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308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

Evaluation of Crude Protein Needs for Large White Male Turkeys from 16 to 20 Weeks of Age¹

P. W. Waldroup¹, C.A. Fritts¹, J. H. Kersey¹, E. A. Saleh¹, B. J. Kerr² and M.T. Kidd²

¹Poultry Science Department, University of Arkansas, Fayetteville AR 72701, USA

²Nutri-Quest, Inc., Chesterfield MO 63017, USA

E-mail: Waldroup@uark.edu

Abstract: A study was conducted to determine the minimum crude protein content of finisher diets based on corn and soybean meal supplemented with commercially available amino acids for male Large White turkeys. Diets were formulated to contain a minimum of 105% of NRC (1994) recommended levels of Met, Lys, TSAA, Thr, and Trp for diets fed 16 to 20 wk of age; no other essential amino acids were specified. The crude protein content of the diets ranged from 75 to 100% of the recommended level of 16.5%. When diets were formulated to contain at least the minimum recommended levels of Met, TSAA, Lys, Thr, reducing the crude protein content of the diet to less than 85% resulted in a significant reduction in weight at 20 wk or body weight gain from 16 to 20 wk. Addition of Ile and Val to diets formulated to contain 80 or 85% of the recommended crude protein level had no significant effect on body weight or weight gain, indicating that a deficiency of these amino acids *per se* was not responsible for the reduction in performance on diets with low levels of crude protein. Feed conversion was more variable and was not significantly influenced by dietary crude protein.

Key words: Turkeys, amino acids, crude protein, requirements

Introduction

Providing a nutritionally adequate feed represents the major portion of the cost of growing poultry. Meeting the crude protein and amino acid needs of turkeys makes up a significant portion of the feed costs. Therefore, providing the essential amino acid needs by carefully blending intact protein sources with commercially available amino acids produced by fermentation or chemical synthesis is a potential means of minimizing cost of production.

Much less is known about amino acid needs of turkeys than for other poultry species such as broilers and laying hens. This is especially true after the first few weeks of age. The NRC (1994) recommendation for crude protein during the latter stages of growth (*ca.* 12 to 20 wks of age) are based primarily upon studies by Jensen *et al.* (1965); Summers *et al.* (1968); Potter *et al.* (1981). While these studies were well designed and well conducted, the turkey of today is markedly different in rate of gain, feed conversion and carcass conformation from that used by these authors. Amino acid recommendations by NRC (1994) for the turkey past 3 to 4 wks of age are based almost entirely upon mathematical models (Hurwitz *et al.*, 1983) with little or no confirmation by actual feeding trials.

Methionine and lysine supplements have been available to the poultry industry for many years, and nutritionists and

producers have become accustomed to using these to meet the amino acid needs of the turkey. More recently, threonine and tryptophan have become commercially available. Use of these amino acids results in a reduction in the crude protein content, and a subsequent reduction in the amounts of other essential amino acids that are not available for commercial usage. Thus, information regarding the extent to which crude protein content of diets may be reduced by use of supplemental amino acids is economically important to the turkey industry. In addition, researchers who wish to study amino acid requirements of turkeys during the growing and finishing phases need information regarding the extent to which crude protein may be reduced without impairing performance. Therefore, a study was conducted to determine the extent to which crude protein content of the diet of finishing turkeys may be reduced using commercially available amino acids.

Materials and Methods

Diets were formulated by linear programming² using corn and soybean meal of known crude protein and moisture content as primary sources of crude protein. Amino acid content of these two ingredients was adjusted proportionally to crude protein content based on NRC (1994) published values. The diets were formulated to meet a minimum of 105% of NRC (1994) suggested needs

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Waldroup *et al.*: Crude Protein for Finishing Turkeys

Table 1: Composition (g/kg) of diets for turkeys 16 to 20 weeks of age with varying levels of crude protein with lysine, methionine, threonine, and tryptophan values at least 105% of NRC (1994) recommendations

Ingredients	Crude protein % of NRC recommendation					
	100%	95%	90%	85%	80%	75%
Yellow corn (7.5% CP)	679.12	705.37	732.56	759.42	786.84	815.38
Soybean meal (46.7% CP)	243.76	220.14	195.39	170.93	145.94	119.87
Poultry oil	46.77	42.82	38.66	34.56	30.31	25.85
Dicalcium phosphate	11.54	11.71	11.89	12.07	12.25	12.43
Ground limestone	8.44	8.50	8.56	8.62	8.68	8.75
Iodized salt	4.00	4.00	4.00	4.00	4.00	4.00
Trace mineral mix ¹	1.00	1.00	1.00	1.00	1.00	1.00
Vitamin premix ²	5.00	5.00	5.00	5.00	5.00	5.00
DL-Methionine (98%)	0.29	0.53	0.79	1.04	1.29	1.56
L-Threonine (99%)	0.08	0.45	0.83	1.21	1.60	2.01
L-Lysine HCl (98%)	0.00	0.48	1.32	2.15	2.99	3.88
L-Tryptophan (99%)	0.00	0.00	0.00	0.00	0.10	0.27
Total	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00

¹Provides per kg of diet: Mn (from MnSO₄•H₂O) 100 mg; Zn (from ZnSO₄•7H₂O) 100 mg; Fe (from FeSO₄•7H₂O) 50 mg; Cu (from CuSO₄•5H₂O) 10 mg; I from Ca(IO₃)₂•H₂O, 1 mg.

²Provides per kg of diet: vitamin A (from vitamin A acetate) 16,520 IU; cholecalciferol 7,200 IU; vitamin E (from dl-alpha-tocopheryl acetate) 50 IU; vitamin B₁₂ 0.022 mg; riboflavin 13.75 mg; niacin 105 mg; pantothenic acid 30.25 mg; menadione (from menadione dimethylpyrimidinol) 3.85 mg; folic acid 2.2 mg; choline 1040 mg; thiamin (from thiamin mononitrate) 3.3 mg; pyridoxine (from pyridoxine HCl) 5.5 mg; d-biotin 0.181 mg; ethoxyquin 125 mg; Se 0.275 mg.

for methionine, total sulfur amino acids, lysine, threonine, and tryptophan. No other amino acid minimums were specified. Commercially available amino acids DL-Methionine, L-Lysine HCl, L-Threonine, and L-Tryptophan were made available to provide needs for these amino acids as the crude protein content of the diet was altered.

A series of diets were formulated in which the crude protein content was specified to be exactly 75, 80, 85, 90, 95, or 100% of the NRC (1994) suggested crude protein content of 16.5% for the period of 16 to 20 weeks of age. The diet formulated for 100% CP met all minimum recommendations for essential amino acids specified by NRC. Two additional diets (80 and 85% of recommended CP) were also fortified with additional L-Isoleucine and L-Valine to determine if they might be deficient in these branched-chain amino acids. Diets were fortified with complete vitamin and trace mineral mixes obtained from a commercial producer and were considered to be nutritionally adequate in all respects other than protein and amino acid content. Composition of the diets is shown in Table 1. All mixed feeds were analyzed for crude protein and amino acid content by a commercial lab³ experienced in amino acid analysis. Diets were fed in pelleted form.

Males of a commercial Large White turkey strain⁴ were obtained from a local hatchery. From day-old to 16 wk of

age they had been fed nutritionally adequate diets. At 16 wk of age they were examined to make sure all were in good physical condition and randomly allotted among 96 litter floor pens in a house of commercial design. Ten birds were placed in each pen (5.6 m²). Each pen was equipped with a small range-type feeder and an automatic water fountain. Adjustments in sidewall curtains and automatic fans maintained house temperature at desired levels. Bird care followed recommended guidelines (FASS, 1999). The test diets and tap water were available for ad libitum consumption. Twelve pens were assigned to each dietary treatment in a randomized block design with blocks being quadrants of the house.

Birds were individually weighed at 16 and 20 wk of age and pen feed consumption determined. The birds were observed at least twice daily and the weight of birds that died or that were removed to relieve suffering from leg disorders was recorded and used to adjust feed consumption.

Pen means were used as the experimental unit. Data were analyzed as a one-way ANOVA using the General Linear Models option of SAS (SAS Institute, 1991). Initial pen weight at 16 weeks was used as a covariate for analysis of body weight gain and feed conversion. Significant differences among treatment means were separated using repeated t-tests using the Lsmmeans option of SAS. All statements of statistical significance are based on a probability of (P ≤ 0.05).

³Experiment Station Chemical Laboratories, University of Missouri, Columbia MO 65211.

⁴Nicholas Turkey Breeder Farms, Sonoma CA 95476

Waldroup *et al.*: Crude Protein for Finishing Turkeys

Table 2: Nutrient analysis of diets for turkeys 16 to 20 weeks of age with varying levels of crude protein having lysine, methionine, threonine and tryptophan values at least 105% of NRC (1994) recommendations¹

Nutrient ²	Basis ³	% of NRC (1994) crude protein recommendation							
		100%	95%	90%	85%	80%	75%	85AA ⁴	80AA ⁴
Crude protein	C	16.50	15.68	14.85	14.03	13.20	12.34	14.03	13.20
Crude protein	A	16.58	15.82	14.78	13.96	13.11	12.47	14.08	13.34
Met	C	0.30	0.31	0.32	0.34	0.35	0.36	0.34	0.35
Met	A	0.33	0.35	0.36	0.37	0.37	0.40	0.36	0.39
Cys	A	0.34	0.32	0.31	0.29	0.28	0.25	0.30	0.29
TSAA	C	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
TSAA	A	0.67	0.67	0.67	0.66	0.65	0.65	0.66	0.68
Lys	C	0.87	0.84	0.84	0.84	0.84	0.84	0.84	0.84
Lys	A	0.94	0.90	0.93	0.88	0.89	0.88	0.89	0.93
Trp	C	0.21	0.20	0.18	0.16	0.16	0.16	0.16	0.16
Trp	A	0.22	0.18	0.18	0.16	0.16	0.16	0.16	0.16
Thr	C	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
Thr	A	0.70	0.70	0.71	0.68	0.67	0.66	0.69	0.72
Ile	C	0.68	0.64	0.60	0.55	0.51	0.46	0.65	0.61
Ile	A	0.73	0.67	0.67	0.56	0.52	0.48	0.65	0.63
His	C	0.44	0.42	0.40	0.37	0.34	0.32	0.37	0.34
His	A	0.49	0.45	0.44	0.39	0.37	0.35	0.39	0.39
Val	C	0.77	0.73	0.69	0.64	0.60	0.55	0.74	0.70
Val	A	0.68	0.59	0.64	0.63	0.83	0.77	0.76	0.67
Leu	C	1.50	1.43	1.37	1.30	1.23	1.16	1.30	1.23
Leu	A	1.67	1.56	1.55	1.38	1.33	1.29	1.40	1.37
Arg	C	1.06	0.99	0.91	0.84	0.76	0.68	0.84	0.76
Arg	A	1.18	1.09	1.05	0.90	0.85	0.77	0.92	0.90
Phe	C	0.79	0.74	0.70	0.65	0.60	0.55	0.65	0.60
Phe	A	0.66	0.62	0.71	0.70	0.90	0.84	0.81	0.71
Gly	C	0.68	0.65	0.60	0.56	0.52	0.48	0.56	0.52
Gly	A	0.74	0.68	0.65	0.58	0.54	0.50	0.58	0.58
Ser	C	0.82	0.77	0.72	0.67	0.61	0.56	0.67	0.61
Ser	A	0.84	0.82	0.76	0.67	0.62	0.60	0.71	0.69
Gly+Ser	C	1.50	1.42	1.32	1.23	1.13	1.04	1.23	1.13
Gly+Ser	A	1.58	1.50	1.41	1.25	1.16	1.10	1.29	1.27
Phe+Tyr	C	1.44	1.35	1.26	1.18	1.09	1.00	1.18	1.09
Phe+Tyr	A	1.54	1.41	1.36	1.21	1.12	1.05	1.20	1.19

¹Analyses conducted by Experiment Station Chemical Laboratories, University of Missouri, Columbia MO 65211.

²All diets calculated to contain 3,200 ME kcal/kg (NRC, 1994).

³C = calculated from NRC (1994); A = analyzed value.

⁴Valine and isoleucine added to diets to provide NRC (1994) minimum levels of these amino acids.

Results and Discussion

Crude protein and amino acid content of the mixed feeds were in good agreement with calculated values (Table 2). Therefore the results of this study should be a valid indication of potential performance of turkeys fed the various dietary treatments.

The dietary crude protein content significantly influenced both body weight and actual body weight gain during the test period (Table 3). When diets were formulated to contain at least 105% of the minimum levels of methionine, TSAA, lysine, threonine, and tryptophan recommended by NRC (1994), reducing the crude protein

content of the diet to less than 85% resulted in a significant reduction in weight at 20 wk or body weight gain from 16 to 20 wk. Addition of isoleucine and valine supplements to diets formulated to contain 80 or 85% of the crude protein level suggested by NRC (1994) had no significant effect on body weight or weight gain, indicating that a deficiency of these amino acids *per se* was not responsible for the reduction in performance on diets with low levels of crude protein. Feed conversion during the test period of 16 to 20 weeks was more variable and was not significantly influenced by dietary crude protein level (Table 3).

Waldroup *et al.*: Crude Protein for Finishing Turkeys

Table 3: Effects of diets containing different levels of crude protein with lysine, methionine, threonine, and tryptophan at least 105% of NRC (1994) recommendations on performance of male Large White turkeys from 16 to 20 weeks of age¹

Crude protein % of NRC (1994)	20 wk BW(kg)	16-20 wk BW gain (kg) ²	16-20 wk Feed:Gain (kg/kg)
100	15.42 ^a	4.02 ^a	4.958
95	15.12 ^a	3.72 ^{abc}	4.526
90	15.18 ^{ab}	3.78 ^{ab}	4.444
85	15.10 ^{abc}	3.70 ^{abc}	4.204
80	14.68 ^c	3.28 ^c	5.174
75	14.77 ^{bc}	3.37 ^{bc}	4.941
85 + AA ²	14.93 ^{bc}	3.53 ^{bc}	5.411
80 + AA ²	14.96 ^{abc}	3.67 ^{abc}	4.669
Pooled SEM	0.162	0.165	0.357

¹Means of twelve pens of ten Large White males per treatment. ²Valine and isoleucine added to diets to provide NRC (1994) minimum levels of these amino acids.

^{abc}Means in row with common superscript do not differ significantly (P < 0.05).

Results of this study are in agreement with recent work from our laboratory (Kidd *et al.*, 1997; Waldroup *et al.*, 1997a,b). Kidd *et al.* (1997) reported that decreasing the CP of diets of male turkeys fed from 0 to 18 wk to 84% of NRC (1994) recommendations resulted in a significant reduction in 18 wk BW; however, addition of 0.1% Thr improved performance similar to that of birds fed diets with 92 or 100% of NRC recommended CP levels. Reducing dietary CP from 100 to 84% had no adverse effects on feed conversion. Waldroup *et al.* (1997a) fed diets formulated to contain from 85 to 120% of NRC (1994) suggested amino acid requirements with no minimum protein level from 0 to 20 wk of age to male turkeys and reported that a minimum of 105% of the recommended amino acid levels, in the absence of a minimum CP level, was necessary for optimum performance. This study was conducted under environmental temperatures that frequently exceeded 27 °C, which may have contributed to the higher need for essential amino acids. In a further study conducted under more temperate climates, Waldroup *et al.* (1997b) reported that the amino acid levels suggested by NRC (1994) are adequate to support maximum performance when diets are changed at 4-wk intervals, but may need to be increased when diets are changed at 3-wk intervals. Because the diet formulated to contain 85% of the NRC (1994) in the present study supported good performance and contained a fairly large amount of supplemental methionine, lysine, and threonine, it should serve as a good test vehicle for persons who wish to study the requirements of turkeys for these amino acids during the period of 16 to 20 wks of age. A similar minimum crude protein is suggested for future studies at earlier stages of the growing-finishing period where little knowledge of protein and amino acid needs presently exists.

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