	0.78
Valine	CP constrained	0.98	1.03	1.08
6-9 weeks	Control (total)	Ideal (digest)	Ideal + 5%	Ideal + 10%
Lysine	1.48	1.10	1.16	1.21
Meth + Cys	1.05	0.67	0.70	0.74
Threonine	CP constrained	0.62	0.65	0.68
Valine	CP constrained	0.86	0.90	0.95
9-12 weeks	Control (total)	Ideal (digest)	Ideal + 5%	Ideal + 10%
Lysine	1.30	0.93	0.98	1.02
Meth + Cys	0.95	0.59	0.62	0.65
Threonine	CP constrained	0.53	0.56	0.58
Valine	CP constrained	0.75	0.79	0.83
12-15 weeks	Control (total)	Ideal (digest)	Ideal + 5%	Ideal + 10%
Lysine	1.15	0.76	0.80	0.84
Meth + Cys	0.90	0.50	0.53	0.55
Threonine	CP constrained	0.44	0.46	0.49
Valine	CP constrained	0.64	0.67	0.71
15-18 weeks	Control (total)	Ideal (digest)	Ideal + 5%	Ideal + 10%
Lysine	0.92	0.58	0.61	0.64
Meth + Cys	0.72	0.42	0.44	0.46
Threonine	CP constrained	0.35	0.37	0.39
Valine	CP constrained	0.53	0.56	0.58

*Control treatment diets are formulated on a total amino acid basis, while other diets are formulated on a digestible amino acid basis

**CP constrained: no valine requirement was used and the valine level was set by the constraint on Crude Protein (CP)

Table 2: Diets 0-3 weeks of age (as percentage unless otherwise noted)

		0-3 wks of age		
Ingredients	Industry Std	Ideal	Ideal + 5%	Ideal + 10%
Corn	42.521	46.412	46.851	43.757
Soybean meal	42.605	37.308	39.185	40.133
Pork meal	10.5	13.11	10.5	12.953
Lard	2	2	2	2
Dicalcium phosphate	0.806		0.298	
Sodium bicarbonate	0.2	0.2	0.2	0.2
Limestone	0.161			
Salt (iodized)	0.3	0.3	0.25	0.3
Trace mineral premix	0.1	0.1	0.1	0.1
Vitamin premix	0.075	0.075	0.075	0.075
Selenium premix	0.06	0.06	0.06	0.06
Choline chloride	0.07	0.083	0.083	0.057
Copper sulfate	0.013	0.013	0.013	0.013
Avatek	0.05	0.05	0.05	0.05
BMD-50	0.05	0.05	0.05	0.05
L-lysine HCL	0.133	0.067	0.108	0.052
DL methionine	0.356	0.173	0.177	0.2
Calculated analysis				
Crude protein	29.2364	28.1196	27.7342	30.6555
ME (kcal/kg)	3000	3031.512	3043.544	2995.537
Calcium	1.5	1.5	1.3078	1.5
Phosphorous, available	0.7	0.6436	0.6	0.6
Lysine	1.76	1.45	1.53	1.6
Sulphur amino acids	1.2	0.84	0.88	0.92
Threonine	1.0551	0.8302	0.8604	0.9106
Valine	1.4428	1.08	1.13	1.19
Arginine	2.0466	1.7937	1.8252	1.9796
Histidine	0.7567	0.6146	0.6397	0.677
Isoleucine	1.2034	0.9362	0.9766	1.0444
Leucine	2.2582	1.8888	1.953	2.0348
Aromatic amino acids	2.2482	1.8976	1.955	2.0956
Tryptophan	0.2925	0.2401	0.2509	0.2708
Cost/ton	$196.87	$184.44	$186.23	$193.53

treatment was Ideal + 10%. Thirty-two pens of 25 tom poults were fed for 18 weeks in a curtain-sided two stage building. Body weight, feed:gain and mortality were recorded. All standard husbandry practices were followed

Table 3: Diets 3-6 weeks of age (as percentage unless otherwise noted)

		3-6 wks of age		
Ingredients	Industry Std	Ideal	Ideal + 5%	Ideal + 10%
Corn	42.507	52.741	49.88	47.044
Soybean meal	43.212	33.895	36.828	39.757
Pork meal	10	10.274	10.203	10.132
Lard	2	2	2	2
Dicalcium phosphate	0.693			
Sodium bicarbonate	0.2	0.2	0.2	0.2
Limestone	0.361			
Salt (iodized)	0.3	0.3	0.3	0.3
Trace mineral premix	0.1	0.1	0.1	0.1
Vitamin premix	0.075	0.075	0.075	0.075
Selenium premix	0.06	0.06	0.06	0.06
Choline chloride	0.03	0.066	0.054	0.042
Copper sulfate	0.013	0.013	0.013	0.013
Avatek	0.05	0.05	0.05	0.05
BMD-50	0.05	0.05	0.05	0.05
L-lysine HCL	0.027	0.03	0.026	0.0086
DL methionine	0.323	0.145	0.162	0.168
Calculated analysis				
Crude protein	29.1477	25.4449	26.6031	27.7417
ME (kcal/kg)	3000	3086.284	3069.948	3053.526
Calcium	1.5	1.2	1.2	1.2
Phosphorous, available	0.66	0.5277	0.529	0.5304

Table 3 Contd.

		3-6 wks of age		
Ingredients	Industry Std	Ideal	Ideal + 5%	Ideal + 10%
Lysine	1.68	1.3331	1.35	1.41
Sulphur amino acids	1.17	0.77	0.81	0.84
Threonine	1.0583	0.7582	0.7947	0.8312
Valine	1.4466	0.98	1.03	1.08
Arginine	2.0495	1.6125	1.697	1.7815
Histidine	0.7599	0.5652	0.5935	0.6218
Isoleucine	1.2098	0.8528	0.902	0.9512
Leucine	2.2655	1.7682	1.8345	1.901
Aromatic amino acids	2.2592	1.7435	1.8334	1.9234
Tryptophan	0.2946	0.2189	0.2329	0.2468
	$193.59	$175.32	$179.59	$183.34

Table 4: Diets 6-9 weeks of age (as percentage unless otherwise noted)

		6-9 wks of age		
Ingredients	Industry Std	Ideal	Ideal + 5%	Ideal + 10%
Corn	53.8	58.906	56.614	53.828
Soybean meal	31.4	28.633	30.979	33.9
Pork meal	10	8.458	8.401	8.332
Lard	3	3	2	3
Dicalcium phosphate	0.456			
Sodium bicarbonate	0.2	0.2	0.2	0.2
Limestone				
Salt (iodized)	0.25	0.3	0.3	0.25
Trace mineral premix	0.1	0.1	0.1	0.1
Vitamin premix	0.075	0.075	0.075	0.075
Selenium premix	0.06	0.06	0.06	0.06
Choline chloride	0.021	0.035	0.026	0.014
Copper sulfate	0.013	0.013	0.013	0.013
Avatek	0.05	0.05	0.05	0.05
BMD-50	0.05	0.05	0.05	0.05
L-lysine HCL	0.187	0.019	0.02	
DL methionine	0.326	0.101	0.112	0.128
Calculated analysis				
Crude protein	24.5	22.4085	23.3368	24.4836
ME (kcal/kg)	3140.104	3186.983	3173.943	3159.227
Calcium	1.2767	1	1	1
Phosphorous, available	0.6	0.4485	0.4495	0.4509
Lysine	1.48	1.1	1.16	1.2174
Sulphur amino acids	1.05	0.67	0.7	0.74
Threonine	0.8715	0.6707	0.6999	0.7365
Valine	1.1967	0.86	0.9	0.95
Arginine	1.679	1.4025	1.4701	1.5545
Histidine	0.6289	0.5016	0.5243	0.5526
Isoleucine	0.9793	0.7453	0.7846	0.8338
Leucine	1.9314	1.6118	1.6649	1.7316
Aromatic amino acids	1.8522	1.5439	1.6159	1.7059
Tryptophan	0.2329	0.1902	0.2014	0.2153
Cost/ton	$182.13	$166.57	$170.05	$173.96

Table 5: Diets 9-12 weeks of age (as percentage unless otherwise noted)

		9-12 wks of age		
Ingredients	Industry Std	Ideal	Ideal + 5%	Ideal + 10%
Corn	57.092	64.166	61.551	58.941
Soybean meal	28.488	23.759	26.164	28.571
Pork meal	7	6.91	6.83	6.75
Lard	5.46	4.32	4.61	4.89
Dicalcium phosphate	0.697			
Sodium bicarbonate	0.2	0.2	0.2	0.2
Limestone	0.062			
Salt (iodized)	0.2	0.2	0.2	0.2

Table 5 Contd.

		9-12 wks of age		
Ingredients	Industry Std	Ideal	Ideal + 5%	Ideal + 10%
Trace mineral premix	0.1	0.1	0.1	0.1
Vitamin premix	0.075	0.075	0.075	0.075
Selenium premix	0.06	0.06	0.06	0.06
Choline chloride	0.0054	0.022	0.013	0.0038
Copper sulfate	0.013	0.013	0.013	0.013
Avatek	0.05	0.05	0.05	0.05
BMD-50	0.05	0.05	0.05	0.05
L-lysine HCL	0.158	0.0019		
DL methionine	0.289	0.072	0.084	0.096
Calculated analysis				
Crude protein	21.75	19.64	20.5587	21.4802
ME (kcal/kg)	3300.043	3299.792	3300.133	3300.011
Calcium	1.04	0.8282	0.8259	0.8236
Phosphorous, available	0.52	0.38	0.38	0.38
Lysine	1.3	0.93	0.988	1.0475
Sulphur amino acids	0.95	0.59	0.62	0.65
Threonine	0.7797	0.5903	0.6194	0.6485
Valine	1.0703	0.75	0.79	0.83
Arginine	1.4795	1.2108	1.2785	1.3463
Histidine	0.5688	0.4429	0.4655	0.4881
Isoleucine	0.8817	0.6463	0.6859	0.7256
Leucine	1.7644	1.4664	1.518	1.5697
Aromatic amino acids	1.6747	1.3597	1.4316	1.5036
Tryptophan	0.2098	0.1637	0.175	0.1863
Cost/ton	$178.47	$159.52	$163.52	$167.56

Table 6: Diets 12-15 weeks of age (as percentage unless otherwise noted)

		12-15 wks of age		
Ingredients	Industry Std	Ideal	Ideal + 5%	Ideal + 10%
Corn	62.28	69.302	67.567	65.276
Soybean meal	24.03	17.595	19.357	21.704
Pork meal	6	6.899	6.857	6.799
Lard	5.71	5.5	5.5	5.5
Dicalcium phosphate	0.727			
Sodium bicarbonate	0.2	0.15	0.15	0.15
Limestone	0.136			
Salt (iodized)	0.15	0.2	0.2	0.2
Trace mineral premix	0.1	0.1	0.1	0.1
Vitamin premix	0.075	0.075	0.075	0.075
Selenium premix	0.03	0.03	0.03	0.03
Choline chloride				
Copper sulfate	0.013	0.013	0.013	0.013
Avatek	0.05	0.05	0.05	0.05
BMD-50	0.05	0.05	0.05	0.05
L-lysine HCL	0.155			
DL methionine	0.295	0.036	0.052	0.053
Calculated analysis				
Crude protein	19.5003	17.0466	17.7496	18.6674
ME (kcal/kg)	3349.793	3395.102	3385.083	3371.688
Calcium	0.95	0.8	0.8	0.8
Phosphorous, available	0.48	0.3701	0.3709	0.3719
Lysine	1.15	0.7684	0.8127	0.8717
Sulphur amino acids	0.9	0.5	0.53	0.55
Threonine	0.6959	0.5096	0.5315	0.5607
Valine	0.9572	0.64	0.67	0.71
Arginine	1.3065	1.0252	1.0759	1.1435
Histidine	0.5118	0.3806	0.3976	0.4203
Isoleucine	0.7832	0.5394	0.569	0.6083
Leucine	1.6168	1.3155	1.3552	1.4084
Aromatic amino acids	1.4999	1.1623	1.2163	1.2883
Tryptophan	0.1843	0.1337	0.1421	0.1532
Cost/ton	$171.63	$151.81	$154.60	$157.85

Table 7: Diets-15-18 weeks of age (as percentage unless otherwise noted)

		15-18 wks of age		
Ingredients	Industry Std	Ideal	Ideal + 5%	Ideal + 10%
Corn	68.472	74.655	72.932	71.775
Soybean meal	17.33	12.106	13.867	15.041
Pork meal	6	6.062	6.019	5.991
Lard	6.5	6.5	6.5	6.5
Dicalcium phosphate	0.302			
Sodium bicarbonate	0.15	0.15	0.15	0.15
Limestone	0.444			
Salt (iodized)	0.2	0.2	0.2	0.2
Trace mineral premix	0.1	0.1	0.1	0.1
Vitamin premix	0.075	0.075	0.075	0.075
Selenium premix	0.03	0.03	0.03	0.03
Choline chloride				
Copper sulfate	0.013	0.013	0.013	0.013
Avatek	0.05	0.05	0.05	0.05
BMD-50	0.05	0.05	0.05	0.05
L-lysine HCL	0.101			
DL methionine	0.183	0.0085	0.014	0.025
Calculated analysis				
Crude protein	16.6206	14.3739	15.0671	15.5356
ME (kcal/kg)	3430	3484.512	3474.476	3467.8
Calcium	0.95	0.7	0.7	0.7
Phosphorous, available	0.39	0.3288	0.3296	0.3301
Lysine	0.92	0.6101	0.6544	0.6839
Sulphur amino acids	0.72	0.42	0.44	0.46
Threonine	0.5894	0.4291	0.451	0.4656
Valine	0.8146	0.53	0.56	0.58
Arginine	1.0955	0.8362	0.8869	0.9207
Histidine	0.437	0.3203	0.3373	0.3486
Isoleucine	0.6519	0.4367	0.4663	0.486
Leucine	1.4254	1.1683	1.2081	1.2345
Aromatic amino acids	1.2677	0.9721	1.0261	1.0621
Tryptophan	0.1492	0.1055	0.1139	0.1195
Cost/ton	$158.68	$144.46	$147.01	$148.87

Table 8: Body weight gain of turkeys fed industry standard versus ideal protein rations (kgs)

	3 wk wt	6 wk wt	9 wk wt	12 wk wt	15 wk wt	18 wk wt
Industry	0.65a	2.57a	5.21a	9.02a	12.50a	16.06a
Ideal ratio	0.61b	2.48a	5.05a	8.75a	12.18a	15.32b
Ideal + 5%	0.64ab	2.63a	5.26a	9.08a	12.46a	15.83ab
Ideal + 10%	0.65a	2.62a	5.21a	8.85a	12.35a	15.58ab
SE	0.01	0.04	0.06	0.08	0.15	0.15

Table 9: Feed:gain adjusted for mortality of turkeys fed industry standard versus ideal protein rations

Trt	3 wk fg	6 wk fg	9 wk fg	12 wk fg	15 wk fg	18 wk fg
Industry	1.34a	1.66a	1.87a	2.09ab	2.28a	2.43a
Ideal ratio	1.30ab	1.59b	1.74b	2.03a	2.22a	2.43a
Ideal + 5%	1.32a	1.59b	1.79b	2.09ab	2.28a	2.44a
Ideal + 10%	1.27b	1.60b	1.81ab	2.14b	2.30a	2.49a
SE	0.02	0.01	0.02	0.02	0.02	0.03

Table 10: Costs per ton of feed for turkeys fed industry standard versus ideal protein rations

	0-3 wk	3-6 wk	6-9 wk	9-12 wk	12-15 wk	15-18 wk
Industry	196.87	193.59	182.13	178.47	171.63	158.68
Ideal ratio	184.44	175.32	166.57	159.52	151.81	144.46
Ideal + 5%	186.23	179.59	170.05	163.52	154.60	147.01
Ideal + 10%	193.54	183.34	173.96	167.56	157.85	148.87

industry diet while the diets with 5 or 10% AA additions did not differ from the control. Small differences in feed efficiency occurred through different phases of the trial, but there were no differences at the conclusion of the trial. No differences in mortality or parts yield were noted (data not shown).

While data on use of ideal proteins is available for broilers (Emmert and Baker, 1997) and pigs (Wang and Fuller, 1989), no previous data on practical use of an ideal protein in turkeys is available. These data would indicate that the exact requirements were slightly low in the starter period, most likely adequate through the growout period and slightly deficient during the final 15-18 weeks. The addition of a safety factor (5% additional AA) overcame these deficiencies. Cost savings when comparing the ideal + 5% treatment with the industry standard diet were dramatic. Cost savings per ton of feed ranged from $10.64 to $17.03 per ton of feed depending on phase. Cost savings occurred in all phases, but significant cost savings did occur during times of high feed intake. Overall cost savings were approximately 8% and should be stable with increasing feed prices. While further testing of this concept is needed to confirm these results and adjust suggested requirements slightly, these data would indicate that ideal protein based turkey diets can be successfully fed with significant cost savings possible.

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