ISSN 1682-8356
ansinet.org/ijps

INTERNATIONAL JOURNAL OF

POULTRY SCIENCE

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International Journal of Poultry Science 1 (4): 59-62, 2002

Evaluation of Amino Acid Needs of Large White Male Turkeys on an Age-Adjusted Basis[1]

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Abstract: The increased growth rate of Large White turkeys has prompted producers to change feeds at more frequent intervals than previously. However, nutrient recommendations by established agencies such as the National Research Council (1994) have not adjusted to this change. Using regression analysis of published amino acid recommendations, modified amino acid recommendations were calculated for feeding on three week intervals. Male Large White turkeys were fed diets formulated to provide from 90 to 115% of the modified recommendations from day-old to 18 weeks of age; samples of the birds were processed to determine carcass characteristics. Based upon the results of the present study, the amino acid recommendations derived from regression analysis of NRC recommendations appear to be a good basis for use when changing diets at intervals of 3 week for male Large White turkeys. To insure maximum breast meat yield, these should be increased by approximately 5%.

Key Words: Turkeys, amino acids, feed change intervals, carcass

Introduction

Amino acid requirements suggested by NRC for Large White are based upon age-defined feeding periods. Until 1971, recommendations were given only for crude protein, based on 8-week feeding intervals with amino acid recommendations given only for "starting poults". Beginning in 1971 (NRC, 1971), nutrient recommendations were based on 4-week feeding intervals; these age periods were continued through the latest edition (NRC, 1994). During this time, the growth rate of the turkey has changed markedly, with birds being grown to heavier weights and marketed at an earlier age. As a result, the commercial turkey industry has been faced with the problem of adapting nutrient recommendations based on chronological age to the changing "physiological age" of the bird.

The significant influence of feed change intervals on many of the factors related to turkey production and processing is of great economic importance and is also important in comparing results from various studies related to amino acid requirements. In several research studies evaluating NRC recommendations (Moran *et al*., 1995; Waibel *et al*., 1995) diets were changed at 3-week intervals. In both studies the authors indicated that the recommendations were extrapolated or adjusted for the different time interval but gave no information relating to how this adjustment was carried out. Waldroup *et al*. (1997) reported that higher amino acid levels were required to maximize live performance and breast meat yield when diets were changed at 3-week versus 4-week intervals, using the 4-week NRC (1994) nutrient recommendations but changing at earlier ages for the 3-week feeding periods. Nixey (1983) recommended reducing the number of diets fed and increasing the time interval of feeding each diet to improve turkey productivity. The present study was conducted to determine if a linear adjustment in nutrient recommendations based on NRC (1994) 4-week intervals would improve the performance of turkeys fed on 3-week feeding intervals.

Materials and Methods

Day-old male poults of a commercial Large White strain[2] were obtained from a local hatchery and randomly assigned to pens in a commercial-type steel truss house with new softwood shavings over concrete floors. Fifteen poults were placed in each of 96 pens (56 ft^2). Each pen was equipped with two tube feeders and one automatic water fount. At 9 weeks the tube feeders were replaced with a small range-type feeder. Supplemental feeder flats and water founts were used during the first 7 d. Whole-house brooding was used with initial temperature at 90 °F with a 5 °F decline weekly to a minimum temperature of 70 °F. Incandescent lights provided for 23 hr illumination.

The nutrient recommendations suggested by the NRC (1994) were subjected to regression analysis to fit the equation Y = a + bX where Y equals the requirement for a particular nutrient and X equals the age of the bird on the middle day of the feeding period. The equations generated for the various nutrients are given in Table 1. Using these equations, one can then calculate the estimated nutrient requirements for any given feeding period.

Table 1: Age-adjusted nutrient requirements of turkeys as determined by regression analysis of NRC (1994) requirements

Nutrient[1]	Equation[2]
Metabolizable energy (kcal/kg)	Y = 2750 + 3.5714 X
Crude protein	Y = 29.62 – 0.1037 X
Calcium	Y = 1.2105 – 0.00449 X
Nonphytate phosphorus	Y = 0.6035 – 0.00222 X
Valine	Y = 1.2519 – 0.00439 X
Lysine	Y = 1.7545 – 0.007295 X
Arginine	Y = 1.6712 – 0.007295 X
Methionine	Y = 0.5724 – 0.002448 X
TSAA	Y = 1.1145 – 0.004438 X
Threonine	Y = 1.0752 – 0.003673 X
Tryptophan	Y = 0.2739 – 0.000959 X
Gly + Ser	Y = 1.05 – 0.003571 X
Histidine	Y = 0.6074 – 0.00281 X
Isoleucine	Y = 1.1659 – 0.00505 X
Leucine	Y = 2.0524 – 0.008163 X
Phenylalanine	Y = 1.05 – 0.003571 X
Phe + Tyr	Y = 1.842 – 0.007448 X

[1]As percent of the diet unless indicated otherwise.
[2]Where Y = the selected nutrient and X = age in days at midrange of feeding period.

[1]Published with approval of the Director, Arkansas Agricultural Experiment Station

Table 2: Nutrient requirement of Large White turkeys adjusted to a three-week feeding period by regression analysis of NRC (1994) recommendations

Nutrient[1]	Feeding period (day of age)						
	0-21	21-42	42-63	63-84	84-105	105-126	126-147
ME (kcal/kg)	2787.50	2862.50	2937.50	3012.50	3087.50	3162.50	3237.50
Crude protein	28.53	26.36	24.18	22.00	19.83	17.65	15.48
Calcium	1.16	1.07	0.97	0.88	0.79	0.69	0.60
Nonphytate P	0.58	0.53	0.49	0.44	0.39	0.35	0.30
Valine	1.21	1.11	1.02	0.93	0.84	0.74	0.65
Lysine	1.68	1.52	1.37	1.22	1.07	0.91	0.76
Arginine	1.59	1.44	1.29	1.14	0.98	0.83	0.68
Methionine	0.55	0.50	0.44	0.39	0.34	0.29	0.24
TSAA	1.07	0.97	0.88	0.79	0.70	0.60	0.51
Threonine	1.04	0.96	0.88	0.80	0.73	0.65	0.57
Tryptophan	0.26	0.24	0.22	0.20	0.18	0.16	0.14
Gly + Ser	1.01	0.94	0.86	0.79	0.71	0.64	0.56
Histidine	0.58	0.52	0.46	0.40	0.34	0.28	0.22
Isoleucine	1.11	1.01	0.90	0.79	0.69	0.58	0.48
Leucine	1.97	1.80	1.62	1.45	1.28	1.11	0.94
Phenylalanine	1.01	0.94	0.86	0.79	0.71	0.64	0.56
Phe + Tyr	1.76	1.61	1.45	1.29	1.14	0.98	0.83

[1]Expressed as percentage of diet unless indicated otherwise.

Table 3: Ingredient composition (g/kg) and nutrient composition of diets formulated to meet 90 or 115% of estimated nutrient requirements for Large White turkeys adjusted to a three-week feeding period by regression analysis of NRC (1994) amino acid recommendations

Ingredient	0-21 d		21-42 d		42-63 d		63-84 d		84-105 d		105-126 d	
	90%	115%	90%	115%	90%	115%	90%	115%	90%	115%	90%	115%
Yellow corn	530.58	324.02	576.78	387.98	601.31	429.40	643.53	486.40	691.62	551.83	737.67	618.60
Soybean meal (48%)	414.35	590.81	363.65	524.99	336.58	483.65	293.20	427.76	244.81	364.64	200.02	301.98
Poultry oil	0.16	31.18	5.83	34.20	14.04	39.96	19.22	42.94	23.52	44.65	27.56	45.54
Dicalcium phosphate	25.25	24.05	22.95	21.85	20.47	19.46	18.10	17.18	15.76	14.94	13.39	12.69
Ground limestone	14.10	13.64	15.70	15.27	14.63	14.24	13.61	13.25	12.60	12.28	10.28	10.01
Iodized salt	4.51	4.53	4.52	4.53	4.53	4.54	4.54	4.55	4.55	4.56	4.56	4.57
Vitamin premix[1]	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Trace mineral mix[2]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Lysine HCl (98%)	2.48	2.11	2.33	1.94	1.26	0.75	1.01	0.43	0.75	0.12	0.52	0.00
DL Methionine (98%)	2.20	3.27	1.81	2.77	1.18	2.00	0.79	1.49	0.39	0.98	0.00	0.53
L Threonine	0.37	0.39	0.43	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Nutrient composition[3]												
ME (kcal/kg)	2787.50	2787.50	2862.50	2862.50	2937.50	2937.50	3012.50	3012.50	3087.50	3087.50	3162.50	3162.50
Crude protein (%)	23.83	30.17	21.88	27.67	20.98	26.38	19.28	24.20	17.52	21.96	15.77	19.54
Met (%)	0.58	0.76	0.52	0.68	0.45	0.59	0.39	0.52	0.33	0.44	0.27	0.37
Lys (%)	1.51	1.93	1.37	1.75	1.23	1.58	1.10	1.40	0.96	1.23	0.82	1.05
TSAA (%)	0.96	1.23	0.87	1.12	0.79	1.01	0.71	0.91	0.63	0.80	0.54	0.69
Thr (%)	0.94	1.20	0.86	1.10	0.79	1.01	0.73	0.93	0.66	0.84	0.59	0.75

[1]Provides per kg of diet: vitamin A, 9900 IU; cholecalciferol, 3300 IU; vitamin E, 13 IU; vitamin B_{12}, 0.013 mg; riboflavin, 6.6 mg; niacin, 66 mg; d-pantothenic acid, 16.5 mg; choline, 660 mg; menadione, 1.1 mg; folacin, 1.1 mg; thiamin, 1.1 mg; pyridoxine, 3.3 mg; d-biotin, 0.11 mg; Se, 0.2 mg; ethoxyquin, 125 mg. [2]Provides per kg of diet: Mn 100 mg; Zn 100 mg; Fe 50 mg; Cu 10 mg; I 1 mg. [3]Based on analysis of ingredients used in preparing diets.

[2] Nicholas 700, Nicholas Trukey Breeding Farms, Sonoma CA

Table 4: Performance of male Large White turkeys fed diets adjusted to three week feeding intervals by regression analysis of NRC (1994) amino acid recommendations (live data are means of 16 pens of 25 males each; carcass data are means of 16 replicates of two birds each)

Age	Minimum amino acid (% of calculated requirement)						P diff	SEM
(wk)	90	95	100	105	110	115		
				Body weight (g)				
3	505[b]	549[a]	551[a]	545[a]	560[a]	553[a]	0.0015	9
6	1,978[c]	2,084[ab]	2,044[bc]	2,088[ab]	2,148[a]	2,176[a]	0.006	36
9	4,680[bc]	4,765[ab]	4,678[bc]	4,437[c]	5,051[a]	5,035[a]	0.0016	106
12	7,251[c]	7,577[bc]	7,731[ab]	7,568[bc]	8,032[a]	8,070[a]	0.0006	130
18	13,562[c]	13,766[bc]	13,927[abc]	13,854[bc]	14,105[a]	14,431[a]	0.04	188
				Feed conversion (grams feed per gram gain)				
0-3	1.502	1.491	1.460	1.457	1.453	1.460	0.50	0.02
0-6	1.690	1.663	1.688	1.668	1.641	1.632	0.14	0.01
0-9	1.825	1.804	1.789	1.860	1.757	1.778	0.31	0.03
0-12	2.065	2.064	1.994	2.014	1.983	1.991	0.07	0.02
0-18	2.489	2.510	2.535	2.467	2.490	2.464	0.93	0.05
				Cumulative mortality (%)				
0-3	5.83	3.33	0.83	3.33	0.83	0.83	0.31	2.83
0-6	9.17	6.67	3.33	5.00	2.50	3.33	0.33	2.47
0-9	10.00	8.33	3.33	5.00	3.33	4.17	0.34	2.55
0-12	10.83	8.33	3.33	5.83	4.17	5.00	0.41	2.72
0-18	12.50	10.83	4.17	9.17	9.17	6.67	0.31	2.83
				Carcass characteristics[1]				
Hot carcass	75.34	74.82	74.70	76.61	75.97	76.07	0.15	0.58
Chilled carcass	77.82	78.10	77.25	78.94	78.07	78.98	0.42	0.66
Breast	28.28[b]	28.69[b]	28.37[b]	29.32[a]	28.96[ab]	29.76[a]	0.04	0.45
Abdominal fat	1.08[a]	0.95[a]	0.94[a]	0.89[a]	1.02[a]	0.66[b]	0.007	0.07
Drumsticks	13.96[a]	13.76[a]	13.68[a]	12.69[b]	12.12[b]	13.16[b]	0.001	0.17
Thigh	18.35	18.43	18.09	17.87	18.78	17.74	0.16	0.30
Wings	11.34	11.03	11.15	11.12	10.65	10.97	0.05	0.15
Skeletal rack	28.08	28.09	28.71	29.00	28.49	28.37	0.27	0.32

[1]As percent of preslaughter weight. [abc]Means in row with common superscript do not differ significantly ($P \leq 0.05$)

Nutrient requirements were generated for 3-week feeding intervals (Table 2). Using these requirements, diets were formulated in which the minimum amino acid requirements ranged from 90 to 115% of suggested levels. Other nutrients such as calcium, nonphytate phosphorus, and metabolizable energy were maintained at 100% of the estimate. Corn and soybean meal served as intact protein sources, with nutrient composition used in the formulation based upon analysis of ingredients used in the study. Lysine HCl, DL-methionine, and L-threonine supplements were used to attain the minimum amino acid levels with minimum excess crude protein. Composition and calculated nutrient content of sample diets formulated to provide 90 and 115% of the suggested levels are found in Table 3. Crude protein was determined on all diets; amino acid content was determined on diets formulated to provide 90, 100, and 110% of recommended amino acid levels. Analyses indicated that the diets were within expected values. Diets were pelleted with steam, with diets offered during the first 3 week fed as crumbles. Each diet was assigned to 16 pens of poults.

Feeds were changed at 3 week intervals during the study. The poults were individually weighed at 3, 6, 9, 12, and 18 weeks. At the end of each 3 week feeding interval, any

[2] Nicholas 700, Nicholas Trukey Breeding Farms, Sonoma CA

remaining feed was weighed to determine feed consumption. Birds were checked twice daily; any bird that died was weighed with the weight used to adjust feed consumption. Feed conversion ratio (FCR) was calculated as :

$$\frac{\text{(weight of feed consumed)}}{\text{(weight of live birds + weight of dead birds).}}$$

At the conclusion of the study, two birds per pen nearest the pen mean were processed to determine carcass yield. The birds were fasted for 8 hr with access to water prior to slaughter. They were transported one mile to the processing plant where they were killed and bled by an electric knife, scalded at 140 °F, defeathered, manually eviscerated, and chilled overnight in a static ice bath. The following day the carcasses were divided into parts by trained technicians.

Pen means served as the experimental unit for statistical analysis. Data were subjected to a one-way ANOVA using the general linear models procedure of SAS (SAS Institute, 1991). Mortality data were converted to $\sqrt{n+1}$ prior to analysis; means are shown as natural numbers. Where significant differences among means were observed, means were separated using repeated tests using the lsmeans option of SAS. Statements of statistical significance are based on $P \leq 0.05$.

Results and Discussion

Body weight of male Large White turkeys was significantly influenced by dietary amino acid level (Table 4). As the bird grew older, it appeared to be more sensitive to the dietary amino acid level in the diet. For birds up to 9 weeks of age, diets containing 95 to 100% of the amino acid needs estimated from the regression analysis supported body weights that did not differ significantly from that of birds fed higher levels; however at 12 and 18 weeks of age amino acid levels of 100 to 110% of the estimate were required to support maximum gains. This is in agreement with the report of Waldroup *et al.* (1997) who reported that when birds were fed at three week feed change intervals the amino acid needs were greater than when fed the same diets at 4 week intervals.

Feed conversion was not significantly affected by dietary amino acid level of the diet (Table 4), although there was a trend toward improved feed conversion as the dietary amino acid levels increased. Dietary amino acid levels also did not significantly affect mortality, but again there was a trend to reduced mortality as amino acid levels improved especially at the lower levels of amino acids.

Carcass composition was significantly influenced by dietary amino acid levels (Table 4). No significant differences in dressing percentage, either on hot or chilled carcass basis. Breast meat yield improved as dietary amino acids increased, with approximately 105% of the amino acid estimate supporting maximum yield. Abdominal fat content was inversely related to dietary amino acid level, decreasing as the dietary amino acid and crude protein content increased. Percentage of drumsticks was inversely proportional to that of breast meat, as would be expected since parts were calculated as percentage of the carcass. The impact of feed change intervals on many of the production factors related to turkey production is of great economic importance. Waibel (1976) suggested that more frequent diet changes were more efficient, supporting the earlier recommendations of Dunkelgod *et al.* (1961). In contrast, Nixey (1983) recommended reducing the number of diets fed and increasing the time interval of feeding each diet to improve turkey productivity. Salmon *et al.* (1982) reported that frequency of changes in dietary protein concentration had little influence upon growth rate in turkeys receiving adequate dietary protein; however a lower protein level was sufficient to maintain maximum growth rate when diets were changes less frequently.

Based upon the results of the present study, the amino acid recommendations derived from regression analysis of NRC (1994) recommendations, presented in Table 2, appear to be a good basis for use when changing diets at intervals of 3 week for male Large White turkeys. To insure maximum breast meat yield, these should be increased by approximately 5%, in agreement with the data of Waldroup *et al.* (1997).

References

Dunkelgod, K. E., E. W. Gleaves, L. V. Tonkinson, R. H. Thayer, R. T. Sirny and R. D. Morrison, 1961. Practical nutrient intake standards and feed formulas for growing market turkeys. Oklahoma State University Processed Series P:391, Stillwater, OK.

Moran, E. T., K. K. Krueger and H. L. Stilborn, 1995. Performance of turkeys at 110 vs. 115% of NRC (1994) recommendations. J. Appl. Poult. Res., 4: 138-147.

Nixey, C., 1983. The amino acid requirements of turkeys reassessed. Pages 82-108 in: Proceedings California Nutrition Conference, Fresno CA.

NRC., 1971. Nutrient Requirements of Poultry. 6th rev. ed. National Academy Press, Washington, DC.

NRC., 1994. Nutrient Requirements of Poultry. 9th rev. ed. National Academy Press, Washington, DC.

Salmon, R. E., K. E. Dunkelgod and B. J. Wilson, 1982. Influence of dietary protein concentration and frequency of diet changes on rate of growth, efficiency of food utilization and carcass quality of Large White turkeys. Br. Poult. Sci., 23: 501-517.

SAS Institute, 1991. SAS® User's Guide: Statistics. Version 6.03 edition. SAS Institute, Inc., Cary, NC.

Waibel, P. E., 1976. Turkey nutrition and flexible feed formulation. Feed stuffs 48: 33-35.

Waibel, P. E., C. W. Carlson, J. K. Liu, J. A. Brannon and S. L. Noll, 1995. Replacing protein in corn-soybean turkey diets with methionine and lysine. Poult. Sci., 74:1143-1158.

Waldroup, P. W., J.A. England, A. L. Waldroup, and N. B. Anthony, 1997. Response of two strains of Large White male turkeys to amino acid levels when diets are changed at three- or four-week intervals. Poult. Sci., 76: 1543-1555.