International Journal of Poultry Science 3 (6): 373-377, 2004

Digestible Lysine Requirements of Male Turkeys in Their First Six Weeks

Jeffre Firman
University of Missouri-Columbia, 116 Animal Sciences Department, Columbia, Missouri 65211, USA
E-mail: FirmanJ@mizzou.edu

Abstract: Two floor pen trials were conducted using 1200 and 960 Nicholas White toms, respectively, in order to determine the digestible lysine requirements during the first 6 week growth (7 to 18 and the 23 to 37 days) period. Poults were fed a typical corn, soybean meal (SBM) and pork meal based diet until the start of each trial, when they were weighed and sorted into 48 floor pens in a curtain-sided building. Dietary treatments included eight levels of digestible lysine ranging from 1.10 to 1.45% in the first experiment and 1.02 to 1.37% in the second experiment. In each experiment, a positive control 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 a crude protein level of 21.7% for the first period and 20.75% for the second period. The positive control was also corn, SBM and pork meal and was formulated on a total AA basis to meet nutrient requirements set by the NRC. All diets were iso-caloric (3100kcal/kg). Lysine-HCL (98.5%) was used for the titrations and glutamic acid was titrated inversely to keep nitrogen levels similar. The experiments were set up as randomized complete blocks. Birds fed digestible lysine levels of 1.30% and above in the first experiment and 1.19% and above in the second experiment had weight gains that were equal to the positive control (P<. 05). No feed:gain differences were observed between treatments in either experiment. Splined regression analysis determined the requirement for optimum bodyweight gain to be 1.31% digestible lysine for the 7 to 18 day period and 1.19% for the 23 to 37 day period.

Key words: Turkeys, Lysine, digestible lysine requirements

Introduction

It has become common practice to include synthetic amino acids (AA) such as lysine and methionine in rations for young turkeys. Additions of these AAs allow for a reduction in the diet's protein level without a decrease in performance (Baldini and Rosenberg, 1954; Balloun, 1962; Fisher and Dowling, 1956). As more synthetic AAs such as threonine become economically practical ingredients, further reductions in protein are possible. Benefits of reduced protein levels will include reduced feed costs and decreased nitrogen excretion (Firman *et al*., 1999).

As more synthetic AA's are fed, increased focus must be placed on AA balances, availabilities and interactions. The ideal protein concept deals with these issues by establishing a specific requirement for each of the EAA's. Ideal protein is the perfect balance of AAs needed for growth and maintenance without excesses or deficiencies. These values have been established for the pig (Agricultural Research Council, 1981; Wang and Fuller, 1989; Chung and Baker, 1992), and for the chick (Sasse and Baker, 1973; Baker and Han, 1994) and have recently been estimated for the turkey (Firman and Boling, 1998). 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.

Unfortunately, there is little data available on the digestible lysine requirements of starting turkeys (Boling and Firman, 1998). This work utilized hens reared in batteries and provided the estimated requirement of 1.34% used in this study. Other researchers have found requirements on a total basis. Almquist (1952) determined a lysine level of 1.50% was necessary to prevent feather barring and provide optimum growth in bronze turkeys. This requirement is similar to the 1.50% lysine determined by Tuttle and Balloun (Tuttle and Balloun, 1974) using large white turkeys, but is much lower than the 1.68% found by Warnick and Anderson (Warnick and Anderson, 1973).

Digestible AA values are more beneficial than requirements expressed on a total basis because in these experiments most of the AA for which the requirement was being determined was 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 85%, a deficiency could result. Using digestible formulation also allows for more accurate pricing of ingredients and more flexibility in the feed formulation matrix. These experiments were designed to determine the digestible lysine requirement for maximal growth of male turkeys from 7 to 18 and 23 to 37 days of age.

Materials and Methods

The lysine deficient basal diets (Table 1 and 2) were formulated using the determined digestible nutrient values on least-cost diet formulation software. Protein-containing 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 and 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 (Table 1 and 2) were formulated on a total AA basis to contain levels of protein and amino acids recommended by the NRC (National Research Council, 1994) for each period. All diets in the experiment were isocaloric based on internal numbers. Levels of lysine tested in the first experiment were 1.10, 1.15, 1.20, 1.25, 1.30, 1.35, 1.40 and 1.45% on a digestible basis. Levels of digestible lysine in the second experiment were 1.02, 1.07, 1.12, 1.17, 1.22, 1.27, 1.32, and 1.37% of the diet. These levels were based on the work done by Boling and Firman (Boling and Firman, 1998). 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 each trial.

For the first experiment, a total of 1200 Nicholas White toms were weighed and wing banded at seven days of age. For the second experiment, 960 poults were weighed and wing banded. Poults were then computer sorted by weight into forty-eight pens to assure that starting pen weights were similar. The experiment was set up in a randomized complete block design, with eight treatments being randomized within each of six blocks. Eight levels of lysine were used with six replicate pens each and a positive control was included at the expense of three replicates of the highest lysine level. Poults were housed in a curtain sided building with litter floors and the trial period lasted 11 days for the first trial and 14 days for the second trial. Lighting was provided 23 hours per day and the feed and water were provided *ad libitum*.

At the end of the trial period, the poults 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; Lamberson and Firman, 2002).

Table 1: Composition of basal and NRC based positive control diets For the 7 to 18 day period

Ingredients	Basal diet[3] %	NRC diet[3] %
Corn	59.91	42.00
SBM (48%)	28.67	46.45
Pork Meal	5.00	5.00
Lard	2.00	3.80
Dicalcium phosphate	1.53	1.40
Sodium Bicarbonate	0.75	-----
Limestone	0.56	0.52
Salt (iodized)	0.20	0.40
Trace mineral premix[1]	0.10	0.10
Vitamin premix[2]	0.08	0.08
Selenium premix[2]	0.03	0.03
Choline Chloride	0.14	0.07
Coban	0.08	0.08
Copper sulfate	0.01	0.01
DL-methionine	0.21	0.10
Other amino acids	0.74	-----
Calculated Analysis		
Crude protein	21.75	27.97
ME, kcal/kg	3,100	3,100
Calcium	1.20	1.20
Phosphorus (available)	0.60	0.60
Lysine[3]	1.10	1.67
Sulphur amino acids	0.85	1.05
Threonine	0.80	1.05
Valine	1.08	1.47
Arginine	1.48	2.00
Histidine	0.53	0.77
Isoleucine	0.99	1.31
Leucine	1.74	2.36
Phenylalanine +Tyrosine	1.65	2.41
Tryptophan	0.25	0.39

[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.

Results and Discussion

Treatment means for gain, feed intake and feed conversion can be found in Table 3 and 4. In the first

Table 2: Composition of basal and NRC based positive control diets for the 23 to 37 day period

Ingredients	Basal diet[3] %	NRC diet[3] %
Corn	62.12	46.65
SBM (48%)	26.67	41.64
Pork Meal	4.00	5.00
Lard	3.40	4.80
Dicalcium phosphate	1.15	0.90
Sodium Bicarbonate	0.70	-----
Limestone	0.45	0.34
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	0.15	0.05
Coban	0.07	0.07
Copper sulfate	0.01	0.01
DL-methionine	0.18	0.05
Other amino acids	0.65	-----
Calculated Analysis		
Crude protein	20.77	26.00
ME, kcal/kg	3,205	3,203
Calcium	0.96	1.00
Phosphorus (available)	0.49	0.50
Lysine[3]	1.02	1.56
Sulphur amino acids	0.80	0.95
Threonine	0.74	0.97
Valine	1.01	1.37
Arginine	1.38	1.86
Histidine	0.50	0.72
Isoleucine	0.92	1.21
Leucine	1.63	2.22
Phenylalanine + Tyrosine	1.55	2.24
Tryptophan	0.23	0.36

[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.

experiment, poults fed the basal diet with digestible lysine levels of 1.30% and above had bodyweight gains that were similar to those of the positive control. Feed conversion was similar for all treatment groups. Splined regression analysis of the data determined the digestible lysine requirement for optimum gain to be 1.31% (Fig. 1). No requirement could be determined from the feed:gain data.

In the second experiment, poults fed the basal diet with digestible lysine levels of 1.17% and above had bodyweight gains that matched those of the positive control. Feed conversion was similar for all levels of lysine tested with the exception of the highest being significantly better than the lowest level (P<0.05). The feed conversion of the birds fed the positive control diet was significantly worse than all levels of lysine tested. Splined regression analysis of the data determined the digestible lysine requirement for optimum gain to be 1.19% (Fig. 2). No requirement could be determined from the feed:gain data.

The digestible requirement of 1.31% determined for gain during the 7 to 18 day period is very similar to the requirement found by Boling and Firman of 1.34%, using hens (Boling and Firman, 1998). These data support the work done by Potter and Shelton (Potter and Shelton, 1980), which suggested that protein requirements are similar between male and female turkeys until about the

Table 3: Performance of tom poults fed graded levels of digestible lysine from 7 to 18 days of age

Digestible Lysine(%)	Weight[2] gain(g)	Feed[2] intake(g)	Feed: Gain
1.10	233d	404c	1.73
1.15	243cd	411c	1.69
1.20	253bc	423bc	1.68
1.25	254bc	435ab	1.71
1.30	260ab	441ab	1.69
1.35	262ab	445a	1.70
1.40	267a	443a	1.66
1.45	261*ab	438*ab	1.68*
PC	269*a	442*a	1.70*
Significance	P<.0001	0.0004	NS
Standard error[1]	4.50	6.81	0.03
	6.36*	9.64*	0.04*

[1]Standard error differs in treatments 1.45 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 23 to 37 days of age

Digestible Lysine(%)	Weight[2] gain(g)	Feed[2] intake(g)	Feed: Gain[2]
1.02	723b	1185c	1.64b
1.07	706b	1179c	1.67b
1.12	747b	1173c	1.57bc
1.17	781a	1227bc	1.57bc
1.22	792a	1243bc	1.57bc
1.27	795a	1256bc	1.58bc
1.32	798a	1269b	1.59bc
1.37	805a*	1192c*	1.48c*
PC	801a*	1539a*	1.92a*
Significance	P<.0001	0.0004	P<0.002
Standard error[1]	10.05	36.07	0.04
	14.22*	51.01*	0.06*

[1]Standard error differs in treatments 1.37 and PC (n=3).
[2]Means with no common letter are significantly different.

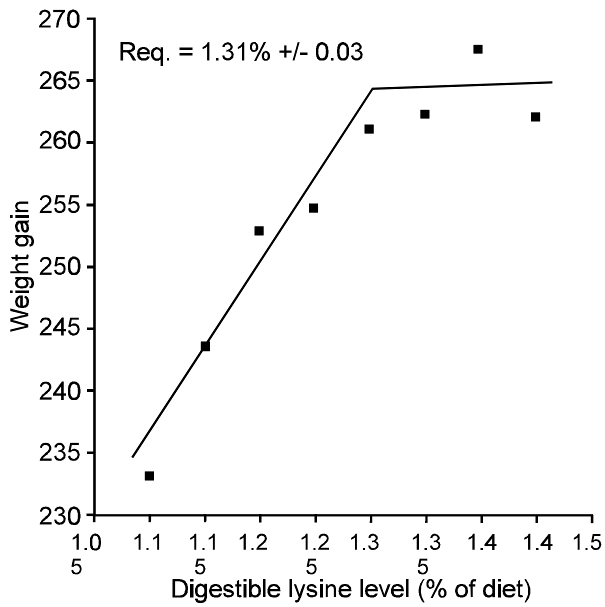

Fig. 1: Breakpoint Requirements Based on Gain of Poults Fed Graded Levels of Lysine from 7 to 18 Days of Age

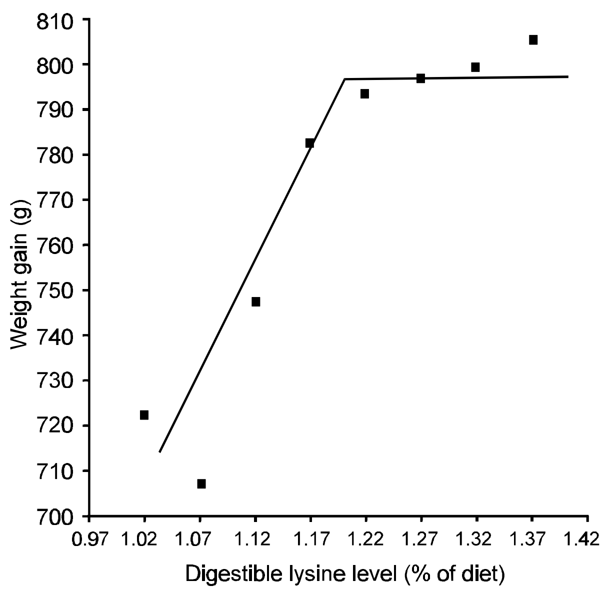

Fig. 2: Breakpoint Requirement Based on Gain of Poults Fed Graded Levels of Lysine from 23 to 37 Days of Age

eighth week. It is difficult to compare the digestible requirement found in this study with levels determined by other researchers because there have been no other studies published on digestible lysine for turkeys. For the purpose of comparison we can use the lysine digestibility of a typical corn and SBM diet of 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. Using this conversion the requirement for the starting period as indicated by the NRC (National Research Council, 1994) of 1.60% becomes approximately 1.36% on a digestible basis. This comparison shows that the NRC's requirement is sufficient and may be slightly high when compared to these data. These data would also suggest a lower requirement than that found by Waldroup and others (Waldroup *et al*., 1997), who determined poults needed 105% of the NRC's recommended amino acid levels for optimum growth. It is even more difficult to compare this experiment with previous work done by Warnick and Anderson (Warnick and Anderson, 1973) because corn and SBM based diets were not used, but the 1.68% total lysine requirement they determined is certainly higher than the 1.31% digestible lysine found in this experiment. The work done by Tuttle and Balloun (Tuttle and Balloun, 1974) using corn and SBM based diets determined the lysine requirement to be 1.50%, which after adjustment to a digestible basis, would be very close to the 1.31% determined in this study.

Using this same conversion for the 23 to 27 day period, the requirement of 1.50% for the 4 to 8 week period as recommended by the NRC (National Research Council, 1994) becomes approximately 1.28% on a digestible basis. This comparison shows that the NRC's requirement is sufficient and may be somewhat high when compared to the requirement of 1.19% determined in this study. The work done by Tuttle and Balloun (Tuttle and Balloun, 1974) using corn and SBM based diets determined the lysine requirement to be 1.40% for the 4-8 week period, which after adjustment to a digestible basis, is very close to the 1.19% determined in this study.

The lack of feed:gain response in both experiments was unexpected. In previous work (Boling and Firman, 1998), feed intake remained relatively constant even in the lysine deficient groups which resulted in a feed:gain response. In these studies feed intake was depressed for the deficient groups, which resulted in similar feed conversion for all treatments.

The lysine requirement determined in these experiments can now be used as the baseline for the Missouri Ideal Turkey Protein. These numbers have been combined with other results from our laboratory to construct an ideal AA profile for starting turkeys. It can be concluded from these experiments that there is room for a small reduction in the dietary lysine level of starting turkey rations, especially for those producers who are feeding above NRC levels.

References

Agricultural Research Council, 1981. The Nutrient Requirements of Pigs. Commonwealth Agricultural Bureaux, Slough, UK.

Almquist, H.J., 1952. Amino acid requirements of chickens and turkeys-a review. Poult. Sci., 31: 966-981.

Baker, D.H. and Y. Han, 1994. Ideal amino acid profile for chick during the first three weeks posthatching. Poult. Sci., 73: 1441-1447.

Baldini, J.T. and H.R. Rosenberg, 1954. Low protein diets for turkey poults. Poult. Sci., 33: 1041-1045.

Balloun, S.L., 1962. Lysine, Arginine and Methionine balance of diets for turkeys to 24 weeks of age. Poult. Sci., 41: 417-424.

Boling, S.D. and J.D. Firman, 1998. Digestible lysine requirement of female turkeys during the starter period. Poult. Sci., 77: 547-551.

Chung, T.K. and D.H. Baker, 1992. Ideal AA pattern for 10-kilogram pig. J. Anim. Sci., 70:3102-3111.

Firman, J.D., 1992. Amino acid digestibilities of soybean meal and meat meal in male and female turkeys of different ages. J. Appl. Poult. Res., 1: 350-354.

Firman, J.D. and S.D. Boling, 1998. Ideal protein in turkeys. Poult. Sci., 77: 105-110.

Firman, J.D., K. Baker and D. Moore, 1999. Precision feeding of turkeys: ideal protein and beyond. Arkansas Nutrition Conference.

Fisher, H. and J. Dowling, 1956. Low protein diets for turkeys raised under practical conditions. Poult. Sci., 35: 239-241.

Lamberson, W.R. and J.D. Firman, 2002. A comparison of quadratic versus segmented regression procedures for estimating nutrient requirements. Poult. Sci., 81: 481-484.

National Research Council, 1994. Nutrient requirements of Poultry. 9th rev. ed. National Academy Press, Washington, DC.

Potter, L.M. and J.R. Shelton, 1980. Methionine and protein requirements of turkeys from 8 to 16 weeks of age. Poult. Sci., 59: 1268-1274.

Robbins, K.R., 1986. A method, SAS program, and example for fitting the broken-line to growth data. The University of Tennessee Agricultural Experiment Station. Research Report 86-09, Knoxville, TN.

Sasse, C.E. and D.H. Baker, 1973. Modification of the Illinois reference standard amino acid mixture. Poult. Sci., 52: 1970-1972.

Tuttle, W.L. and S.L. Balloun, 1974. Lysine requirements of starting and growing turkeys. Poult. Sci., 53: 1698.

Waldroup, P.W., M.H. Adams and A.L. Waldroup, 1997. Evaluation of national research council amino acid recommendations for large white turkeys. Poult. Sci., 76: 711-720.

Wang, T.C. and M.F. Fuller, 1989. The optimum dietary amino acid pattern for growing pigs. 1. Experiments by amino acid deletion. Br. J. Nutr., 62: 77-89.

Warnick, R.E. and J.O. Anderson, 1973. Essential amino acid levels for starting turkey poults. Poult. Sci., 52: 445-452.