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Digestible Lysine Requirements of Male Turkeys During the 12 to 18 Week Period

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Abstract: Two floor pen trials were conducted using turkey toms in order to determine the digestible lysine requirement for the 72 to 83 and 84 to 95 day feeding periods. Prior to the studies, birds were fed a typical corn, soybean meal (SBM) and porkmeal based diet. At the beginning of each trial, birds were weighed and sorted into 48 floor pens in a curtain-sided building. Dietary treatments for the first experiment included eight levels of digestible lysine ranging from 0.54 to 0.75% and from 0.44 to 0.65% in the second experiment. A 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 porkmeal based with intact crude protein levels of 14.3% in the first experiment and 13.2% in the second experiment. The positive control diet was also corn, SBM and pork meal based and was formulated on a total AA basis to meet or exceed nutrient requirements set by the NRC (1994). Lysine-HCL (98.5%) was used for the titration and glutamic acid was titrated inversely to keep nitrogen levels similar. The experiments were set up as randomized complete blocks and the trial periods lasted for eleven days. Segmented regression analysis determined the digestible lysine requirement for the 72 to 83 day period to be 0.68 and 0.67% for growth and feed conversion, respectively. For the 84 to 95 day period, the digestible lysine requirement was determined to be 0.53% for optimum bodyweight gain and 0.54% for feed conversion.

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

Introduction

Lysine is usually considered the second or third limiting AA for turkeys during the starting and early growing periods when typical corn and SBM diets are fed. During the late growing phases and finishing, lysine can become first limiting as more corn and less SBM are used (Balloun, 1962; Carter *et al*., 1962; Hurwitz *et al*., 1983). Due to lysine's importance in these rations and the quantity of feed consumed during the late growth phases, it is crucial to accurately define the lysine requirement for these periods. Defining this requirement would not only reduce nitrogen excretion and diet costs, it also creates the baseline for an ideal protein ratio.

Ideal protein is the exact 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), 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 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 little data available on the digestible lysine requirements of turkeys beyond the starting period (Boling and Firman, 1998). Several researchers have determined requirements on a total basis, but these numbers vary greatly. Kratzer *et al*. (1956) determined the lysine requirement for bronze turkeys to be 0.56% during the 16 to 19 week period, while Jensen *et al*. (1976) found the requirement to be 0.76% for the same period, using large white turkeys. Requirements determined on a total basis are useful, but do pose problems. In these experiments most of the AA for which the requirement was being determined was being provided in a 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 your feed formulation matrix.

These experiments were designed to determine the digestible lysine requirements for optimum growth and feed conversion of tom turkeys during the 12 to 18 week period. Requirements determined will then be used to extend the Missouri Ideal Turkey Profile to include this growth period.

Materials and Methods

The lysine deficient basal diets (Table 1 and 2) were formulated using digestible nutrient values on least-cost

Table 1: Composition of basal and NRC based positive control diets for the 72 to 83 day period

Ingredients	Basal diet[3]%	NRC diet[3]%
Corn	74.94	66.72
SBM (48%)	12.35	21.74
Pork Meal	2.00	2.00
Lard	6.80	7.80
Dicalcium phosphate	0.86	0.73
Sodium Bicarbonate	0.30	-----
Limestone	0.43	0.45
Salt (iodized)	0.25	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	0.03
Avatek	0.05	0.05
Copper sulfate	0.01	0.01
DL-methionine	0.09	0.01
Other amino acids	0.64	-----
Sucrose	1.00	-----
Calculated Analysis		
Crude protein	14.33	16.50
ME, kcal/kg	3,500	3,500
Calcium	0.64	0.65
Phosphorus (available)	0.31	0.32
Lysine[3]	0.54	0.92
Sulphur amino acids	0.55	0.65
Threonine	0.58	0.62
Valine	0.70	0.88
Arginine	0.79	1.12
Histidine	0.33	0.48
Isoleucine	0.55	0.75
Leucine	0.92	1.57
Phenylalanine + Tyrosine	0.79	1.43
Tryptophan	0.18	0.22

[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 0.55mg, Niacin 35mg, Pantothenic acid 14mg, Choline 1300mg, Selenium premix analysis: Ca 36.08%, Se 0.06%. [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 84 to 95 day period

Ingredients	Basal diet[3]%	NRC diet[3]%
Corn	77.80	70.63
SBM (48%)	9.09	18.04
Lard	8.00	9.20
Dicalcium phosphate	0.05	0.97
Sodium Bicarbonate	0.20	-----
Limestone	0.60	0.58
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	0.09	0.05
Avatek	0.05	0.05
Copper sulfate	0.01	0.01
DL-methionine	0.22	-----
Glutamic acid	2.00	-----
Other amino acids	0.49	-----
Calculated Analysis		
Crude protein	13.21	14.00
ME, kcal/kg	3,600	3,600
Calcium	0.53	0.55
Phosphorus (available)	0.30	0.28
Lysine[3]	0.44	0.76
Sulphur amino acids	0.40	0.57
Threonine	0.53	0.52
Valine	0.63	0.76
Arginine	0.66	0.92
Histidine	0.28	0.42
Isoleucine	0.46	0.65
Leucine	0.78	1.40
Phenylalanine + Tyrosine	0.66	1.23
Tryptophan	0.16	0.18

[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 0.55mg, Niacin 35mg, Pantothenic acid 14mg, Choline 1300mg, Selenium premix analysis: Ca 36.08%, Se 0.06%. [3]Amino acid levels are expressed on a digestible basis for the experimental diet and on a total basis for the positive control.

diet formulation software. Digestible values for the corn, SBM and porkmeal used were obtained using a standard digestibility assay (Firman, 1992). Cecectomized turkeys were withdrawn from feed for 36 hours and then fed a known amount of the feedstuff. Excreta were collected for 48 hours post feeding. Excreta were also collected from fasted birds during the same period 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 Laboratory using the AOAC method 15:982.30. A corn, SBM and porkmeal based positive control ration was formulated for each feeding period on a total basis to contain levels of protein and amino acids recommended by the NRC (1994). The experimental and positive control diets were isocaloric. Levels of lysine tested in the first experiment were 0.54, 0.57, 0.60, 0.63, 0.66, 0.69, 0.72 and 0.75% expressed on a digestible basis. Digestible levels of lysine for the second experiment were 0.44, 0.50, 0.53, 0.56, 0.59 and 0.62%. Lysine and all other EAA levels fed 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 experiment, a total of 192 British United Turkey males were weighed and wing-banded at 84 days of

Table 3: Performance of tom poults fed grade d levels of digestible lysine from 72 to 83 days of age

Digestible Lysine(%)	Weight[2] gain(g)	Feed:Gain[2]
0.54	883.3	4.54
0.57	960.4	4.53
0.60	935.4	4.59
0.63	988.9	4.39
0.66	1218.3b	3.40
0.69	1481.2a	3.05
0.72	1397.9a	3.28
0.75	1462.5a*	3.20*
PC	1550.0a*	3.05*
Significance	P< 0.0001	P< 0.001
Standard error[1]	78.99	0.38
	111.7*	0.54*

[1]Standard error differs in treatments 0.75 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 84 to 94 days of age

Digestible Lysine(%)	Weight[2] gain(g)	Feed:Gain[2]
0.44	497.2d	6.43ab
0.47	352.8d	7.92a
0.50	944.4cd	6.04b
0.53	1263.3bc	4.82bc
0.56	1280.6bc	4.27c
0.59	1236.1bc	4.30c
0.62	1408.3ab	3.71c
0.65	1669.4a*	3.53c*
PC	1550.0ab*	3.61c*
Significance	P< 0.0001	P< 0.001
Standard error[1]	120.7	0.56
	170.7*	0.80*

[1]Standard error differs in treatments 0.65 and PC (n=3).
[2]Means with no common letter are significantly different.

age. For the second experiment, 144 84-day-old Nicholas males were used. Birds were computer sorted by weight into forty-eight pens to assure starting pen weights were similar. 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 in the study with six replicate pens for each level. A positive control was included at the expense of three replicates of the highest lysine level. Birds were housed in a curtain sided building with litter floors and the trial period lasted eleven days in both experiments. Lighting was provided 23 hours a day and feed and water were provided *ad libitum*.

At the end of the 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 and feed:gain using the segmented regression analysis model of SAS (Robbins, 1986; Lamberson and Firman, 2002).

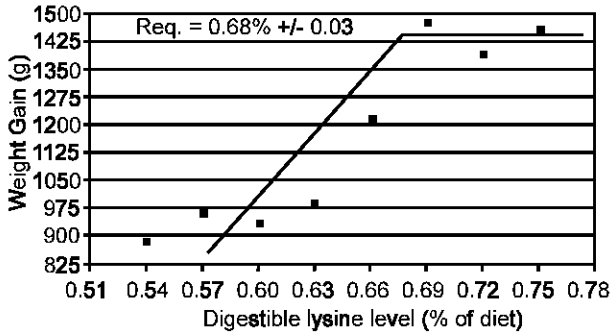

Fig. 1: Breakpoint Requirement Based on Gain of Poults Fed Graded Levels of Lysine from 72 to 83 Days of Age

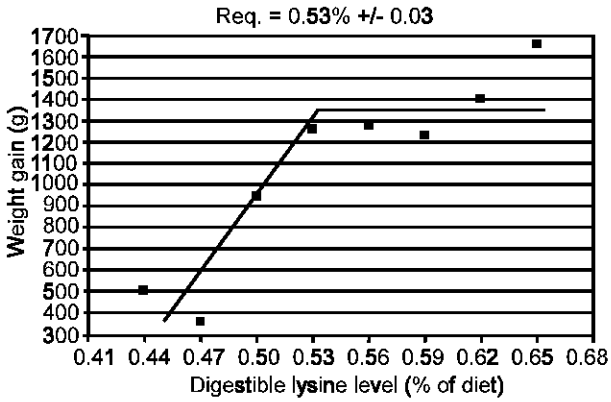

Fig. 2: Breakpoint Requirement Based on Gain of Poults Fed Graded Levels of Lysine from 15 to 18 Weeks of Age

Results and Discussion

Treatment means for gain, feed intake and feed conversion can be found in Table 3 and 4. In the first experiment, birds fed the basal diet with digestible lysine levels of 0.69% and above had weight gains and feed conversion that were similar to the positive control (P> 0.05). Segmented regression analysis determined the digestible lysine requirement for the 72 to 83 day period to be 0.68% for optimum bodyweight gain and 0.67% for feed conversion (Fig. 1 and 3). Confidence intervals (95%) for the requirements determined for gain and feed:gain were plus or minus 0.03 and 0.02, respectively.

For the second experiment, birds fed the basal diet with digestible lysine levels of 0.53% and above had bodyweight gains and feed conversion that matched those of the positive control (P<0.05). Segmented regression analysis of the data determined the digestible lysine requirement for optimum gain and feed conversion to be 0.53 and 0.54% respectively (Fig. 2 and 4). Confidence intervals (95%) for the requirements determined for gain and feed:gain were plus or minus 0.02.

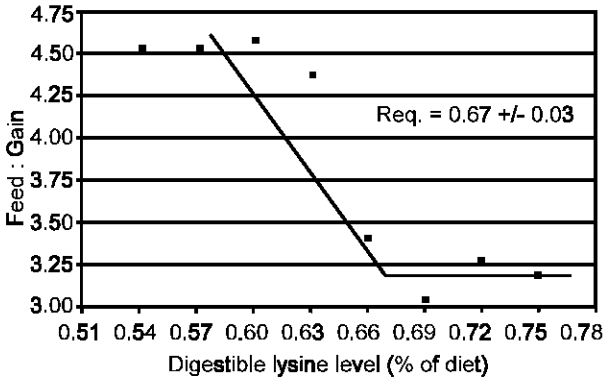

Fig. 3: Breakpoint Requirement Based on Feed:Gain of Poults Fed Graded Levels of Lysine from 12 to 15 Weeks of Age

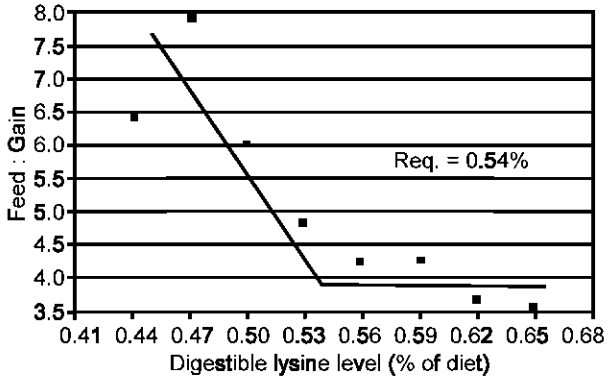

Fig. 4: Breakpoint Requirement Based on Feed:Gain of Poults Fed Graded Levels of Lysine from 15 to 18 Weeks of Age

It is difficult to compare the digestible requirements found in these experiments with levels determined by other researchers because there have been no other studies published on digestible lysine for turkeys of the same age. For the purpose of comparison we can use the lysine digestibility of a typical corn and SBM diet of 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 data published for the 16 to 20 week growth period corresponds to the 12 to 15 week period used in this experiment (NRC, 1994) due to genetic improvements in performance. Using the conversion factor of 85%, the requirement for the 16 to 20 week period as indicated by the NRC (1994) of 0.80% becomes approximately 0.68% 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 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 determined by Jensen *et al.* (1976) of 0.76% seems to agree with this experiment, but the lysine digestibility of their wheat, cottonseed, distillers grain and meat and bone meal diets is not known. Potter *et al.* (1981) found a requirement of 0.90% for 11 to 20 week turkeys, which may also agree with the results of this experiment if one considers the length of the growth period examined.

To 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 in each experiment the requirement can be estimated to be 2.83 grams of lysine/day for both periods.

The lysine requirements determined in this experiment can now be used as the baseline for the Missouri Ideal Turkey Profile. These numbers will be combined with other results from our laboratory to construct an ideal AA profile on a digestible basis for the final feeding period. 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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