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

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Digestible Lysine Requirements of Male Turkeys During the 6 to 12 Week Period

K. Baker, J. D. Firman, E. Blair, J. Brown and D. Moore
University of Missouri – Columbia, 116 Sciences Department, Columbia, MO 6521, USA
E-Mail: FirmanJ@missouri.edu

Abstract: Two floor pen trials were conducted using Nicholas White male turkeys in order to determine the digestible lysine requirements for the 49 to 61 day and the 72 to 83 day feeding periods. Prior to the study, birds were fed a typical corn, soybean meal (SBM) and pork meal based diet. They were then weighed and sorted into 48 floor pens in a curtain-sided building. Dietary treatments included eight levels of digestible lysine ranging from 0.88 to 1.23% in the first trial and 0.68 to 0.96% in the second trial. A high protein positive control treatment was added at the expense of three replicates of the highest lysine level. The lysine deficient basal diet was corn, SBM and pork meal with an intact crude protein level of 18.4% in the first experiment and 15% in the second experiment. The positive control diet was also corn, SBM and pork meal and was formulated on a total AA basis to meet nutrient requirements set by the NRC (1994). Lysine-HCL (98.5%) was used for the titration and glutamic acid was titrated inversely to maintain nitrogen at similar levels. The experiments were set up as a randomized complete block. Splined regression analysis determined the digestible lysine requirement for the 49 to 61 day period to be 1.09% for optimum bodyweight gain and 1.11% for feed conversion. The digestible lysine requirement for the 72 to 83 day period was 0.87 and 0.86% for optimum body weight gain and feed conversion, respectively.

Key words: Turkey, amino acid, lysine, ideal protein

Introduction

In order to assure maximal growth many turkey producers are currently overfeeding protein, or more specifically, amino acids. This overfeeding results in higher feed costs and excess levels of nitrogen being excreted into the litter (Firman *et al*., 1999). To reduce these excesses an ideal protein ratio has been estimated for the turkey (Firman and Boling, 1998). Ideal protein is the perfect balance of AA's needed for growth and maintenance without excesses or deficiencies. These values have been established for the pig (ARC, 1981; Wang and Fuller, 1989; Chung and Baker, 1992), and the chick (Sasse and Baker, 1973; Baker and Han, 1994). Amino acid requirements are expressed as a ratio to lysine so that in the future, only the lysine requirement needs to be determined for new strains of birds or different production parameters. Lysine was chosen as the reference AA for several reasons, it is generally second limiting in poultry rations, there is a relatively large amount of requirement data available and lysine is primarily used for protein accretion (Baker and Han, 1994). Due to lysine's role as the reference AA, the lysine requirement used in the ratio should be defined as precisely as possible.

Currently an ideal profile for turkeys is being constructed at the University of Missouri; unfortunately there are no data available on the digestible lysine requirements of turkeys beyond the starting period (Boling and Firman, 1998). Several researchers have found requirements on a total basis, but these numbers vary greatly. Kratzer *et al*. (1956) determined the lysine requirement for bronze turkeys to be 0.85% during the 8 to 12 week period, while Potter *et al*. (1981) found the requirement to be 1.40% for the same period using large white turkeys. More recently, Noll and Waibel (1987) determined that lysine requirements of 8 to 12 week turkeys ranged from 1.09 to 1.25% in experiments conducted at various environmental temperatures. Lehmann *et al*. (1996) determined the level of lysine needed for optimum growth and feed efficiency to be 1.20% using 8 to 12 week old B.U.T. toms. All of these studies were determining requirements on a total AA basis. Requirements found on a total basis are useful, but pose several problems. In these experiments much of the lysine for which the requirement was being determined was being provided in its pure form which is considered to be 100% percent available (Chung and Baker, 1992). When the new requirement is then used in a typical ration where lysine digestibility is only around 85%, a deficiency could result. Using digestible formulation also allows for more accurate pricing of ingredients and more flexibility in the feed formulation matrix.

This experiment was designed to determine the digestible lysine requirements for optimum growth and feed conversion of tom turkeys during the 6 to 12 week period.

Materials and Methods

The lysine deficient basal diets (Tables 1 and 2) were formulated using determined digestible AA values on least-cost diet formulation software. Protein-containing

Table 1: Composition of basal and nrc based positive control diets for the 49 to 61 day period

Ingredients	Basal diet[3] %	NRC diet[3] %
Corn	66.98	56.87
SBM (48%)	22.37	31.44
Pork Meal	3.00	3.00
Lard	4.40	5.20
Dicalcium phosphate	0.96	0.56
Sodium Bicarbonate	0.60	-----
Limestone	0.45	0.23
Salt (iodized)	0.20	0.30
Trace mineral premix[1]	0.10	0.10
Vitamin premix[2]	0.08	0.08
Selenium premix[2]	0.03	0.03
Choline Chloride	0.04	-----
Coban	0.07	0.07
Copper sulfate	0.01	0.01
DL-methionine	0.14	0.04
Other amino acid	0.56	-----
Calculated Analysis		
Crude protein	18.44	22.00
ME, kcal/kg	3,300	3,300
Calcium	0.81	0.85
Phosporus (available)	0.40	0.42
Lysine[3]	0.88	1.35
Sulphur amino acids	0.71	0.83
Threonine	0.66	0.82
Valine	0.88	1.15
Arginine	1.21	1.54
Histidine	0.45	0.61
Isoleucine	0.81	1.00
Leucine	1.48	1.94
Phenylalanine + Tyrosine	1.38	1.87
Tryptophan	0.20	0.29

[1]Trace mineral premix analysis: Ca 2.50%, Fe 6.0%, Mg 2.68%, Mn 11.0%, Zn 11.0%, I 2000ppm. [2]Vitamin premix provided per kilogram of diet: vitamin A 1500IU, D 200IU, E 10IU, K 2mg, Thiamin 1.8mg, Riboflavin 4.5mg, Pyridoxine 3.5mg, Folic acid .55mg, Niacin 35mg, Pantothenic acid 14mg, Choline 1300mg, Selenium premix analysis: Ca 36.08%, Se.06%. [3]Amino acid levels are expressed on a digestible basis for the experimental diet and on a total basis for the positive control.

Table 2: Composition of basal and nrc based positive control diets for the 72 to 83 day period

Ingredients	Basal diet[3] %	NRC diet[3] %
Corn	74.42	62.23
SBM (48%)	18.82	26.63
Pork Meal	3.00	3.00
Lard	5.20	6.40
Dicalcium phosphate	0.83	0.80
Sodium Bicarbonate	0.30	-----
Limestone	0.43	0.37
Salt (iodized)	0.20	0.25
Trace mineral premix[1]	0.10	0.10
Vitamin premix[2]	0.08	0.08
Selenium premix[2]	0.03	0.03
Choline Chloride	0.07	0.01
Coban	0.05	0.05
Copper sulfate	0.01	0.01
DL-methionine	0.05	0.03
Other amino acids	0.40	-----
Calculated Analysis		
Crude protein	15.11	19.00
ME, kcal/kg	3,400	3,400
Calcium	0.75	0.75
Phosporus (available)	0.37	0.38
Lysine[3]	0.68	1.08
Sulphur amino acids	0.55	0.73
Threonine	0.55	0.71
Valine	0.70	1.00
Arginine	0.94	1.31
Histidine	0.37	0.54
Isoleucine	0.64	0.87
Leucine	1.30	1.74
Phenylalanine + Tyrosine	1.13	1.64
Tryptophan	0.15	0.25

[1]Trace mineral premix analysis: Ca 2.50%, Fe 6.0%, Mg 2.68%, Mn 11.0%, Zn 11.0%, I 2000ppm. [2]Vitamin premix provided per kilogram of diet: vitamin A 1500IU, D 200IU, E 10IU, K 2mg, Thiamin 1.8mg, Riboflavin 4.5mg, Pyridoxine 3.5mg, Folic acid .55mg, Niacin 35mg, Pantothenic acid 14mg, Choline 1300mg, Selenium premix analysis: Ca 36.08%, Se.06%. [3]Amino acid levels are expressed on a digestible basis for the experimental diet and on a total basis for the positive control.

feedstuffs were analyzed for total AA content and digestibility values for the corn, SBM and porkmeal used were obtained using a standard digestibility assay (Firman, 1992). Briefly, cecectomized turkeys are withdrawn from feed for 36 hours. They are then tube fed a known amount of the feedstuff. Excreta are collected 48 hours after the feeding. Excreta are also collected from fasted birds during the same period in order to account for endogenous AA loss. Collected excreta are then weighed, dried, reweighed and ground before AA analysis via high-pressure liquid chromatography at the University of Missouri Agricultural Experiment Station using the AOAC method 15:982.30. Corn, SBM and porkmeal based positive control rations (Tables 1 and 2) were formulated on a total AA basis to contain levels of protein and amino acids recommended by the NRC (1994) for each corresponding period. All diets in each of the experiments were isocaloric based on internally determined values. Levels of lysine tested in the first experiment were 0.88, 0.93, 0.98, 1.03, 1.08, 1.13, 1.18 and 1.23% of the diet on a digestible basis. Levels of lysine tested in the second experiment were 0.68, 0.72, 0.76, 0.80, 0.84, 0.88, 0.92 and 0.96% of the diet on a digestible basis. Lysine and all other EAA levels were based on work done in this lab or estimated from previous experiments when no data were available. Lysine was titrated using lysine-HCL and glutamic acid was inversely titrated to provide similar total nitrogen levels among treatments.

In the first trial, a total of 576 Nicholas White toms were

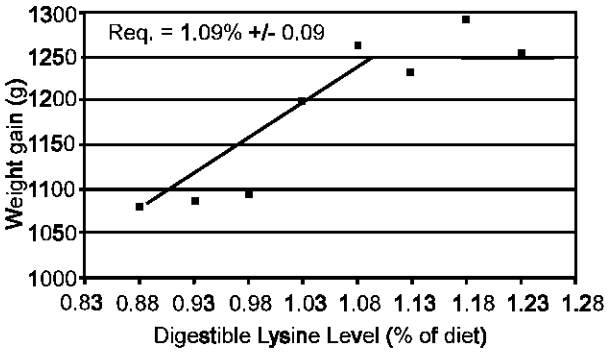

Fig. 1: Breakpoint Requirements Based on Gain of Poults Fed Graded Levels of Lysine from 49 to 61 Days of Age

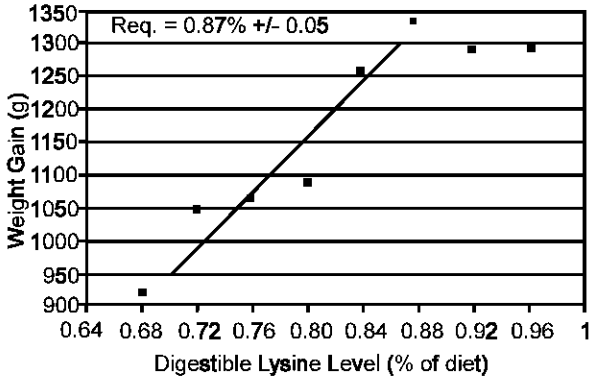

Fig. 2: Breakpoint Requirement Based on Gain of Poults

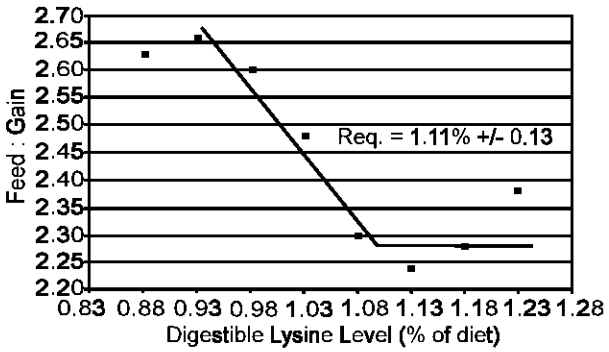

Fig. 3: Breakpoint requirement based on Feed : Gain of poults fed graded levels of lysine form 49 to 61 days of age

weighed and wing banded at forty-nine days of age. For the second trial, 432 Nicholas White toms were weighed and wing banded at seventy-two days of age. In each trial, the birds were computer sorted by weight into forty-eight pens to assure similar starting pen weights and distribution of weights within pens. Each of the experiments were set up as randomized complete blocks with eight treatments being randomized within each of six blocks. Eight levels of lysine were used with six replicate pens for each level. A positive control was included at the expense of three replicates of the highest lysine level. Toms were housed in a curtain sided building with litter floors and the trial period lasted twelve days in the first experiment and eleven days in the second experiment. Lighting was provided for 23 hours each day and the feed and water were provided *ad libitum*.

At the end of each trial period, the birds were weighed and feed disappearance was measured. Mortality was recorded daily and used for feed efficiency adjustment. Treatment effects were analyzed by ANOVA and the lysine requirements were determined for optimum gain with a splined regression model using SAS software (Robbins, 1986). This was considered the superior method for determination of the requirement (Lamberson and Firman, 2002).

Results and discussion

Treatment means for gain and feed conversion can be found in Tables 3 and 4. In the first experiment, birds fed the basal diet with digestible lysine levels of 1.08% and above had bodyweight gains and feed conversion that matched those of the positive control ($P<0.05$). Splined regression analysis of the data determined the digestible lysine requirement for optimum gain and feed conversion to be 1.09 and 1.11% respectively (Fig. 1 and 3).

For the second experiment, treatment means for gain and feed conversion can be found in Table 4. During the experiment, turkeys fed digestible lysine levels of .84% and above had bodyweight gains and feed conversion that were similar to the positive control ($P<0.05$). Splined regression analysis determined the requirements to be 0.87 and 0.86% digestible lysine for bodyweight gain and feed conversion respectfully (Fig. 2 and 4).

It is difficult to compare the digestible requirements determined in these experiments with levels determined by other researchers because there have been no other studies published on digestible lysine for turkeys of this age. For the purpose of comparison we can use the lysine digestibility of a typical corn and SBM diet of approximately 0.85% (Firman, 1992), but we must keep in mind that this number does not account for the synthetic lysine which is often added to experimental diets. To facilitate comparisons we must also assume older data published for the 8 to 12 week period corresponds to the 6 to 9 week period used in this experiment (NRC, 1994). Using the conversion factor of 85%, the requirement for the 8 to 12 week period as indicated by the NRC (1994) of 1.30% becomes approximately 1.11% on a digestible basis. This comparison shows that the NRC's requirement agrees very well with the results of this study. These data would then disagree with the results found by Waldroup *et al.* (1997), who determined toms

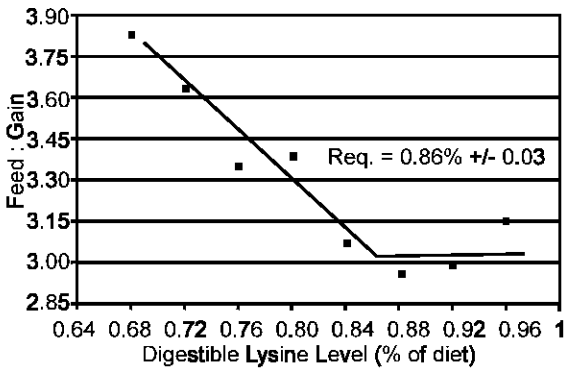

Fig. 4: Breakpoint requirement based on Feed : Gain of poults fed graded levels of lysine from 72 to 83 days of age

Table 3: Performance of tom poults fed graded levels of digestible lysine from 49 to 61 days of age

Digestible Lysine(%)	Weight[2] gain(g)	Feed:Gain[2]
0.88	1081.3c	2.63a
0.93	1088.0c	2.65a
0.98	1097.2c	2.60a
1.03	1200.3b	2.48ab
1.08	1263.2ab	2.30b
1.13	1233.7ab	2.24b
1.18	1292.9a	2.28b
1.23	1254.9ab*	2.38ab*
PC	1248.6ab*	2.38ab*
Significance	P<0.0001	P<0.02
Standard error[1]	32.42	0.10
	45.85*	0.14*

[1]Standard error differs in treatments 1.23 and PC (n=3).
[2]Means with no common letter are significantly different.

Table 4: Performance of tom poults fed graded levels of digestible lysine from 72 to 83 days of age

Digestible Lysine(%)	Weight[2] gain(g)	Feed:Gain[2]
0.68	921.6c	3.83a
0.72	1051.5bc	3.64ab
0.76	1062.4bc	3.35bc
0.80	1089.0b	3.39bc
0.84	1261.6a	3.06c
0.88	1334.5a	2.96c
0.92	1295.3a	2.99c
0.96	1296.6a*	3.15c*
PC	1355.2a*	3.10c*
Significance	P< .0001	P< .001
Standard error[1]	57.47	0.15
	81.27*	0.21*

[1]Standard error differs in treatments .96 and PC (n=3).
[2]Means with no common letter are significantly different.

needed 105% of the NRC's recommended amino acid levels for optimum growth, however, the authors did state that high environmental temperatures may have contributed to the increased AA levels required. Requirements determined by Noll and Waibel (1987) at various temperatures (1.09 to 1.25% lysine) seem to agree with those found in the first experiment, but the lysine digestibility of their diets is not known. The lysine requirement of 1.20% determined by Lehmann (1996) for the 8 to 12 week period also seems to support the results of this experiment, but the complex diets used in Lehmann's study makes the comparison more difficult. To facilitate comparisons in the second experiment, we must assume data published for the 12 to 16 week growth period corresponds to the 9 to 12 week period used in this experiment (NRC, 1994) since growth rates have continued to increase. Using the comparisons mentioned above, the NRC's (1994) requirement for the 12 to 16 week period of 1.0% digestible lysine becomes 0.85% which closely agrees with the results of this experiment. These data would then disagree with the results found by Waldroup *et al.* (1997) who determined toms needed 105% of the NRC's recommended amino acid levels for optimum growth, however, the authors did state that high environmental temperatures may have contributed to the increased AA levels required. The requirement found for the 12 to 16 week period by Jensen *et al.* (1976) of 0.96% is certainly similar to the findings of this experiment, but how closely they agree on a digestible basis is unclear. Potter's (1981) requirement of 1.2% seems too high when compared to this study, but once again the digestibility of their diets is unknown.

For turkey producers, requirements expressed on a percentage basis may not be as useful as a requirement expressed on a grams/day basis. Expressing the bird's requirement in this way allows producers to adjust the lysine percentage in the diet to accommodate for changes in intake that may be caused by stocking density or environmental temperature. By using the intake corresponding to the level of lysine that provided maximal growth, the requirement can be estimated to be 2.61 grams of lysine/day for the 49 to 61 day period and 3.16 grams of lysine/day for the 72 to 83 day period.

The lysine requirements determined in this experiment can now be used as the baseline for the Missouri Ideal Turkey Profile. These numbers have been combined with other results from our laboratory to construct an ideal AA profile on a digestible basis for use in a modeling equation. By switching to digestible AA formulation and using this profile, diet costs and nitrogen excretion can be minimized, especially for those producers who are feeding above NRC recommended levels.

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